Transport Accident Investigation Commission

Final report
Tuhinga whakamutunga

Aviation inquiry AO-2021-001
Kavanagh Balloons E-260, ZK-FBK
Hard landing and ejection of occupants
Wakatipu Basin, near Arrowtown
9 July 2021

May 2023

The Transport Accident Investigation Commission
Te Kōmihana Tirotiro Aituā Waka

No repeat accidents – ever!

"The principal purpose of the Commission shall be to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person."

Transport Accident Investigation Commission Act 1990, s4 Purpose

The Transport Accident Investigation Commission is an independent Crown entity and standing commission of inquiry. We investigate selected maritime, aviation and rail accidents and incidents that occur in New Zealand or involve New Zealand-registered aircraft or vessels.

Our investigations are for the purpose of avoiding similar accidents in the future. We determine and analyse contributing factors, explain circumstances and causes, identify safety issues and make recommendations to improve safety. Our findings cannot be used to pursue criminal, civil or regulatory action.

At the end of every inquiry, we share all relevant knowledge in a final report. We use our information and insight to influence others in the transport sector to improve safety, nationally and internationally.

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Key Commission personnel

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Chief Investigator of Accidents	Naveen Kozhuppakalam
Investigator-in-Charge for this inquiry	Ian McClelland
Commission General Counsel	Cathryn Bridge

Notes about Commission reports
Kōrero tāpiri ki ngā pūrongo o te Kōmihana

Citations and referencing

The citations section of this report lists public documents. Documents unavailable to the public (that is, not discoverable under the Official Information Act 1982) are referenced in footnotes. Information derived from interviews during the Commission's inquiry into the occurrence is used without attribution.

Photographs, diagrams, pictures

The Commission owns the photographs, diagrams and pictures in this report unless otherwise specified.

Verbal probability expressions

For clarity, the Commission uses standardised terminology where possible.

One example of this standardisation is the terminology used to describe the degree of probability (or likelihood) that an event happened or a condition existed in support of a hypothesis. The Commission has adopted this terminology from the Intergovernmental Panel on Climate Change and Australian Transport Safety Bureau models. The Commission chose these models because of their simplicity, usability and international use. The Commission considers these models reflect its functions. These functions include making findings and issuing recommendations based on a wide range of evidence, whether or not that evidence would be admissible in a court of law.

Terminology	Likelihood	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

Figure 1: Kavanagh Balloons E-260, ZK-FBK
(Credit: Sunrise Balloon Adventures)

Figure 2: Location of accident
(Credit: Land Information New Zealand)

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1 Executive summary
Tuhinga whakarāpopoto

What happened

1.1. On Friday 9 July 2021, Kavanagh Balloons E-260 ZK-FBK was being flown on a scenic flight around the Wakatipu Basin. On board were the pilot and 10 passengers. After two attempted landings, the balloon landed fast and hard in a paddock.

1.2. The pilot and two of the passengers were ejected during the landing and sustained serious injuries. The balloon bounced and slid a further 150 metres before coming to rest. The eight passengers who stayed in the balloon basket were either not injured or sustained minor injuries. The balloon sustained minor damage.

Why it happened

1.3. The pilot decided not to land during the first two approaches because they had safety concerns. As the balloon continued towards Kawarau Gorge the wind speed continued to increase. In the final few seconds of flight, as the balloon neared the ground, the wind speed decreased and the balloon basket hit the lip of a gully.

1.4. The two passengers who were ejected were not prepared for the landing. They were not in the correct crouched landing position and were not holding on to the rope handles as required.

1.5. The pilot was standing up and manipulating the balloon's control ropes when the basket struck the lip of the gully. The pilot, like the two ejected passengers, was therefore vulnerable to being thrown from the basket. The pilot was also not wearing the available restraint harness fitted to the pilot's compartment.

What we can learn

1.6. Safety briefings need to ensure that passengers are prepared to handle unusual or emergency situations.

1.7. Pilots should include an appropriate margin of safety when selecting their landing points, and follow checklists to ensure safety-critical items are not missed.

1.8. A pilot should wear a restraint harness during critical phases of flight to reduce the risk of their being ejected from the basket. If the pilot is ejected from the basket, it is **virtually certain** that an accident will occur, potentially resulting in injury to the passengers. The pilot would have no control of the balloon and the passengers would be left unattended.

Who may benefit

1.9. All pilots, operators and passengers may benefit from the findings and lessons in this report.

2 Factual information
Pārongo pono

Narrative

2.1. On Friday 9 July 2021, Kavanagh Balloons E-260 ZK-FBK (the balloon) (see Figure 3), owned and operated by Sunrise Balloon Adventures (the operator), was booked to fly 10 passengers on a scenic flight around the Wakatipu Basin. At 0635 the pilot checked the weather conditions and forecast and made an initial decision to continue with preparations for the flight. The pilot contacted the crew chief, who travelled to the operator's base. Together they discussed the weather conditions and decided the flight was to proceed.

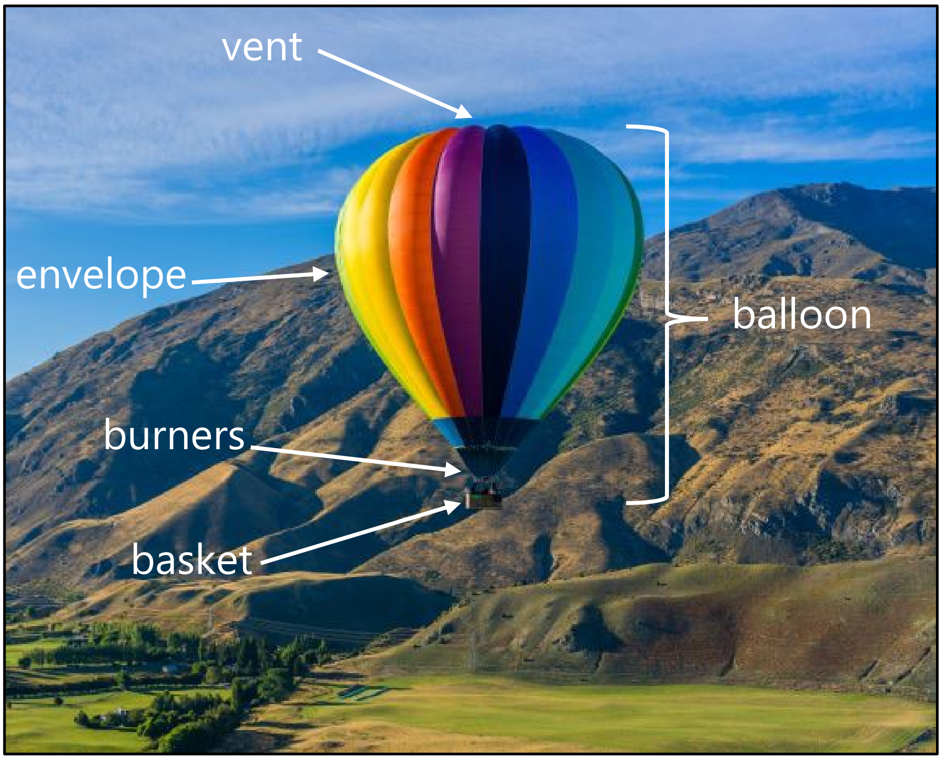

Figure 3: Balloon components
(Credit: Sunrise Balloon Adventures)

2.2. At 0755 the operator's bus started uplifting the passengers from their pick-up points, arriving at the launch site at 0825. The operator had several launch sites available, depending on the wind direction. The site selected that morning was on the western side of the Wakatipu Basin. The pilot and crew chief had arrived at the site first and prepared the balloon for inflation. The passengers, after disembarking the bus, were welcomed, given a briefing on safety around the launch site, weighed and given passenger information forms to complete.

2.3. The passengers were then taken to the basket, which was lying on its side[1], and given a briefing by the pilot on loading, the flight and preparing for the landing. Two of the passengers then assisted the crew with inflating the balloon's envelope.[2]

2.4. Once the basket was upright, the pilot and passengers boarded the basket and the passengers were given safety briefing cards to read and return. Photographs were taken and hot air continued to be added to the envelope during this time. The pilot obtained take-off clearance over a radio from air traffic control, Queenstown control tower, and commenced take-off at 0905.

2.5. The flight proceeded normally, initially climbing to about 6000 feet (1830 metres [m]) above mean sea level, or about 5000 feet (1500 m) above the Wakatipu Basin (see Figure 4). At this stage the pilot took several photographs of the basket occupants using a remotely controlled camera that was suspended away from the basket. The camera control malfunctioned, but the camera continued to record video. The recording included sound.

2.6. At about 0925 the pilot started descending the balloon as they flew towards Arrowtown. The pilot's intention was to use the morning katabatic wind[3] that flowed down the Arrow River on the eastern side of the basin. This would alter the flightpath from an easterly direction to a more southerly direction.

2.7. As the balloon descended, the pilot told the passengers to prepare for landing. The pilot advised them that it could be a tip-over landing.[4] The passengers were instructed to face away from the direction of travel, crouch down and hold on. The ground speed at this stage was recorded as about 8 knots (15 kilometres per hour [km/h]) and reducing as the balloon descended.

2.8. At about 0935 the pilot identified a paddock ahead on which they thought it was suitable to land. At about 30-40 feet (9-15 m) above the intended landing area, two of the passengers voiced their concerns about the health of a third passenger in their compartment. Consequently, the pilot decided to abort the landing and overshoot, so applied heat and climbed away. The sick passenger was attended to during this time.

2.9. The balloon, carried by the katabatic wind, continued flying in a southerly direction towards Arrow Junction. At about 0945 the pilot identified another potential landing site short of the main road between Queenstown and Cromwell. As the balloon descended, it started drifting towards a fence line. The pilot, concerned that they would collide with the fence, decided to abort the landing for a second time. The balloon crossed the main road and flew towards the Kawarau River and Gorge. The groundspeed of the balloon continued to steadily increase during this time.

2.10. At 0950 the video recorded the pilot identifying an open paddock ahead and briefing the passengers for a fast landing, including to 'make sure you hang on good'. A minute later the pilot advised the passengers it was going to be 'a hard landing'.[5] Five seconds

[1] The normal position before inflating the envelope. As the envelope inflates the basket is pulled upright, and loading can commence.

[2] Typically, several passengers help hold the mouth of the envelope open to assist with the blowing in of cold then hot air.

[3] A downslope wind generated when the air cools and becomes increasingly dense. Normally prevalent early in the morning after a cool night.

[4] A landing where the basket does not remain upright, but tips over onto its side.

[5] Sometimes referred to as a heavy landing, when a landing exceeds the manufacturer's limitations, often expressed as a rate of descent or a 'g' loading. This may result in a loss of control and/or aircraft damage and will require an inspection.

before landing the pilot told the passengers to 'hang on team'. The pilot then pulled the rip line[6] to collapse the vent panel at the top of the envelope.[7] The bottom of the basket would have been about 2 m above the level of the intended landing area at this time. The balloon landed at 0952:50, with the basket striking the lip of a gully leading up to the paddock (see Figures 5 and 6).

2.11. When the basket struck the ground, the pilot and two of the passengers were ejected from the basket, sustaining serious injuries.[8] The balloon bounced and slid for about 150 m before breaking through a deer fence and coming to rest with the envelope draped over a power line leading to a farmhouse.

2.12. The support crew, comprising a crew chief and bus driver, arrived at the scene within a few minutes. A third company employee, who was not rostered for work that morning and was driving in the area, saw the balloon crossing the main road at speed. They decided to follow and arrived at the scene at the same time as the support crew. Together they secured the balloon, including turning off the gas bottles and burner pilot lights, and started rendering first aid and support to the passengers and pilot. They were assisted by people from the farmhouse and several nearby workers who rushed to help. Emergency services started arriving on the scene within 15 minutes.

2.13. The pilot, after receiving treatment at Lakes District Hospital in Queenstown, was discharged later the same day. The two passengers, who were ejected from the basket, were transferred by helicopter to Dunedin Hospital for treatment and discharged three days later. Of the eight passengers who remained in the basket, seven sustained minor injuries and one was uninjured.

[6] A red-coloured line attached directly to the top of the envelope. Sometimes described by other balloon manufacturers as the rapid deflation line.

[7] The flight manual stated that the rip line was not to be activated if the basket floor was more than 2 metres above the intended landing point, unless in an emergency.

[8] As described in Annex 13, Aircraft Accident and Incident Investigation, to the Convention on International Civil Aviation.

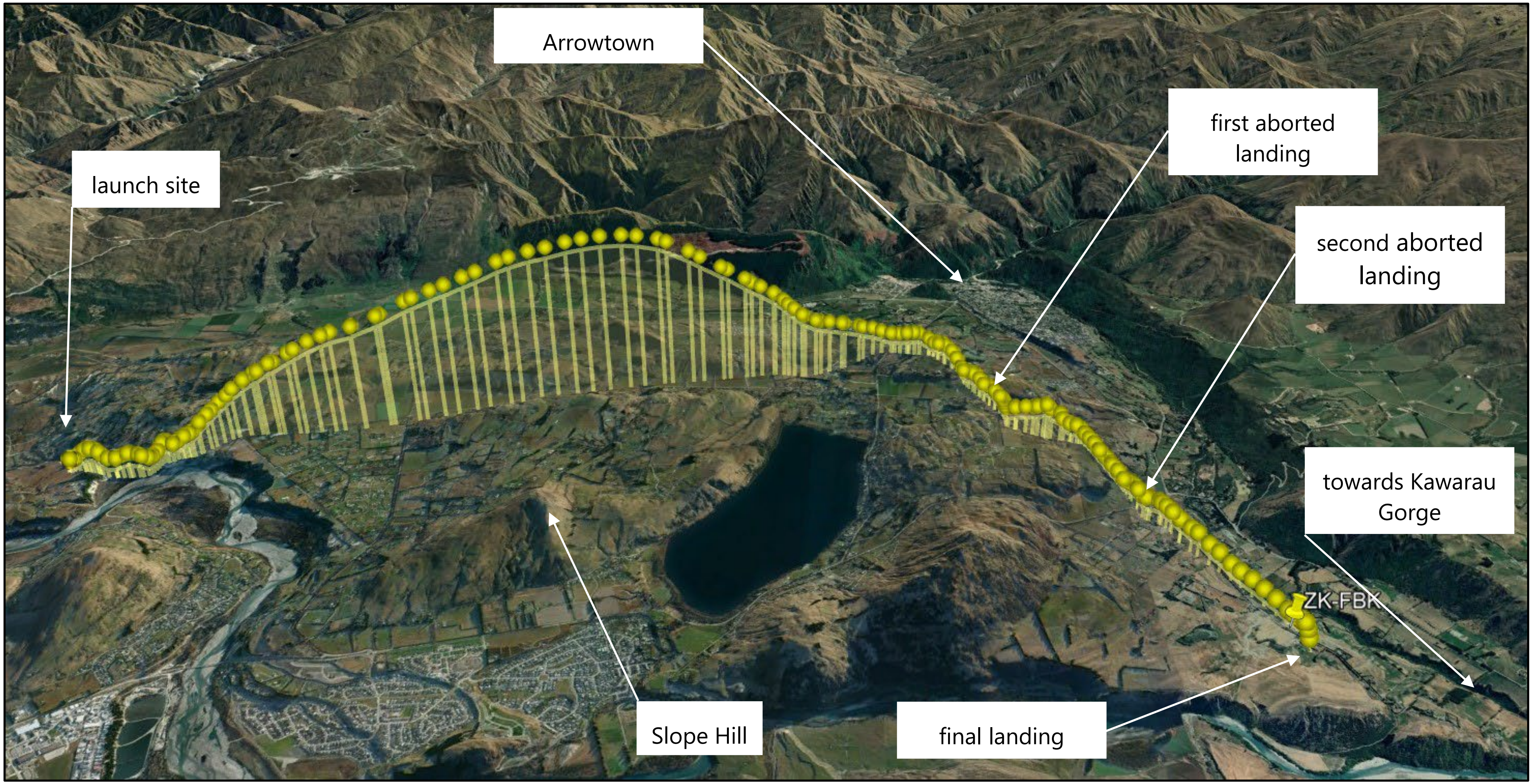

Figure 4: Flightpath of ZK-FBK

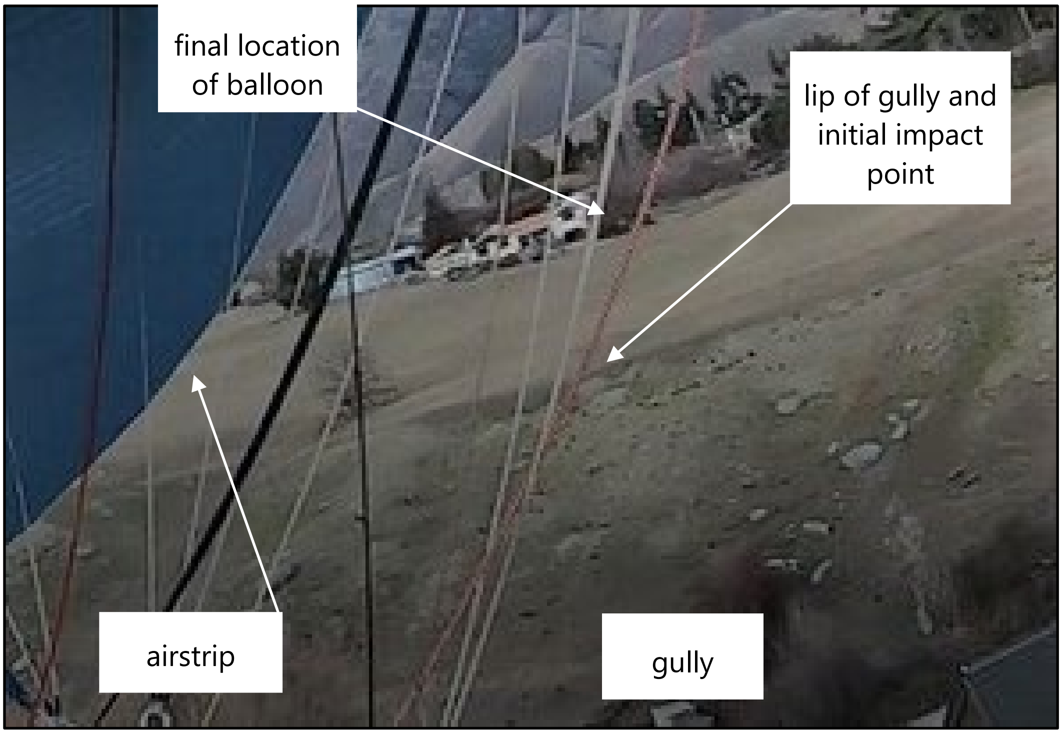

Figure 5: Approaching to land, taken from onboard video camera
(Credit: Sunrise Balloon Adventures)

Figure 6: Impact point

Personnel information

Pilot

2.14. The pilot, aged 46, held a Commercial Pilot Licence (Balloon) and a current 'class 1' medical certificate valid until 10 January 2022. The certificate contained no restrictions.

2.15. The pilot had started flying balloons in July 2009 and had obtained a commercial balloon licence on 10 August 2011. The pilot's next biennial flight review was due on 30 August 2022. At the time of the occurrence the pilot had accrued a total of 1281 hours' flying balloons and a further 11 hours' flying aeroplanes.

2.16. The pilot had last flown on 6 July 2021, six days before the occurrence. The flight had been conducted using ZK-FBK, the occurrence balloon. A review of the pilot's 72-hour history identified nothing of relevance. On the day of the occurrence, the pilot and fellow workers reported nothing of concern about the pilot's health. Post-occurrence drug and alcohol testing was completed in accordance with the operator's procedures. These were negative for any performance-impairing substances.

Passengers

2.17. Two of the passengers lived locally, while the remaining eight had travelled from around New Zealand. For the two passengers who were ejected, English was not their first language. However, in interviews both were able to communicate without difficulty and advised that they had had no problems understanding the ground crew or pilot on the day.

Aircraft information

2.18. ZK-FBK was a Kavanagh Balloons Pty Limited E260 hot air balloon, serial number E260-539.[9] The envelope had been constructed in June 2017 and imported new to New Zealand, where it was fitted to the operator's Lindstrand basket.[10]

2.19. The balloon was powered by three Cameron burners supplied by four gas bottles located in the corners of the pilot's compartment. Fuel flow was either direct bottle to burner or via a cross-feed. The bottles were fitted with a single-action lever for quick shut-off if required. The duration of fuel supply with four full bottles was between two and three hours, depending on load and usage. A typical commercial flight would take about one hour.

2.20. The basket was of a 'double-T' construction, with four passenger compartments and the pilot's compartment in the centre (see Figure 7). According to the flight manual, each passenger compartment was approved to hold four persons. The passenger compartments were fitted with rope handles for passengers to hold on to when landing. The mandatory equipment list contained in the balloon's flight manual included a requirement for 'an approved pilot restraint fitted to the basket'.[11] The basket for ZK-FBK was equipped with a pilot restraint harness, installed at manufacture and still fitted at the time of the occurrence flight.

2.21. The New Zealand Civil Aviation Authority had issued a Certificate of Airworthiness for the balloon in the standard category in November 2017. The certificate was non-

[9] '260' related to the size of the envelope: 260,000 cubic feet (about 7400 cubic metres).
[10] Fitted in accordance with Supplemental Type Certificate SVL502.
[11] This requirement was also contained in the minimum equipment list of the flight manual for Cameron balloons.

terminating provided the balloon was operated and maintained in accordance with the manufacturer's manuals for the balloon. A review of the maintenance documents recorded that the balloon had been maintained as required by the manufacturer, and there were no outstanding defects recorded or reported.

2.22. At the time of the occurrence the balloon's envelope had flown a total of 75.9 hours since manufacture. The next scheduled maintenance was either a 100-hour check due at 156.2 hours[12] or a review of airworthiness due on 30 March 2022, whichever occurred first.

2.23. The maximum approved take-off weight for the balloon was 1940 kilograms. The actual take-off weight on the morning of 9 July 2021 was calculated by the Transport Accident Investigation Commission (Commission) investigators to be 1684 kilograms.

[12] The balloon had typically flown less than 100 hours per year, so the maintenance cycle was based on the review of airworthiness.

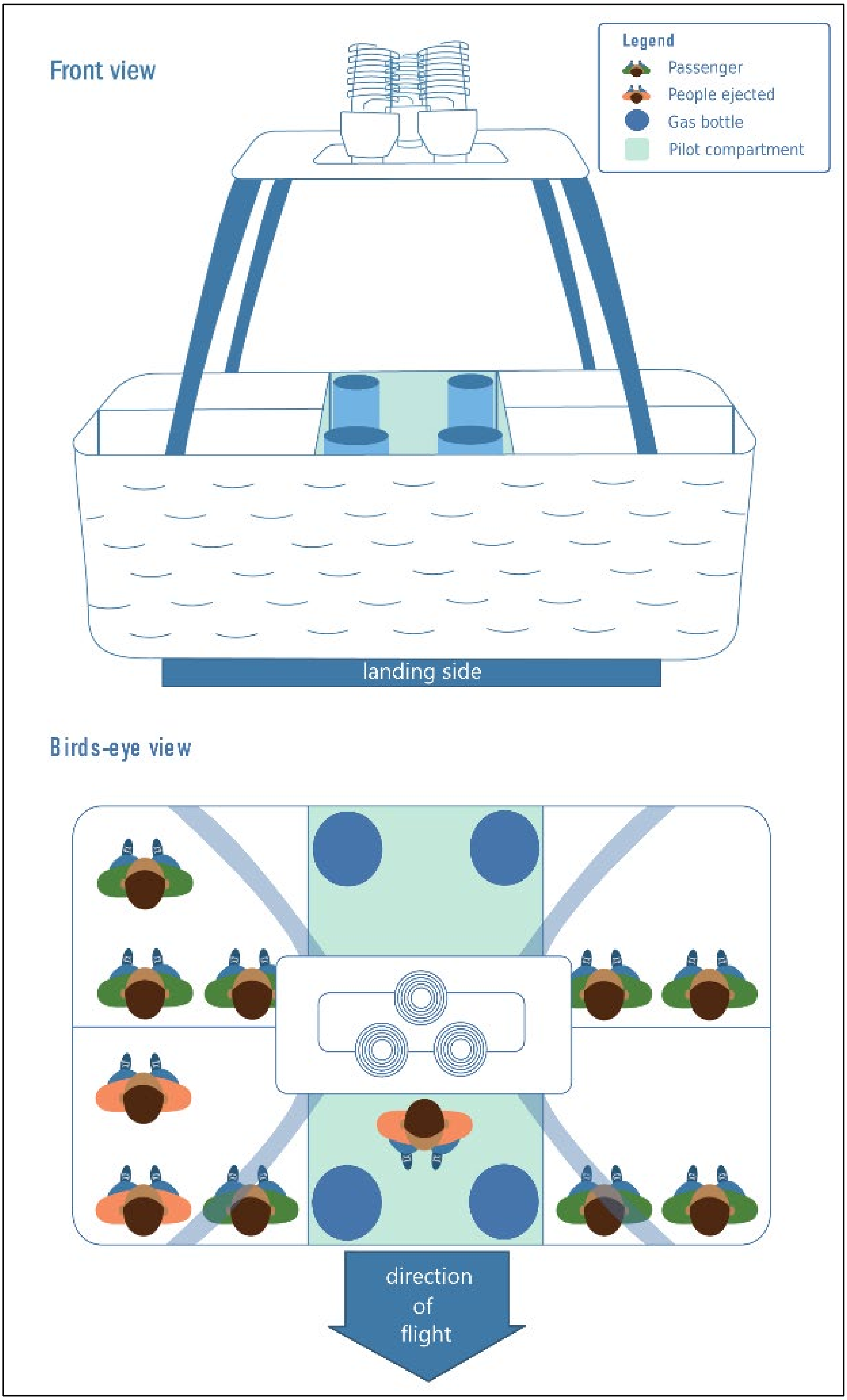

Figure 7: Balloon configuration

Flight controls

2.24. The flightpath of a balloon is determined by the direction of the wind. Wind direction and speed vary with altitude and are further modified by the topography of the land. A pilot could therefore climb or descend to alter the overall flightpath of a balloon. The ascent of a balloon is managed by adding heat to the envelope. However, the effect of this is not immediate. Depending on the size and mass of the balloon and the volume and rate of heat added, the delay before a balloon reacts could be anywhere from 5 to 10 seconds, possibly longer.

2.25. Descent can be initiated in several ways, firstly by allowing the temperature in the envelope to cool naturally by not adding heat. Should a more immediate or faster descent be required, a pilot can activate the vent line.[13] This pulls down a vent panel in the top of the envelope and allows heated air to escape. The vent should only be opened for short periods, otherwise the envelope may collapse from venting too much air or possibly from descending too quickly.

2.26. For an emergency or fast descent when close to the ground or when the envelope is being collapsed, a pilot can activate the rapid deflation system. This is achieved by pulling in the rip line, which collapses the vent panel and allows a larger release of air from the envelope compared to pulling the vent line.

2.27. ZK-FBK, like other large balloons, was fitted with turning vents, allowing the balloon to be rotated. During a flight these could be used to give passengers different views of the environment. However, their main purpose is to orientate the basket for landing. Elongated baskets, like the double-T of ZK-FBK, are designed to be landed with one of the longer sides facing the direction of flight.

Meteorological information

2.28. On the morning of the flight, the pilot obtained weather information from a range of sources, including MetFlight[14], Navigatus[15] and automated weather stations located about the basin.[16]

2.29. The MetService forecast for 9 July 2021 was for a westerly wind of 12 knots (22 km/h), 30 kilometres (km) visibility and FEW[17] cloud at 5000 feet (1500 km). The automatically generated weather report for Queenstown Aerodrome recorded the conditions at the time of take-off, 0905, to be surface wind of 210° magnetic at 7 knots (13 km/h), visibility 48 km, overcast cloud at 6500 feet (1091 m), a temperature of 9° Celsius, a dew point of -1° Celsius and a QNH[18] pressure of 1004 hectopascals.

2.30. Weather stations located around the basin recorded a generally westerly to south-westerly wind of about 7 knots, increasing to 12 knots (13-22 km/h) on occasions.

[13] A line, normally coloured red and white, used to open a vent at the top of an envelope and increase the rate of descent.

[14] A general aviation weather briefing service provided by MetService (the Meteorological Service of New Zealand).

[15] Real-time weather information in the vicinity of aerodromes, provided by Navigatus.aero. See https://www.navigatusconsulting.com/navigatus-aero-awarded-part-174-certification].

[16] For example, Harvest Electronics' facilities located on local vineyards and farms.

[17] Cloud is measured in oktas or eighths. FEW is 1-2 oktas.

[18] A pressure reading to give altitude above mean sea level.

2.31. The conditions at the launch site were reported by the balloon crew and passengers to have been mainly calm with an occasional light gust of wind coming through. This was evidenced by the balloon envelope occasionally swaying.

2.32. A weather-recording site located on Slope Hill, in the centre of the Wakatipu Basin, recorded the wind at 0700 as a west-south-westerly of 15 km/h, gusting to 20 km/h. The average wind speed remained about the same for the next two hours, but the gusts reduced. The wind speed increased during the flight and was about 25 km/h at the time of landing, 0952:50. The wind also backed[19] to the south-west.

2.33. Another weather site located further east towards Kawarau Gorge recorded the wind at 0700 as a westerly of 0.2 km/h, gusting to 1.8 km/h. The 10-minute samples in the next three hours recorded a generally increasing wind, reaching a maximum of 13.7 km/h with gusts up to 27 km/h. The wind direction was between west-northwest and northwest. At 0950 the wind speed had decreased to 8 km/h, with gusts of 26.4 km/h.

Communications, navigation and recorded data

2.34. The balloon was equipped with two radios to enable the pilot to communicate with the Queenstown control tower and ground crew. The pilot and ground crew reported no communication problems during the flight.

2.35. In addition to being recorded by the camera, the flightpath of the balloon was recorded by two onboard satellite-referenced navigation tracking systems: a Garmin GPS (global positioning system) and TrackIt. The balloon was also recorded on the Airways New Zealand Queenstown-based tracking system.[20] The tracking data matched the flightpath of the balloon, including altitude and groundspeed.

2.36. Several of the passengers also took photographs or recorded short video clips during the balloon inflation and flight and made these available to the Commission's investigators.

Site and wreckage information

2.37. The final landing site was a grassed paddock adjacent to a metal road[21] on its right side.[22] At its maximum, the paddock was about 550 m long and 140 m wide. The paddock also served as a landing strip for aeroplanes. The strip was located on the left side of the paddock towards the Arrow River. A farmhouse was located on the right ride of the paddock near the road (see Figure 8). The pilot advised that they had landed on the paddock before.

2.38. The approach path of the balloon took it over a gully and onto the right side of the paddock. This reduced the length available for landing to about 150 m. The first point of landing was about 0.3 m below the lip of the paddock. The indentation made into the hard clay soil matched the shape of the bottom of the basket. The basket then skipped and slid before it broke through a deer fence and came to rest near the farmhouse. The basket was on its landing side with the envelope draped over a powerline leading to the farmhouse.

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[19] When wind backs, the direction moves anti-clockwise. It veers when moving clockwise.
[20] Multilateration, commonly referred to as MLAT, which provides a display much like radar.
[21] An unsealed or shingle road.
[22] Referenced to the direction of flight.

2.39. The balloon sustained minor damage, with several small tears in the envelope and some broken basket cane, and webbing along the rim of the basket tore near one corner.

2.40. The Commission investigators confirmed that the gas bottles were undamaged and still partially full post the accident.

2.41. On 13 August 2021, under the supervision of Commission investigators, the balloon underwent an inflation test. The test confirmed that all the burners and control lines[23] functioned as designed. Other than the damage detailed above, no faults were found.

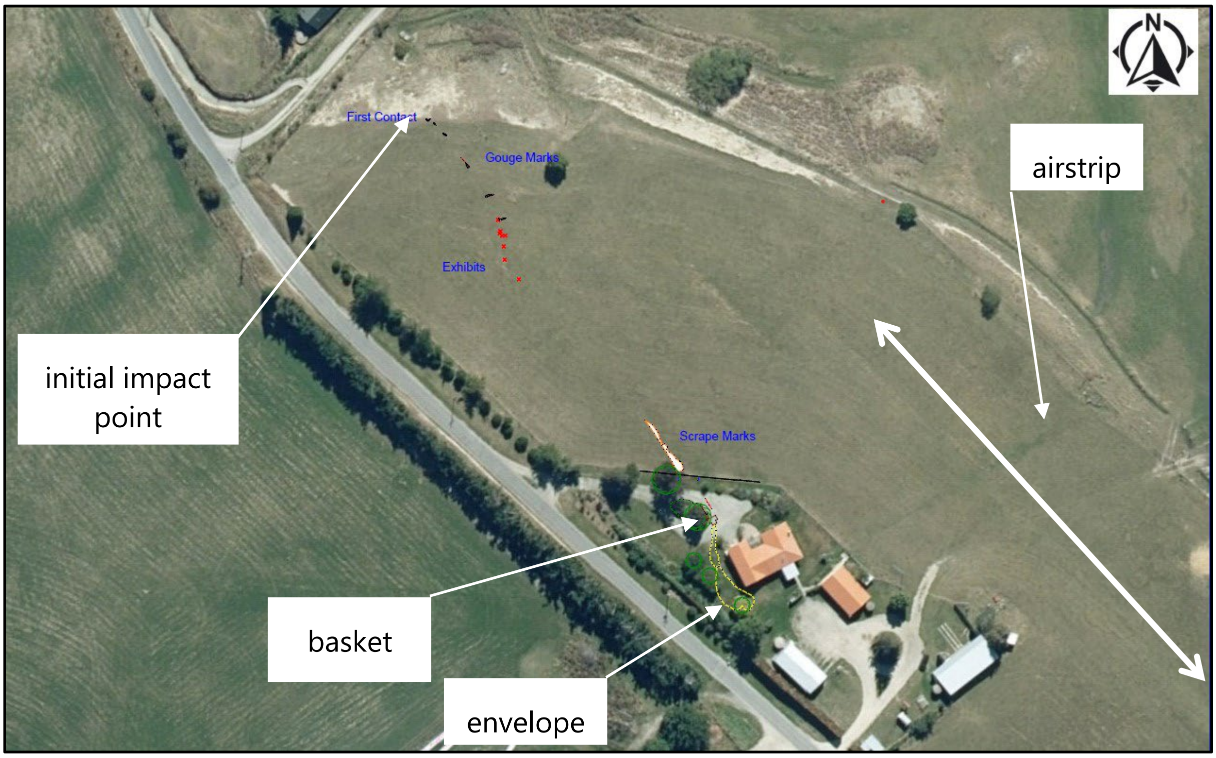

Figure 8: Accident site
(Credit: New Zealand Police)

Organisational information

2.42. Sunrise Balloon Adventures, the operator, had first started flying balloons in 1998. Following the introduction in October 2011 of Civil Aviation Rules Part 115 – Adventure Aviation Certification and Operations, the operator had gained certification to conduct commercial balloon operations. The operator's operations manual listed four balloons that could be used on commercial flights. Their passenger capacity ranged from 13 to 24.

2.43. A review of the operator's files held by the Civil Aviation Authority identified nothing of relevance to this occurrence.

[23] For a balloon, a control line is a rope of a specific colour, depending on its purpose.

Other occurrences

New Zealand

2.44. On 1 January 2022, an Ultramagic Balloons N-250 balloon, registered ZK-MET, was landing after a commercial scenic flight near Methven, Canterbury. On board were the pilot and seven passengers. The landing area was the second paddock in a series of paddocks located immediately after crossing a road. The paddocks were wide, but short in the direction of travel. A powerline ran along the side of the road, approximately perpendicular to the direction of travel.

2.45. Approaching the landing area, the pilot activated the balloon's fast deflation system by pulling down on a red line connected to the parachute at the top of the envelope. The basket initially contacted the ground in a firm landing and bounced, tipping over on its second contact with the ground and ejecting the pilot from the basket. The basket came to rest after approximately 35 m. All passengers remained in their braced landing positions until after the balloon deflated.

2.46. The pilot's final position was behind the basket with the rip line caught around their neck, resulting in serious injury. The passengers were not injured, and the balloon was not damaged.

2.47. The balloon was fitted with a pilot restraint harness, but the pilot had not worn it during the flight. Refer Commission aviation inquiry AO-2022-001, Ultramagic Balloon, S.A. N-250, ZK-MET, Pilot ejection from basket on landing, Lyndhurst, near Methven, 1 January 2022 (TAIC, 2022).

2.48. For a summary of some relevant overseas occurrences, see Appendix 1. The international data indicates a significant relationship between pilots being ejected from baskets and those countries where the wearing of pilot restraint harnesses is not compulsory for landing.

3 Analysis
Tātaritanga

Introduction

3.1. The occurrence flight was a routine flight until the balloon was descended in preparation for landing. After two attempted landings, the balloon landed hard and fast, ejecting two of the passengers from the basket. The pilot, who was not wearing a restraint harness, was also ejected from the basket, leaving no one in control of the balloon. All three suffered serious injuries. Of the remaining eight passengers, seven sustained minor injuries and one was uninjured.

3.2. The following section analyses the circumstances surrounding the event to identify those factors that increased the likelihood of the event occurring or increased the severity of its outcome. It also examines safety issues that have the potential to adversely affect future operations.

What happened

3.3. The weather conditions at the time of take-off and forecast for the flight were within the balloon manufacturer's prescribed limitations. There was a light westerly wind flow over the Wakatipu Basin, with the trend indicating the wind would remain about the same or possibly easing. However, as the morning passed there were occasional changes in the wind velocity. These, combined with the cold katabatic wind flow in the vicinity of the Arrow River and the narrowing of the terrain approaching Kawarau Gorge, resulted in the balloon reaching groundspeeds of up to 18 knots (33 km/h) in the final stages of the flight.[24]

Attempted landings

3.4. Partway through the flight, the pilot became aware that the wind strength was not remaining steady or reducing as forecast, but instead increasing, so attempted to land early. The groundspeed during the first attempt was 10-15 km/h, so a tip-over landing would have been **very likely**. However, nearing the ground one of the passengers became ill. The pilot, unable to ensure that the sick passenger would be secure for the landing, decided to overshoot and land elsewhere.

3.5. During the attempt to land at the second site, the balloon started drifting towards a fence line. The groundspeed was now about 12-20 km/h. Collision with that fence would have **very likely** resulted in the balloon being seriously damaged and the occupants being forcibly ejected from the basket. Consequently, the pilot elected to overshoot for a second time.

3.6. The pilot decided to abort both landings because they thought it was the safest course of action. Continuing with either of the landings would have **very likely** resulted in injury, possibly serious. The pilot was familiar with the area and knew that in each case there were other landing options in the direction of travel. This needed to be weighed against the wind conditions known at the time and the likelihood of the wind increasing in strength.

[24] The only speed limitation stipulated in the flight manual was a maximum of 15 knots (28 km/h) for launching.

Final landing

3.7. The final landing paddock was the last suitable landing option before entering the gorge. The channelling of the wind into the gorge meant that had the flight continued into the gorge, the groundspeed of the balloon would have increased further. There was sufficient fuel available for the pilot to continue through the gorge towards Cromwell and Lake Dunstan. However, there were some unknowns with this course of action, including weather conditions past the gorge and therefore the likely flightpath. In the pilot's judgement, landing before the gorge in the landing paddock, with its flatter ground and long length, was the best option.

3.8. The pilot alerted the passengers several times that it was going to be a fast, bumpy and hard landing. The video recorded several of the passengers making light of the situation, joking and laughing as they approached the paddock. The pilot, aware that the balloon would drag for some distance, aimed to land immediately past the lip of the gully leading up to the paddock.

3.9. The navigation and video recordings show that as the balloon approached the lip of the gully, the groundspeed reduced by a small amount. This would have been a direct result of the wind speed decreasing. It resulted in the descent path steepening. The balloon's proximity to the ground meant there was insufficient time for the pilot to add power (heat) to reduce the rate of descent and correct the approach profile. The steepened descent resulted in the basket striking the side of the gully just below the lip. This caused a sudden slowing of the basket, which then bounced and trailed behind the envelope. Two passengers were ejected from the basket during this time. The balloon then dragged for some 150 m, breaking through a deer fence and coming to rest near the farmhouse.

3.10. The pilot had pulled the rip line immediately before landing. This did not materially alter the descent profile of the balloon, but it did ensure that the envelope started to deflate rapidly as the basket bounced and dragged along the ground. The pulling down of the rip line, a hand-over-hand action, meant the pilot was standing upright as the basket struck the lip of the gully. The pilot, also unrestrained, was ejected immediately after the two passengers were. This is discussed further in paragraphs 3.28-3.30.

Passenger briefings

Safety issue: The pilot did not ensure that the various safety briefings given to the passengers were clearly understood, and as a result several of the passengers were not prepared for a fast and hard landing.

Tip-over landings

3.11. Balloons require benign weather conditions to operate. Manufacturers' wind limitations, for example a maximum of 15 knots (28 km/h) for ZK-FBK, generally apply to take-offs only. Flights will therefore generally commence early in the morning when there is little or no wind. Nevertheless, the pilots also need to be aware of potential changes in weather conditions and plan accordingly.

3.12. With even small increases in wind velocity, the likelihood of a tip-over landing increases. Tip-over landings are not unusual. Expert advice suggested that they occurred in about 40 per cent of flights. Most of these landings were gentle, with little dragging along the ground.

The flight

3.13. The passengers were given several safety briefings, both before and during the flight. The briefing topics included safety around the launch site, entering and exiting the basket, the flight, and how to prepare for landing. The last topics included the need to: face away from the direction of flight with their backs against the wall of the basket; crouch down; and hold on to the rope handles. If there were more than two persons in a compartment, which there were, passengers would need to position in pairs. Each pair would typically have the larger person's back against the basket wall, with their arms round the smaller person in front, holding on to the handles. The person in front would also be crouched down and holding on to the rope handles.

3.14. Once in the basket, the passengers were given passenger safety briefing cards. The cards consisted mainly of wording, with some small supporting figures, of which one accompanied the landing instructions. This showed a person appearing to be standing upright with their back to the direction of flight. The reverse side of the card repeated the information but in Mandarin (Chinese). See Figure 9.

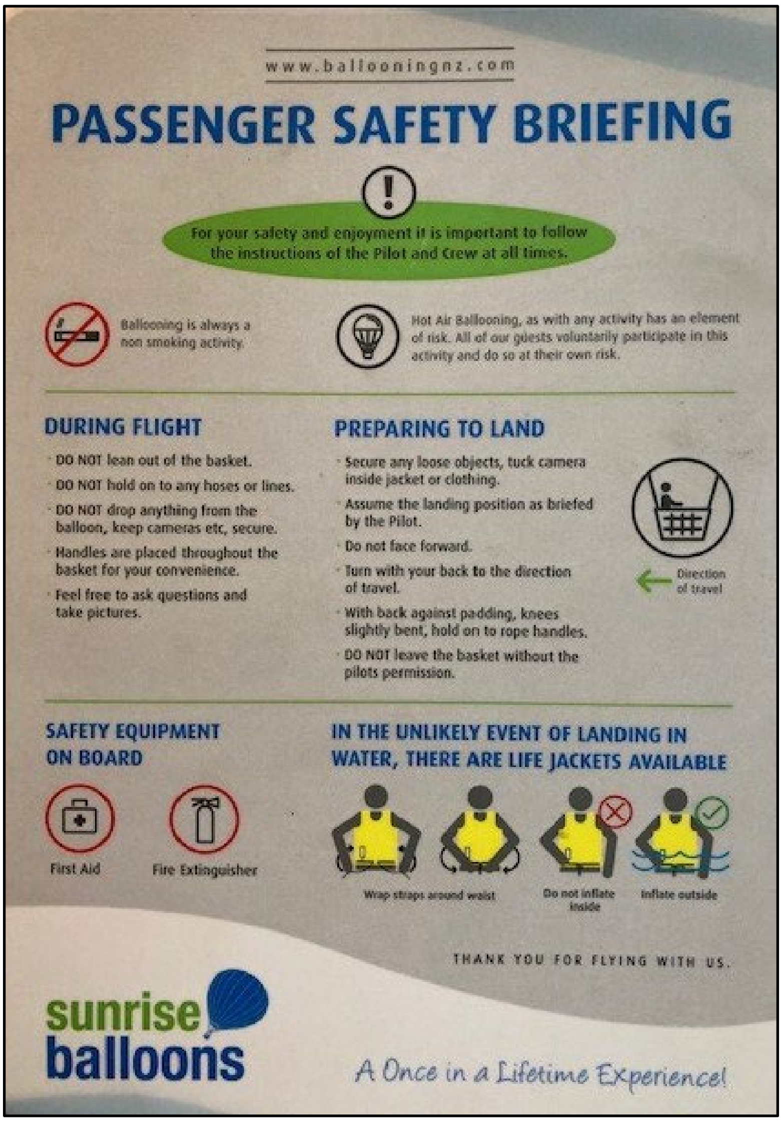

Figure 9: Passenger briefing card
(Credit: Sunrise Balloon Adventures)

3.15. The pilot, before making the first attempt to land, briefed the passengers that they needed to have their backs to the direction of flight, crouch down and hold on to the rope handles on the inside of the basket. On each of the three approaches to land, the pilot also informed the passengers that the landing was going to be fast, hard and bumpy and that the basket was likely to tip over.

3.16. The eight passengers who were not ejected from the basket recalled elements of their previous briefings, so correctly positioned themselves for a tip-over landing. Despite the initial hard impact and the basket being dragged across the paddock on its side and then breaking through a deer fence, they remained in the basket. Further, the audio recording captured the passengers talking after the balloon came to a stop, reminding each other to remain in the basket until the envelope had deflated sufficiently to stop further movement.

Ejected passengers

3.17. The two passengers who were ejected were not correctly positioned for landing. One passenger said they were in a semi-crouched position with their arms tucked into their body and fists clenched. The second passenger said they were still standing up, looking around and holding onto the lip of the basket. Neither was holding on to the rope handles as instructed when the basket struck the lip of the gully. They were therefore unrestrained and exposed to being propelled forward and out of the basket.

3.18. English was not the first language of the two ejected passengers. In interviews both passengers were able to communicate easily. They recalled being able to hear and understand the information being disseminated before take-off and during the flight. However, they recalled that when approaching the final landing area, they were not ready and things happened very quickly. The impact caught them by surprise. They thought the landing was going to be bumpy but safe. The pilot's manner and the laughter from the other passengers had the potential to lead them to not fully appreciate the risks.

3.19. The flight manual for the balloon stated in the approach to landing checklist that: 'Crew and passengers should be briefed for the landing and safe landing positions confirmed well in advance of the touchdown.' The pilot was **very likely** focused on attempting to control the flightpath of the balloon during the challenging circumstances of the landing, and as a result did not conduct a thorough visual assessment of the basket to ensure all the passengers were properly prepared.

Passenger briefings

3.20. A flight in a hot air balloon is a unique experience for most passengers. As a result, passengers can be influenced by the excitement of a flight and may not take in all the relevant and critical information being passed on by the pilot and ground crew. Nevertheless, it is the responsibility of the pilot to ensure that their passengers are appropriately prepared for the flight and any unforeseen eventualities. A tip-over landing, while perhaps not the norm, is nevertheless not unusual and should be covered before every flight.

3.21. Pre-flight safety briefings have a critical function in aviation safety in ensuring passengers understand any safety actions they may have to take during the flight. It is the pilot's responsibility to ensure that the safety briefing is conducted in full and that all passengers pay attention to and are fully conversant with their safety requirements for the flight. Safety actions that passengers are required to take for landing must be covered in full and ideally practised by the passengers, so the pilot can be confident that the passengers can adequately perform them when required.

3.22. On 1 January 2022, ZK-MET, an Ultramagic Balloons N-250 balloon, landed firm and fast. The basket tipped over on landing and the pilot was ejected, suffering serious injury. However, all seven passengers remained in the basket and were not injured. The balloon was undamaged. The investigation into this occurrence, Commission investigation AO-2022-001, identified that the content and delivery of the safety information by the pilot had helped to prevent passenger injury.

3.23. Before the flight, the pilot of ZK-MET had gathered the passengers together and ensured they were listening before delivering the safety briefing. The safety briefing card passed to the passengers had contained mainly diagrams that clearly showed the crouched landing position and rope handles (see Figure 10). The passengers also had to demonstrate their landing positions to the pilot. One or two minutes before landing, the pilot had instructed the passengers to get into their landing positions. This instruction was reportedly delivered clearly and firmly. The pilot then had sufficient time to check the basket to ensure everything was secure before focusing on the final stages of the approach and landing.

3.24. These two occurrences highlight the benefits of operators taking all practical steps in preparation for flights. These steps include ensuring passengers are attentive to briefings and, ideally, briefing cards are provided in support. Briefing cards should contain enough diagrams to ensure the safety messages are clearly understood regardless of any language challenges. Ensuring that passengers practise the landing position not only tells the pilot that the passengers have been listening, but also, and importantly, reinforces the key lessons. Any urgency situations or concerns should not be downplayed, as this could lead passengers to under-appreciate the risks, which may in turn lead to their not being prepared as appropriate.

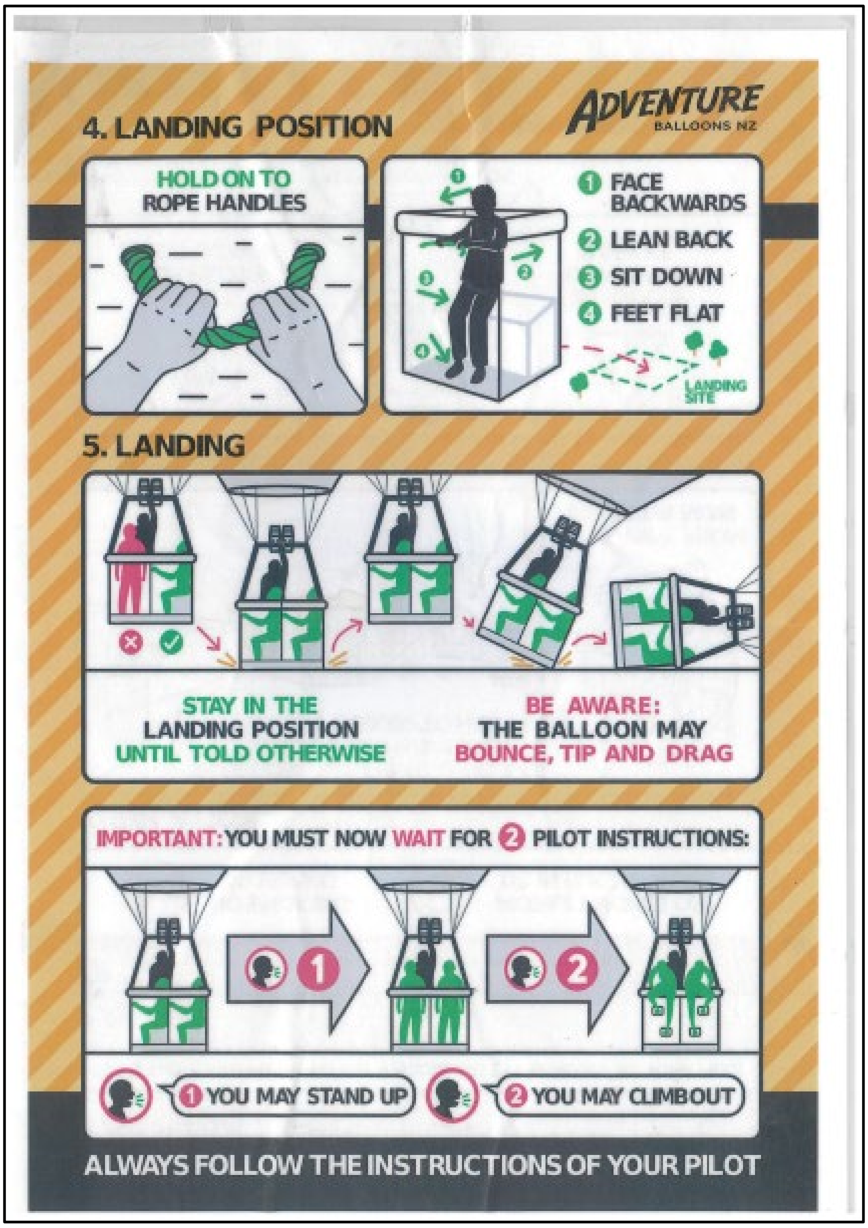

Figure 10: Passenger briefing card

(Credit: Adventure Balloons NZ)

Landing point

3.25. The delay between applying power or heat and a balloon starting to respond can be of 5-10 seconds, possibly longer. Variables include envelope size, the amount of heat added and the rate of application. In this occurrence the pilot was aiming to land immediately past the lip of the gully. However, the balloon dipped below the intended descent profile in the final few seconds. The pilot considered there was insufficient time to correct the descent profile, and as a result the bottom of the basket struck the side of the gully about 0.3 m below the lip. The impact was violent and caused an immediate slowing of the basket, resulting in three unrestrained occupants being propelled forward and out of the basket.

3.26. Had the pilot applied a large amount of power in the last few seconds of flight, the basket would have **very likely** still struck the slope. The reduction in weight in the balloon due to the loss of three occupants, combined with the added heat, could have increased the likelihood of the balloon becoming airborne again, without the pilot on board, which could have made the situation even worse.

3.27. The fast groundspeed meant it was important to land as early and as safely possible on the flat portion of the paddock. However, given the gustiness of the wind it would have been prudent to have aimed to land a short distance, possibly 5-10 m further into the paddock. This would have ensured there was a margin of safety available should something unforeseen occur. It is standard aviation practice for any aircraft approach to have an aim point inset from the start of the landing area. This can be brought closer as conditions permit and a safe landing is assured.

Pilot restraints

Safety issue: Civil Aviation Rules exempt pilots from the requirement to wear restraint harnesses when operating balloons. However, not wearing a restraint harness can increase the risk of a pilot being thrown off a balloon during landing.

3.28. The balloon was fitted with a pilot restraint harness, as are most large balloon baskets, including all Kavanagh Balloons. However, the pilot could not recall previously wearing the restraint harness during flights. The pilot gave several reasons for this, but primarily it was because all take-offs and most landings were in very benign conditions, the operator's exposition made no reference to the wearing of a restraint harness and there was no regulated requirement to do so.

3.29. Under Civil Aviation Rules, balloon pilots in New Zealand were exempt from wearing pilot restraint harnesses during landing.[25] Civil Aviation Rules Part 19 – General Operating and Flight Rules 91.205: Crew members at stations, states:

> *(a) Each crew member on duty during take-off and landing in an aircraft, **other than in a balloon**, shall—*
>
> > *(1) be at their crew member station unless their absence is necessary to perform duties in connection with the operation of the aircraft; and*
> >
> > *(2) have their safety belt fastened while at the crew member station.*

3.30. The operator's procedures made no reference to a requirement for a pilot to wear a restraint harness for any phase of flight. They also did not identify the risk of a pilot being ejected from a basket.

3.31. Had the pilot been wearing the restraint harness it is **virtually certain** that they would have remained in the basket. The same would have applied in the case of the Ultramagic Balloon N-250, ZK-MET occurrence near Methven on 1 January 2022. Refer to Commission investigation report AO-2022-001.

3.32. Appendix 1 gives several examples of pilots being ejected from baskets on landing. The ejection of a pilot compromises the safety of the pilot and the balloon occupants because:

[25] Civil Aviation Rules 91.205.

- the likelihood of injury to the pilot is significant. Both this and the Methven occurrence resulted in serious injuries to the pilots
- the sudden reduction in weight could cause the balloon to become airborne again, or at least drag further along the ground
- no one is left in control of the balloon. Some flight manuals state that downward pressure on the rip line needs to be maintained to ensure the vent remains open during the landing sequence.

Landing checklist

3.33. The flight manual stated in the approach to landing checklist that:

- Crew and passengers should be briefed for the landing and safe landing positions confirmed well in advance of the touchdown.
- The pilot lights and main burners **must** be extinguished before ground contact is made.

3.34. The passengers were informed several times to prepare for a fast, hard and bumpy landing and to prepare for landing. However, the pilot did not conduct a check of the passengers to ensure they were each crouched down correctly and holding on to the rope handles. While the approach was fast and the pilot was focused on flying the balloon, an earlier call to prepare for landing would likely have given the pilot sufficient time to conduct a quick visual check.

3.35. Ideally the pilot would have turned off the fuel supply and purged the lines through to the burners before pulling the rip line. However, in this occurrence the pilot was using the burners as late as possible and immediately moved to pulling down the rip line. Had the fuel lines been disrupted or one of the gas bottles punctured as the basket was dragged through the deer fence, there would have been a significant risk of a fuel-fed fire. As a minimum, the pilot could have isolated the fuel supply before landing by rotating the four single-action fuel shut-off levers through 90°. While this would have left some fuel in the lines, the amount would have been minimal. The pilot could also have turned off the supply from two of the bottles earlier and used the cross-feed from the remaining two bottles to fuel the burners.

4 Findings
Ngā kitenga

4.1. The weather conditions and forecast were suitable for the flight to proceed.

4.2. The safety briefings given by the pilot did not adequately prepare all the passengers for a fast and hard landing.

4.3. The pilot's aim point for landing was too close to the lip of the gully and did not provide a sufficient safety margin.

4.4. The pilot did not check that all the passengers were in the required landing position before landing.

4.5. The pilot was ejected from the basket because they were not wearing the restraint harness fitted to the basket.

4.6. A decrease in the wind speed in the last few seconds caused the balloon to dip and the basket to strike the lip of the gully.

4.7. The force of the impact ejected the pilot and two of the passengers, who were all unrestrained, from the basket, seriously injuring them and damaging the balloon.

4.8. The eight properly positioned passengers who remained in the basket were either uninjured or sustained minor injuries.

4.9. The pilot lights for the burners were not extinguished before landing, as directed by the checklist.

5 Safety issues and remedial action
Ngā take haumanu me ngā mahi whakatika

General

Safety issues are an output from the Commission's analysis. They typically describe a system problem that has the potential to adversely affect future operations on a wide scale. Safety issues may be addressed by safety actions taken by a participant, otherwise the Commission may issue a recommendation to address the issue.

Passenger safety briefings

5.1. Tip-over landings are not uncommon and are a possibility for every balloon flight. The occurrences discussed in this report, the first occurrence on 9 July 2021 and the second occurrence on 1 January 2022 (see paragraphs 2.44 to 2.47), both involved tip-over landings. However, while both pilots were ejected, there was a significantly different outcome for the passengers. The two passengers ejected in the first occurrence were not correctly prepared and positioned for the landing and as a result sustained serious injuries. In comparison, all the passengers in the second occurrence were correctly prepared and positioned for the landing and remained safe in the basket, and none was injured.

5.2. There were several key differences between the briefings given to the two groups of passengers that **very likely** resulted in the different outcomes. Firstly, the briefing cards were quite different. The card used in the second occurrence included more descriptive diagrams and was less reliant on word pictures. This had advantages in being simple and catering to those for whom English was not their first language. The card used in the first occurrence had the instructions written in both English and Mandarin, but was of little use to speakers of other languages.

5.3. Secondly, the pilot in the 1 January 2022 occurrence had the passengers demonstrate the landing position. This had the benefit of further engaging the passengers and ensuring that they were fully aware of what to do in preparation for landing. This might have included the difficulty in crouching down, or how to coordinate body positions with two or more persons in a compartment.

5.4. The final difference between the safety briefings was in the delivery. The two ejected passengers recalled hearing elements of the briefings but not all the detail, for example the use of the grip handles. They also did not fully appreciate the gravity of the situation and were therefore not in the required landing position when the balloon struck the lip of the gully. Pilots need to ensure that any safety messages are appropriately delivered and clearly understood, and that safety actions are conducted when required.

5.5. The operator advised the Commission that their briefing procedures had been amended since the occurrence on 9 July 2021. Passengers were now required to demonstrate the landing position to a pilot or a ground crew person before take-off. This meant that a pilot was assured that passengers knew how to adopt the correct landing position and they only had to issue a short, simple instruction before landing.

5.6. As a result of the actions taken by the operator, no new recommendation was made to address this issue.

Use of a pilot restraint harness during the landing phase of balloon operations

5.7. The Civil Aviation Rules exempt pilots from a requirement to wear restraint harnesses when operating balloons during take-off and landing. However, not wearing a restraint harness can increase the risk of a pilot being thrown out of the balloon during landing. When landing a balloon, a pilot is required to continue controlling the balloon. This usually requires the pilot to be standing and pulling on various control lines, including the rip line. The pilot is therefore unable to crouch down and hold on to the rope handles, and this makes them more vulnerable to falling out of the basket should there be a sudden change in movement of the balloon.

5.8. Most large, multi-compartment baskets are fitted with restraint harnesses. However, because it is not compulsory to wear restraint harnesses, some balloon pilots do not do so. This may be partly due to balloons only being able to take off in the most benign, calm conditions and pilots not recognising the need to wear restraint harnesses at this stage of flight. Nevertheless, wind conditions can change during a flight, including in the final stages of an approach to landing. Therefore, donning a restraint harness prior to descending, when the workload is relatively easy, would ensure a pilot was then able to focus on flying the balloon and managing the passengers.

5.9. The balloon pilot ejection occurrences cited in Appendix 1, including the occurrence near Methven on 1 January 2022, show that this was not an isolated event. The European Union Aviation Safety Agency now requires pilots of balloons fitted with turning vents or separate compartments for pilots to wear restraint systems (harnesses) during landing.[26] A reduction in the number of pilot ejections in Europe and Great Britain reflected the benefits of this rule change. Following a balloon accident in Australia in 2016, when the pilot was ejected from the basket on landing, the Australian Civil Aviation Safety Authority has been reviewing the rules that currently exempted balloon pilots from wearing restraint harnesses.[27]

5.10. The Commission considers that there continues to be a residual safety risk in the system of balloon pilots not wearing restraint harnesses during critical phases of commercial flights. In the Methven occurrence, the operator's exposition and procedures had already mandated the wearing of pilot restraint harnesses on approach to landing and always when below 500 feet (152 m) above ground level. Yet the pilot still chose not to wear the restraint harness fitted to the balloon. Without a rule change pilots may continue to not wear them.

5.11. The Commission therefore considers there is merit in amending the appropriate Civil Aviation Rules to mandate the wearing of pilot restraint harnesses during critical phases of flight for commercial balloon pilots.

5.12. On 22 February 2022 the Commission issued a recommendation that:

> The Director of Civil Aviation take prompt steps to mandate the wearing of pilot restraint harnesses during critical phases of commercial balloon flights. (001/22)

[26] European Union Aviation Safety Agency Rules, Chapter 1 – Air Operations and Licensing, Annex II – Balloon Air Operations BOP.BAS.175 and BOP.BAS.320.

[27] A hard landing involving Kavanagh Balloons E-300, VH-LPG near York, Western Australia on 16 July 2016. See Appendix 1 for further information on this accident.

5.13 On 16 November 2022, the Commission redirected a draft safety recommendation to the Secretary of Transport for comment. On 5 April 2023 the Commission recommended that 'the Secretary of Transport review and revise Civil Aviation Rules Part 91 to mandate the wearing of pilot restraint harnesses during critical phases of commercial balloon flights' (001/23). See the Commission's final report, 'Aviation inquiry AO-2022-001, Utramagic Balloons, N-250, ZK-MET Pilot ejection from basket on landing, Lyndhurst, near Methven, 1 January 2022' for a summary of the safety issue, remedial action, recommendation and response from the Secretary of Transport.

6 Recommendations
Ngā tūtohutanga

General

6.1. The Commission issues recommendations to address safety issues found in its investigations. Recommendations may be addressed to organisations or people, and can relate to safety issues found within an organisation or within the wider transport system that have the potential to contribute to future transport accidents and incidents.

6.2. In the interests of transport safety, it is important that recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

New recommendations

6.3. Given that in inquiry AO-2022-001 the Commission issued a safety recommendation (001/22) to the Director of Civil Aviation and a second safety recommendation (001/23) to the Secretary of Transport to address the residual safety risk of pilots not wearing restraint harnesses during critical phases of flight, no new recommendations are issued in this inquiry.

7 Key lessons
Ngā akoranga matua

7.1. Safety briefings need to include relevant information and be appropriately delivered to help ensure passengers are best prepared to handle any abnormal or emergency situation. For example, having passengers demonstrate the landing position is an effective means of a pilot ensuring that they have clearly understood that element of a safety briefing.

7.2. Pilots should always include an appropriate margin of safety when selecting a landing point.

7.3. Aircraft checklists should be followed as they not only provide aide-memoires but also include actions that may be critical to the safety of flight.

7.4. Pilot restraint harnesses eliminate the risk of pilots being ejected from baskets on landing. They reduce the risk of personal harm and help ensure the pilots remain in control of their aircraft.

7.5. If fitted, restraint harnesses should be worn during critical phases of commercial balloon flights.

8 Data summary
Whakarāpopoto raraunga

Aircraft particulars

Aircraft registration:	ZK-JBK
Type and serial number:	Kavanagh Balloons E-260, s/n E260-539
Number and type of engines:	three Cameron burners
Year of manufacture:	2017
Operator:	Sunrise Balloon Adventures Limited
Type of flight:	commercial air transport
Persons on board:	11

Crew particulars

Pilot's licence:	Commercial Pilot Licence (Balloon)
Pilot's age:	46
Pilot's total flying experience:	1292 hours (1281 hours on balloons)

Date and time	9 July 2021, 0952 NZST	
Location	location	5 km south-southeast of Arrowtown
	latitude:	44° 59´ south
	longitude:	168° 51´ east
Injuries	three serious seven minor	
Damage	minor to balloon	

9 Conduct of the inquiry
He tikanga rapunga

9.1. On 9 July 2021 New Zealand Police notified the Commission of the occurrence. The Commission subsequently opened an inquiry under section 13(5) of the Transport Accident Investigation Commission Act 1990 and appointed an investigator in charge.

9.2. On 10 July 2021 two Commission investigators completed an accident site examination and started witness interviews. In the next three days further interviews were undertaken, including with passengers, the operator, the pilot and support crew. Aircraft and operator documentation was obtained, and the balloon was secured. A third Commission investigator joined the team during this time.

9.3. On 9 August 2021 two Commission investigators travelled to Auckland and interviewed two of the passengers.

9.4. On 13 August 2021 two Commission investigators observed the assembly and inflation of the balloon.

9.5. In March 2022 the Commission engaged an experienced balloon pilot and operator to consult on technical matters relating to hot air ballooning only.

9.6. On 25 January 2023 the Commission approved a draft report for circulation to six interested persons for their comment.

9.7. The Commission received five responses, of which three were submissions. Changes as a result of the submissions are included in the report.

9.8. On 26 April 2023 the Commission approved the final report for publication.

Abbreviations
Whakapotonga

km	kilometre
km/h	kilometres per hour
m	metre

Glossary
Kuputaka

balloon	a balloon includes an envelope, control lines, burners, a basket and other equipment fitted or required to be carried
control line	for a balloon, a rope of a specific colour, depending on its purpose
hard landing	sometimes referred to as a heavy landing, when a landing exceeds the manufacturer's limitations, often expressed as a rate of descent or a 'g' loading. This may result in a loss of control and/or aircraft damage and will require an inspection
katabatic wind	a downslope wind generated when the air cools and becomes increasingly dense. Normally prevalent early in the morning after a cool night
knot	one nautical mile (1.852 kilometres) per hour
rip line	a red-coloured line used to collapse the panel at the top of the envelope, to deflate the envelope rapidly
tip-over landing	a landing where the basket does not remain upright, but tips over onto its side

Citations
Ngā tohutoru

AAIU, 2015 Air Accident Investigation Unit (Belgium) Safety Investigation Report AAIU-2015-10, Cameron Balloons Z-210, Sleidinge, Belgium, 31 July 2015.

ATSB, 2016 Australian Transport Safety Bureau Safety Report AO-2016-080, Hard landing involving Kavanagh Balloons E-300 VH-LPG, near York, Western Australia, 16 July 2016.

ATSB, 2021 Australian Transport Safety Bureau Safety Report AO-2022-003, Hard landing involving Kavanagh Balloons B-350, VH-BSW, 2 kilometres south of Lilydale Airport, Victoria, Australia, 31 December 2021.

NTSB, 2014 United States National Transportation Safety Board Report ERA14LA290, Cameron Balloons USZ-225, N65625, Fatal accident Spring Creek, Pennsylvania, 15 June 2014.

NTSB, 2016 United States National Transportation Safety Board Report CEN16LA183, Cameron Balloons USZ-150, N6952D, Collision with terrain, Oklahoma, 13 May 2016.

NTSB, 2018 United States National Transportation Safety Board Report CEN18LA364, Lindstrand 77A, N370LB, Hard landing, Missouri, 2 September 2018.

TAIC, 2022 Transport Accident Investigation Commission aviation inquiry AO-2022-001, Ultramagic Balloon S.A. N-250, ZK-MET, Pilot ejection from basket on landing, Lyndhurst, near Methven, 1 January 2022.

Appendix 1 Similar balloon accidents

Pennsylvania, United States, 15 June 2014

The pilot of a Cameron Balloons USZ-225 balloon, N65625, had instructed the passengers to crouch down and hold on in preparation for landing. After the initial landing, the basket rocked back and forth several times. The pilot was reportedly reaching for a rope when they lost their balance and fell out of the basket and was killed. One of the passengers pulled the rope. (National Transportation Safety Board [NTSB], 2014)

Sleidinge, Belgium, 31 July 2015

The Cameron Balloons Z-210 balloon hit the ground hard. The pilot lost their balance, fell overboard and got caught under the basket. The pilot was seriously injured, but none of the nine passengers were injured.

The pilot wore a restraint harness, as prescribed by Cameron, However, the restraint harness was incorrectly secured to a point higher up in the basket and not to an anchor point on or near the floor.

The report made reference to the then current United Kingdom Civil Aviation Authority rules which prescribed the use of pilot restraints. The report also referenced European Union Aviation Safety Agency rules which stated:

> **Restraint system**: According to Regulation (EU) No 965/2012, a balloon must be equipped with a restraint system only, when the balloon is equipped with a separate compartment for the pilot-in-command and CAT [commercial air transport] operations are conducted. As a result of the consultation, the requirements on restraint systems have been expanded as follows:
>
> - A restraint system is prescribed for all operations, when the balloon is either equipped with a separate compartment for the pilot-in-command or when it is equipped with turning vents.
> - For such balloons the pilot-in-command must wear the restraint system at least during landing. (Air Accident Investigation Unit [AAIU], 2015)

Oklahoma, United States, 13 May 2016

A Cameron Balloon US Z-150 balloon, N6952D, collided with trees and terrain during a landing in Edmond, Oklahoma. The basket impacted the ground, and the pilot and one passenger were ejected from the basket. The pilot continued to hold onto the quick deflation line and was dragged alongside the basket. The balloon became airborne and ascended to a height of 75 to 100 ft above the ground, with the pilot still holding onto the line. The balloon continued across the field until it came to rest after contacting trees.

The pilot reported that there were no mechanical malfunctions during the flight. The pilot's safety recommendation was, "Use of a pilot restraint harness so pilot is not ejected. (NTSB, 2016)

York, Western Australia, 16 July 2016

The pilot of a Kavanagh Balloons E-300 balloon, VH-LPG, was preparing to land with 16 passengers on board. The balloon made an initial ground contact with about 15 knots of forward speed. When the balloon struck the ground, the pilot was ejected from the balloon basket. The basket was then dragged over the top of the pilot as the balloon envelope continued to deflate. The balloon envelope came to rest draped over trees and a fence with the basket lying on its side.

The pilot was seriously injured, one passenger received a minor injury and the balloon sustained minor damage. The balloon operator advised that as a result of the accident they were modifying all their balloons with a pilot restraint harness.

The Australian Transport Safety Bureau (ATSB) report included the following safety message:

> Landing with forward speed in a balloon poses the risk of personnel thrown forwards out of the balloon basket, which can then place them in the path of the basket. Passengers are briefed about this risk and are able to use both hands to secure themselves to a handhold for landing. However, the balloon pilot is required to continue using their hands to control the balloon throughout the landing sequence and is therefore exposed to a higher risk of being thrown out of the balloon basket.
>
> Installation and use of a pilot restraint harness, in accordance with the balloon and harness manufacturers' recommendations, will reduce the risk of a pilot being thrown out of the balloon basket during landing. (Australian Transport Safety Bureau [ATSB], 2016)

Missouri, United States, 2 September 2018

A Lindstrand 77A balloon, N370LB, landed hard in high winds. The pilot was ejected from the basket. The immediate reduction of weight in the basket resulted in the balloon climbing with the passenger on board. The pilot yelled to the passenger to grab the rip line, which caused the balloon to enter a rapid descent from about tree-top level. The balloon impacted the ground hard, which resulted in serious injuries to the passenger. The pilot stated there was no mechanical malfunction or failure of the balloon. (NTSB, 2018)

Victoria, Australia, 31 December 2021

A Kavanagh Balloons B-350 balloon, VH-BSW was on a scenic charter flight with a pilot and 16 passengers on board, when the pilot was advised that the surface wind near the landing area was increasing. The pilot assessed several landing options over the next 17 minutes as the wind continued to increase. While landing, the balloon impacted the ground hard, seriously injuring two of the passengers.

The ATSB found that 'the pilot rejected several suitable landing fields to avoid possible post-landing logistical and operational difficulties. This progressively reduced the safe landing sites available to the pilot.' The selected landing site presented high risks in the prevailing windy conditions. The investigation also found that:

> All the required actions of the pre-flight passenger safety briefing were not completed, probably due to time pressure and the pilot's assumption that all passengers would understand an abbreviated briefing. The incomplete briefing probably resulted in 2 passengers adopting a deep squat position during landing, causing their injuries. (ATSB 2021)

Kōwhaiwhai - Māori scroll designs

TAIC commissioned its four kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngāti Raukawa, Tūwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to avoid them. A 'waka whai mārama' (i te ara haumaru) is 'a vessel/vehicle in pursuit of understanding'. Waka is a metaphor for the Commission. Mārama (from 'te ao mārama' – the world of light) is for the separation of Rangitāne (Sky Father) and Papatūānuku (Earth Mother) by their son Tāne Māhuta (god of man, forests and everything dwelling within), which brought light and thus awareness to the world. 'Te ara' is 'the path' and 'haumaru' is 'safe' or 'risk free'.

Corporate: Te Ara Haumaru - the safe and risk free path

The eye motif looks to the future, watching the path for obstructions. The encased double koru is the mother and child, symbolising protection, safety and guidance. The triple koru represents the three kete of knowledge that Tāne Māhuta collected from the highest of the heavens to pass their wisdom to humanity. The continual wave is the perpetual line of influence. The succession of humps represents the individual inquiries.

Sandy acknowledges Tāne Māhuta in the creation of this Kōwhaiwhai.

Aviation: Ngā hau e whā - the four winds

To Sandy, 'Ngā hau e whā' (the four winds), commonly used in Te Reo Māori to refer to people coming together from across Aotearoa, was also redolent of the aviation environment. The design represents the sky, cloud, and wind. There is a manu (bird) form representing the aircraft that move through Aotearoa's 'long white cloud'. The letter 'A' is present, standing for a 'Aviation'.

Sandy acknowledges Ranginui (Sky father) and Tāwhirimātea (God of wind) in the creation of this Kōwhaiwhai.

Maritime: Ara wai - waterways

The sections of waves flowing across the design represent the many different 'ara wai' (waterways) that ships sail across. The 'V' shape is a ship's prow and its wake. The letter 'M' is present, standing for 'Maritime.

Sandy acknowledges Tangaroa (God of the sea) in the creation of this Kōwhaiwhai.

Rail: rerewhenua - flowing across the land

The design represents the fluid movement of trains across Aotearoa. 'Rere' is to flow or fly. 'Whenua' is the land. The koru forms represent the earth, land and flora that trains pass over and through. The letter 'R' is present, standing for 'Rail'.

Sandy acknowledges Papatūānuku (Earth Mother) and Tāne Mahuta (God of man and forests and everything that dwells within) in the creation of this Kōwhaiwhai.

Transport Accident Investigation Commission

Recent Aviation Occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

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AO-2019-005	BK-117-C1 ZK-IMK controlled flight into terrain (water), Auckland Islands, 22 April 2019
AO-2020-003	Eurocopter EC120-B, ZK-HEK, Loss of control in flight and collision with terrain, Kekerengu, 50 kilometres northeast of Kaikoura, 15 December 2020
AO-2019-006	Cessna 185A, ZK-CBY and Tecnam P2002, ZK-WAK, Mid-air collision, near Masterton, 16 June 2019
AO-2019-002	Bombardiers DHC-8-311, ZK-NEH, and ZK-NEF, 'Loss of seperation' near Wellington, New Zealand, 12 March 2019
AO-2020-001	Pacific Aerospace Cresco 08-600, ZK-LTK impact with terrain Kourarau Hill, Masterton, 24 April 2020
AO-2019-003	Diamond DA42 aeroplane, impact with terrain, 22 nautical miles south-southeast of Taupo, Kaimanawa Ranges, 23 March 2019
AO-2018-005	MD Helicopters 600N, ZK-ILD, Engine control malfunction and forced landing, Ngamatea Station, 14 June 2018
AO-2018-001	Tandem parachute UPT Micro Sigma, registration 31Z, Double malfunction, Queenstown, 10 January 2018
AO-2018-006	Robinson R44, ZK-HTB Loss of control Stevensons Arm, Lake Wanaka 21 July 2018
AO-2017-009 and AO-2017-010	Commission resolution to close aviation inquiries Boeing 787, near Auckland, New Zealand, 5 and 6 December 2017
AO-2019-001	Airbus Helicopters AS350, ZK-HEX, Forced landing, Wakefield, Nelson, 17 February 2019

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