Australian Government

Australian Transport Safety Bureau

Collision with terrain involving Kubicek Balloons BB78Z, VH-RJR

Elwood, Victoria on 20 April 2022

ATSB Transport Safety Report

Aviation Occurrence Investigation (Defined)

AO-2022-028

Interim – 7 December 2022

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Addendum

Page	Change	Date

Interim report

This interim report details factual information established in the investigation's early evidence collection phase, and has been prepared to provide timely information to the industry and public. Interim reports contain no analysis or findings, which will be detailed in the investigation's final report. The information contained in this interim report is released in accordance with section 25 of the *Transport Safety Investigation Act 2003*.

The occurrence

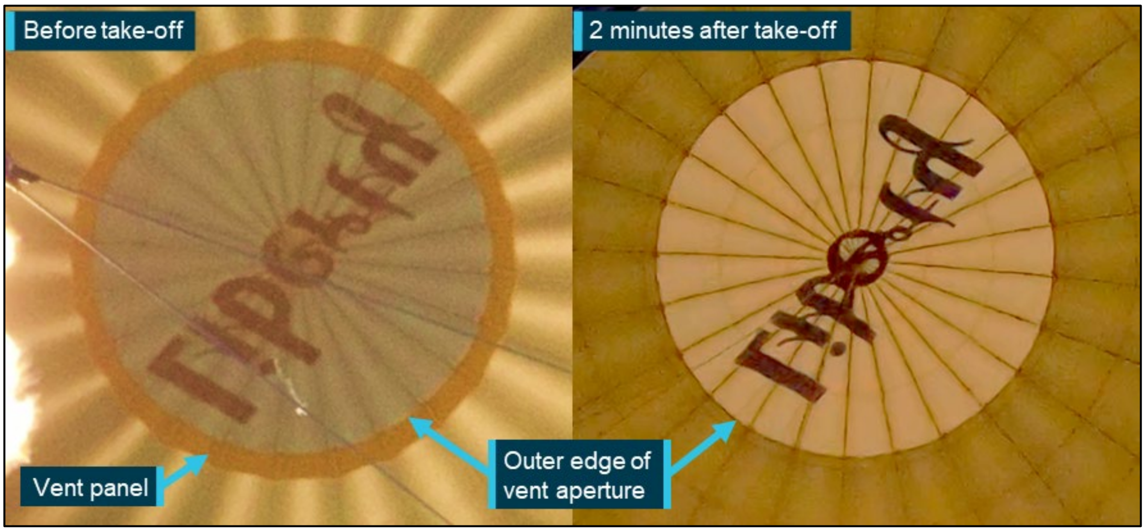
Early on the morning of 20 April 2022, a Kubicek BB78Z hot-air balloon, registered VH-RJR and operated[1] by Liberty Balloon Flights, was being prepared for a balloon transport flight for 13 passengers from Royal Park, Victoria. The intended destination was Moorabbin Airport and this was the first flight of the balloon since manufacture.

The pilot conducted a pre-flight inspection, which involved inflating the balloon envelope with a fan to inspect the deflation vent system (see the section titled *Balloon information*). The basket contained 6 full propane fuel tanks and the burners were used to inflate the envelope with hot air. After the balloon was 'stood up', the pilot confirmed the correct functioning of the deflation vent system.

After the passengers climbed into the basket, the pilot conducted a pre-flight safety briefing, where passengers were asked to physically demonstrate the required landing position. At 0635, the balloon departed for an anticipated 1-hour flight.

Passenger images taken during the incident flight showed the vent panel – a fabric panel used to vent air out of the circular opening at the top of the balloon (vent aperture) – before take-off and about 2 minutes after take-off (Figure 1). The image from shortly after take-off showed that the vent panel was almost, or already, pushing through the vent aperture at normal internal envelope operating temperatures.

Figure 1: Vent panel before and after take-off (both images to scale)



Source: Passenger

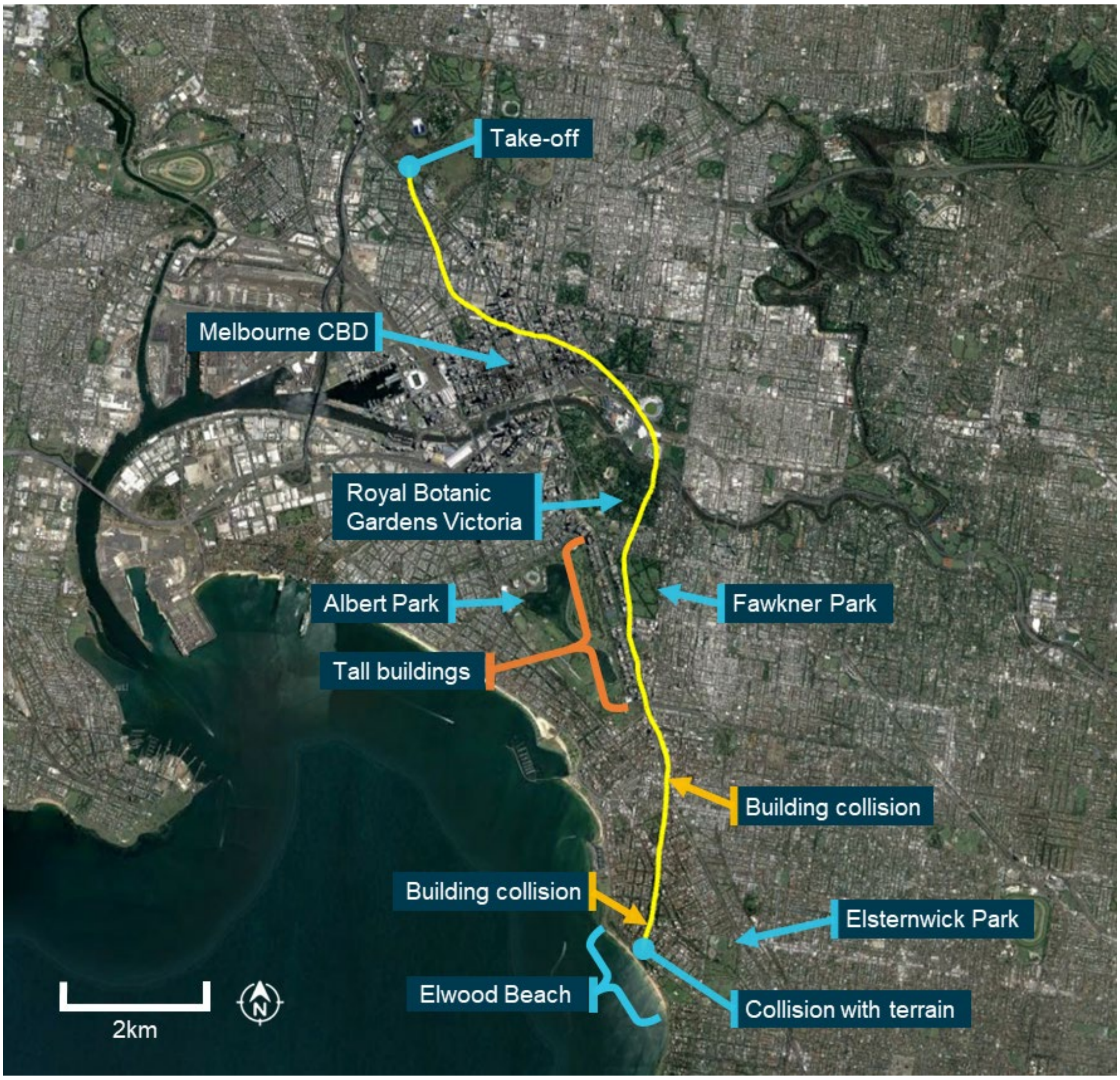
At about 0640, the pilot activated the burners to ascend above the Melbourne Central Business District (CBD). About 4 minutes later, and with the balloon flying over the CBD, the pilot noticed a small gap between the edge of the vent aperture and the vent panel. The pilot attempted to seal the gap using the deflation system rope lines but was unsuccessful. In response, the pilot then

1 The flight was operated under Civil Aviation Safety Regulations Part 131 (Balloons and hot air airships).

descended the balloon to a lower altitude in search of a suitable landing location. As the flight progressed, the gap between the vent aperture and the vent panel expanded and altitude control became increasingly difficult.

At about 0656, the pilot attempted an approach to land at Fawkner Park (Figure 2), but as the balloon descended over the Royal Botanic Gardens it tracked away from the larger central areas of the park. The pilot activated the burners and ascended into north-westerly winds to attempt to track back towards the park's central area but was not successful. The balloon continued to track south-south-east along the western edge of the park adjacent to nearby buildings.

Figure 2: Balloon flight track



Source: Google Earth and Hot Air, annotated by ATSB

At about 0706, the pilot descended the balloon to track towards Elwood Beach and instructed the passengers to adopt the landing position. During the descent, the balloon impacted a glass fence on top of a building. Shortly after, the pilot advised the passengers of a malfunction with the deflation system, for them to remain in the landing position, and the intent to land at Elwood Beach. The pilot continued to fly the balloon at low altitude towards Elwood Beach, which required almost continual operation of 1 or 2 of the balloon's 3 burners to maintain altitude.

At about 0714, the balloon impacted the top of another building. At about this time, fuel for 2 of the balloon's 3 burners was reportedly running very low, which reduced the heat generated by the burners.[2] Unable to maintain altitude, the pilot activated the burners to reduce the descent rate as the balloon descended into a suburban street through trees. As the balloon impacted the trees, the pilot pulled the red rip line to deflate the balloon envelope. However, this was only partially achieved as tree branches pulled the red line out of the pilot's hands.

The basket landed outside the entrance of an apartment building, and the envelope eventually deflated over the building's roof (Figure 3). The balloon and basket sustained minor damage during the collision, and three passengers sustained minor injuries. During the collision, the basket was not orientated with the long side perpendicular to the direction of travel. Although this was the normal procedure for any landing, the impact with the trees rotated the basket, and the pilot did not have time to correct this using the balloon's rotation vents. Further, using the vents would have increased the rate of descent during the landing.

Figure 3: Balloon landing site

Source: ATSB

Context

Pilot information

The pilot held a commercial pilot licence (balloon) and had accumulated 3,950 hours of flying experience, of which about 300 hours were on balloons in the same class[3] as the BB78Z. The

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[2] When fuel quantity diminishes, so does fuel pressure. This decreases burner heat output and the capability for climbing to clear obstacles or arrest a descent.

[3] The Civil Aviation Safety Authority (CASA) classifies balloons into three classes. Class 1 – Hot air balloons that have a volume of not more than 260,000 cubic feet. Class 2 – Hot air balloons that have a volume of more than 260,000 cubic feet. Class 3 – Gas balloons.

pilot had flown 60 hours in the previous 90 days. The occurrence flight was the first flight the pilot was undertaking in a BB78Z.

In discussing the incident, the pilot stated that:

- After noticing the deflation system was not sealing correctly, the pilot maintained the balloon's altitude as low as possible because it was safer and provided more potential landing areas. The heat required to ascend would have depleted the fuel reserves earlier. Moreover, later in the flight, keeping a lower altitude provided the shortest route to Elwood Beach. However, due to this low altitude, the pilot could not slow the balloon's descent fast enough to avoid colliding with the two buildings.
- Albert Park was a potential landing option but there was still a lot of work going on and equipment in the park from the recent Formula One Grand Prix. Good altitude control would also have been necessary to manoeuvre for a landing.
- Elsternwick Park was also an option but based on the prevailing winds would have required an ascent, increasing the fuel used, hence the pilot attempted to land at Elwood Beach.

Meteorological information

North-north-west surface winds at 7-8 kt and an air temperature of 11° C were forecast at Essendon Airport and Moorabbin Airport for the balloon's expected flying time.

The pilot completed a pre-flight load chart based on the temperature at the launch site (10° C) and expected maximum altitude (3,000 ft), which showed that there was sufficient available lifting capacity to conduct the flight.

The balloon's GPS unit recorded its velocity during the flight (indicative of wind speed and direction) which, after descending over the Royal Botanic Gardens, mostly varied between 6-10 kt.

Balloon information

The BB78Z is a 275,000 cubic feet hot-air balloon produced by Kubicek Balloons, a balloon manufacturer based in Czechia. The incident balloon (VH-RJR) was manufactured in 2021 (Figure 4) and included a T-partitioned basket with two passenger compartments fitted with rope handles, and a triple burner system. The envelope has vertical load tapes which transfer the internal envelope forces to carry the basket, and 24 gores (vertical fabric panel sections between vertical load tapes).

Figure 4: VH-RJR

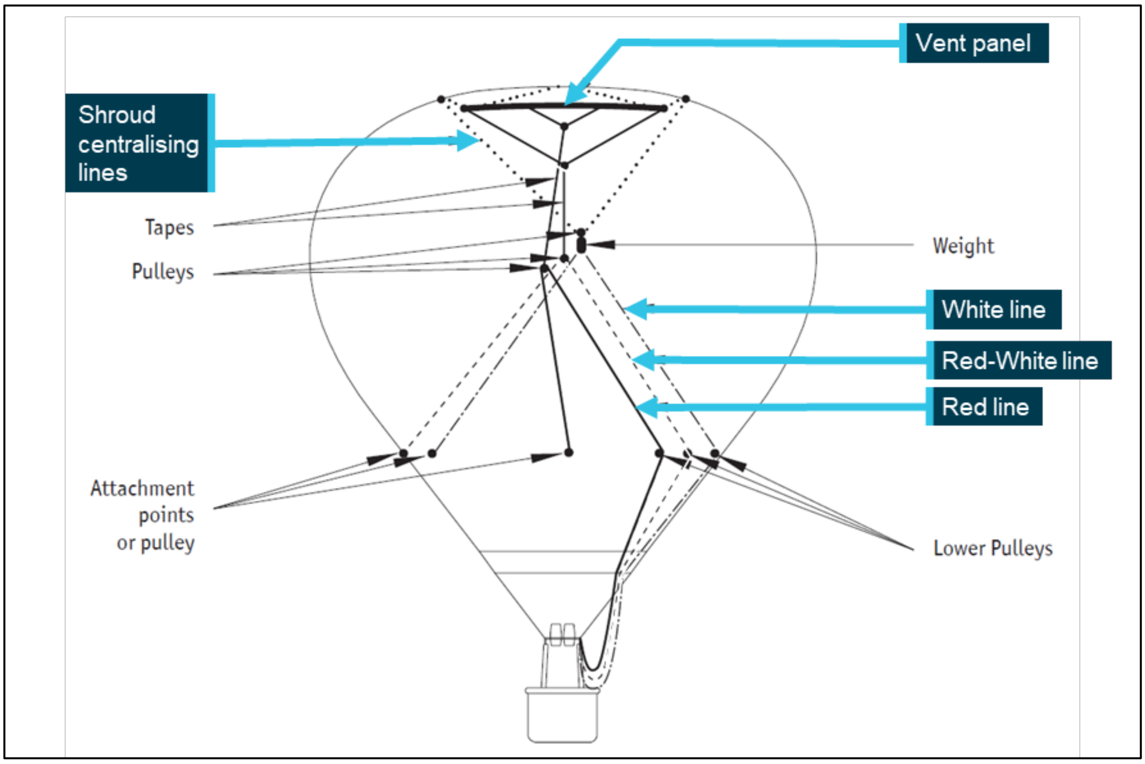
Source: ATSB

The balloon was equipped with a Kubicek 3-line deflation system (Figure 5). In-flight venting was achieved by pulling on the red-white line (parachute vent line) which in turn pulled the vent panel (Figure 6) at the top of the balloon for a controlled release of air through a circular opening (vent aperture). Releasing the parachute vent line allowed the vent panel to close.

The parachute vent line was used to descend the balloon, such as when approaching to land. For final landing, when the balloon was close to the ground, the fast deflation line (red line) was pulled so that the centre of the vent panel was pulled down into the balloon for rapid deflation. A white line was connected to the shroud centralising lines to stretch the vent panel over the vent aperture for proper sealing and to also to reset the vent panel after the red line was pulled. A weight was attached to the white line to assist with sealing.

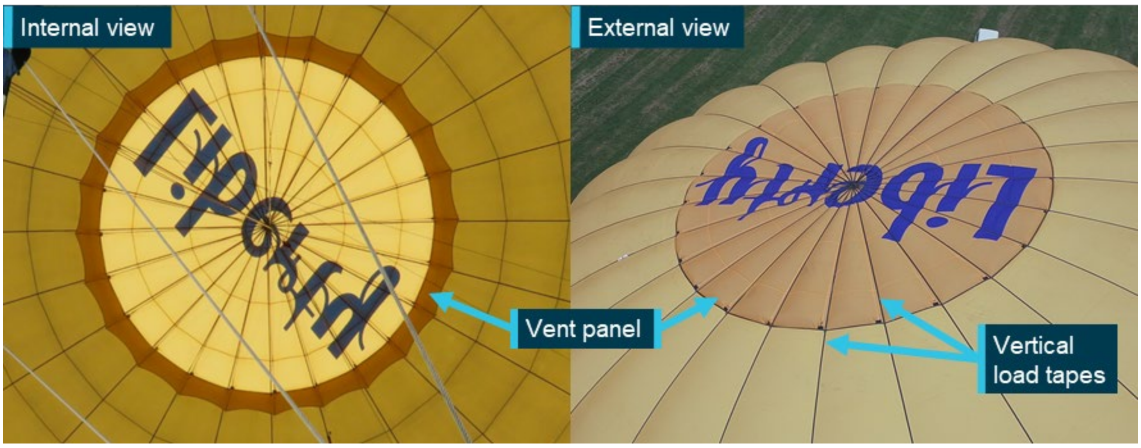
The balloon was also fitted with rotation vents on the side of the envelope which pilots could use to orientate the balloon during flight. These vents were used to ensure that the long side of the basket was perpendicular to the direction of travel during landing so the backwards facing passenger landing position was effective.

Figure 5: VH-RJR deflation system



Source: Kubicek Balloons, annotated by ATSB

Figure 6: Vent panel



Source: ATSB

The envelope was fitted with a temperature label which was a small strip sewn inside the envelope with several temperature-sensitive areas (116-154° C) that changed colour permanently according to the maximum temperature reached. The envelope was also fitted with a temperature warning streamer which fell towards the pilot if the envelope overheated (at least 124° C). Both temperature indicators were located near the top of the balloon.

Certification and entry into service

The BB78Z was certified under the European Union Aviation Safety Agency (EASA) regulations and United States Federal Aviation Administration (FAA) regulations, receiving a type certificate from EASA in 2016, and the FAA in 2017.

The Civil Aviation Safety Authority (CASA) issued this balloon model with a type acceptance certificate in 2018, making the model eligible to receive an Australian standard certificate of airworthiness.

Before VH-RJR was manufactured in 2021, the operator requested a larger vent (aperture and panel) to increase the balloon's descent performance. The manufacturer subsequently increased the radius of the vent aperture from 3.6 m to 4.0 m, which was the same radius used on the manufacturer's larger balloons and used the same type of deflation system. This design change was approved under the manufacturer's Design Organisation Approval.[4] The balloon subsequently completed factory testing before being shipped to the operator, and due to the unique design change, was the only one of its kind produced by the manufacturer. VH-RJR was also the first BB78Z registered in Australia.

The operator received the balloon on 13 April 2022 and submitted the information necessary to apply for the CASA certificate of airworthiness, which was issued shortly after. The balloon's first flight was on 20 April 2022 (the incident flight).

Post-incident balloon testing

The balloon was retrieved from the incident site and stored in a secure facility. In May 2022, the ATSB arranged for tests to be conducted on the balloon's deflation system in Yarra Valley, Victoria, with key stakeholders present. Representatives from the ATSB, balloon manufacturer, operator, and CASA were in attendance.

The envelope was first inflated on the ground using a fan to conduct an external and internal inspection of the envelope (Figure 7), with the following observed:

- white line, shroud centralising lines, and parachute vent line were tangled around the weight
- pulleys and rope lines were serviceable
- there was minor impact damage to the envelope fabric from the landing
- the temperature streamer was intact and the temperature indicator colour was unchanged.

[4] A Design Organisation Approval is the recognition that a Design Organisation complies with the requirements of Part 21 Subpart J of the EASA Commission Regulations. This subpart details the elements required of a design organisation in order to hold the Design Organisation Approval. The approval grants privileges for the organisation to design new products, product modifications or repairs and may include approval for these designs.

Figure 7: Internal envelope inspection

Source: ATSB

The manufacturer, operator, and maintainer considered the deflation system lines to be very likely caused by the abnormal packing of the disturbed envelope after the incident.[5] The lines were then untangled to continue with the test.

A wireless temperature sensor was fitted to provide an indication of the maximum internal envelope temperature reached during the test. The basket was tethered, and the burners were activated to stand the balloon up. People were loaded into the basket to provide a similar weight to the incident flight. The ambient temperature at the time of the test was about 7° C.

The internal envelope temperature was increased while external and internal camera footage of the vent panel was taken (Figure 8). At low temperatures, the vent panel began to push up against the internal envelope and vertical load tapes as designed, creating a seal. At about 90° C, edges of the vent panel between the vertical load tapes pushed up through the aperture creating many gaps for internal envelope air to vent out. Attempts to seal the gaps using the parachute vent line and white line were unsuccessful. At higher temperatures, the gaps became larger and more numerous.

The images indicated vent panel behaviour similar to that observed in the passenger's video (Figure 1) during the incident flight. The pilot, who attended the test, also reported that the vent gaps were very similar to those observed during the incident flight.

5 To avoid deflation system line tangles, the envelope must be packed in a specific manner.

Figure 8: Deflation system testing

Temperature values are approximate
Source: ATSB

After the test, the manufacturer designed a repair to fix the vent panel sealing issue and evaluated whether the spacing between the vertical load tapes at the edge of the vent panel was adversely affecting the seal. Another balloon test was conducted which showed that the repair improved the seal, however the balloon was not considered airworthy. The balloon envelope was subsequently shipped back to the manufacturer's headquarters for further examination.

Manufacturer investigation

The manufacturer's investigation focused on two key aspects:

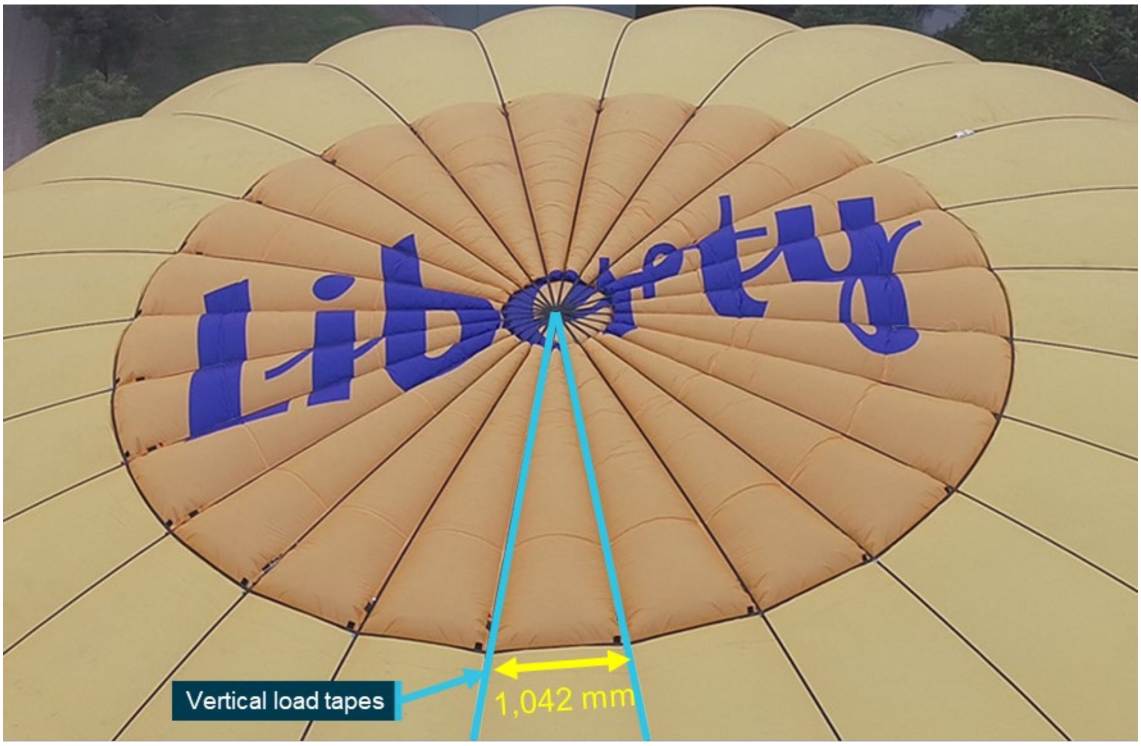
- vent panel seal

- post-manufacture factory testing.

Vent panel seal

The envelope's deflation system dimensions were compared with the design data with no differences found. The design differences between the VH-RJR deflation system and the same size deflation system fitted to the manufacturer's larger certified balloons was also reviewed. The review found that one significant difference was the vertical load tape spacing at the edge of the vent panel (Figure 9).

Figure 9: VH-RJR vent panel spacing between load tapes



Source: ATSB

The vent panel spacing was found to be:

- VH-RJR BB78Z with 24 gores and 4.0 m radius vent aperture – 1,042 mm spacing
- Standard BB78Z with 24 gores and 3.6 m radius vent aperture – 940 mm spacing
- Standard larger balloon with 28 gores and 4.0 m radius vent aperture – 893 mm spacing

The modified deflation system on VH-RJR, which increased the vent panel radius from 3.6 to 4.0 m, was based on larger certified balloons which had 28 gores compared to the 24 gores of the BB78Z. This meant that the spacing at the edge of the vent panel between the load tapes on VH-RJR became 149 mm longer than the larger balloons and 102 mm longer than the standard BB78Z.

Post-manufacture factory testing

The manufacturer's investigation into the post-manufacture factory testing of VH-RJR found the following:

- The factory test inflation report recorded that the internal envelope temperature reached 114 °C during the factory tethered test which was satisfactory.
- Based on information provided within the test inflation report, software was used to estimate the internal temperature reached during the factory test. The calculations estimated the

maximum internal temperature only reached about 89 °C. This was close to the temperature found during the ATSB test where the gaps in the vent panel started to form (about 90° C).

Further investigation

The investigation is continuing and will include review and examination of:

- modification process and procedure
- factory testing process and procedure
- acceptance into service

Should a critical safety issue be identified during the course of the investigation, the ATSB will immediately notify relevant parties so appropriate and timely safety action can be taken.

A final report will be released at the conclusion of the investigation.

General details

Occurrence details

Date and time:	20 April 2022 – 0716 Eastern Standard Time	
Occurrence class:	Serious incident	
Occurrence categories:	Collision with terrain	
Location:	14.6 km north-west of Moorabbin Airport, Victoria	
	Latitude: 37º 530.081' S	Longitude: 144º 58.931' E

Aircraft details

Manufacturer and model:	Kubicek Balloons BB78Z	
Registration:	VH-RJR	
Operator:	Liberty Balloon Flights	
Serial number:	1863	
Type of operation:	Part 131 Balloons and hot air airships-Balloon transport operation	
Departure:	Royal Park, Victoria	
Destination:	Moorabbin Airport, Victoria	
Actual destination:	Elwood, Victoria	
Persons on board:	Crew – 1	Passengers – 13
Injuries:	Crew – 0	Passengers – 3
Aircraft damage:	Minor	