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Australian Transport Safety Bureau

Flight preparation event involving Kavanagh E-260 balloon, VH-FSR

near Alice Springs, Northern Territory | 13 July 2013



Investigation

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Addendum

Page	Change	Date

Safety summary

What happened

On the morning of 13 July 2013 a Kavanagh E-260 balloon, registered VH-FSR, was being prepared for a charter tourist flight near Alice Springs, Northern Territory. Due to the wind conditions at the time, the passengers were pre-loaded into the balloon basket as it lay on its side. As one of the passengers prepared to enter the basket, their scarf became entangled in a fan that was being used to inflate the balloon envelope. Consequently, the passenger was rapidly drawn into contact with the fan's steel guard and the scarf was pulled tightly around their neck. Despite being provided with first aid, and subsequent medical treatment, the passenger died as a result of their injuries several days later.



Source: C and J Siviour

What the ATSB found

The ATSB found that pre-loading of the passengers during the inflation process, although appropriate in the wind conditions, resulted in them coming into close proximity to the operating inflation fan. Additionally, the mesh and steel tubing guard positioned around the inflation fan was ineffective in preventing loose items of clothing from becoming entangled in the wooden fan blades and driveshaft. As a result, when the passenger approached the balloon basket in preparation for loading, their scarf was drawn into the fan blades, leading to fatal injuries.

The pilot conducted two safety briefings prior to the proposed flight that advised the passengers to remain clear of the fan as it was noisy and dangerous. A warning sign fitted to the fan was also pointed out. However, none of the passengers recalled that the specific danger of fan entanglement had been mentioned.

What's been done as a result

Shortly after this accident, the ATSB forwarded a Safety Advisory Notice (SAN) to balloon operators highlighting the circumstances of this occurrence and advising that they review their risk controls in relation to the safety of inflation fans. With the assistance of the Professional Balloon Association of Australia and the Australian Ballooning Federation (ABF) the SAN was also provided to their members. The ABF and Northern Territory (NT) WorkSafe also issued safety alerts highlighting the danger of fan entanglement.

The balloon operator made a number of changes to prevent a similar accident, including:

- modification of all fan guards to reduce the likelihood of entanglement
- establishment of a passenger exclusion zone in the vicinity of the fan
- assignment of a crew member whose sole duty was to operate and supervise the fan
- inclusion of detail on the danger of entanglement in the passenger briefing card.

Safety message

This accident highlights how quickly entanglement in industrial equipment, such as the inflation fan, can cause fatal injury. While highlighting the danger to those unfamiliar can reduce the risk, isolating the hazard through effective fan safeguarding and passenger control is the most effective method of preventing such tragic accidents.

Contents

The occurrence	1
Context	7
Pilot information	7
Meteorological information	7
Cold-air inflation fan	7
The occurrence fan	7
Fan testing	8
Fan design and safety information	9
Flight preparation	11
Passenger briefing	11
Passenger loading procedure	12
Related occurrences	13
Safety analysis	14
Introduction	14
Development of the accident	14
Fan safeguarding	14
Passenger briefing	15
Passenger supervision	15
Findings	16
Contributing factors	16
Safety actions	17
ATSB safety advisory notice to balloon operators	17
Other safety action	17
General details	19
Occurrence details	19
Pilot details	19
Aircraft details	19
Sources and submissions	20
Sources of information	20
References	20
Submissions	20
Appendices	21
Appendix A – Australian Ballooning Federation alert	21
Appendix B – Northern Territory (NT) WorkSafe alert	22
Appendix C – Passenger briefing card	23
Australian Transport Safety Bureau	24
Purpose of safety investigations	24
Developing safety action	24

The occurrence

On 13 July 2013 at about 0530 Central Standard Time¹ a bus containing 10 passengers, a balloon pilot and a driver/ground crew member departed from Alice Springs, Northern Territory for a location on the outskirts of the city. The bus was ferrying the passengers and crew to the launch site of a charter flight in a Kavanagh E-260 balloon, registered VH-FSR. A large trailer, containing the balloon and required launch equipment was towed behind the bus.

As the bus travelled toward the planned departure site, the balloon pilot provided the passengers with a safety briefing that highlighted some of the hazards involved with the flight. That briefing included the requirement for the passengers to remain clear of the fan used to inflate the balloon (see the section titled *Cold-air inflation fan*).

On arrival at the planned launch site the balloon crew assessed that the location was unsuitable as the prevailing wind would have carried the balloon towards power lines during departure. Consequently, the crew decided to move to another location about 2 km away.

Once at the alternative launch site, the wind speed for the departure was found to be greater than ideal. The pilot reported that, as the wind often dropped at around sunrise, it was decided to wait until that time to launch the balloon. On that day sunrise occurred at about 0717.

During the wait the pilot conducted a further passenger briefing that reiterated how the flight was to progress as well as the hazards. Specifically, the passengers were told:

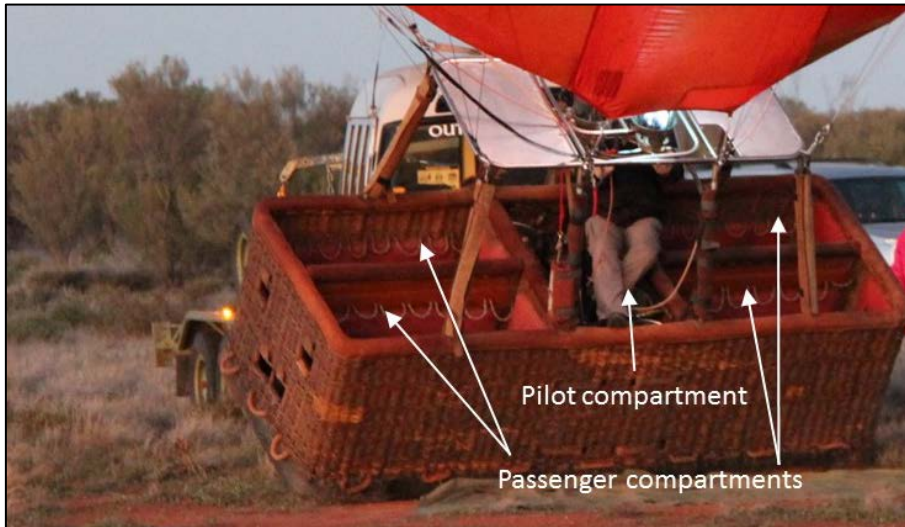
- to remain clear of the cold-air inflation fan
- that they were not permitted between the balloon basket and the bus during inflation.

The requirement to remain clear of the area between the basket and the bus was to minimise the risk of injury should the balloon basket move during inflation. Additionally, as the basket was tethered to the front of the bus during the inflation process, there was also a trip hazard associated with the tether.

The passengers were also informed that, due to the wind, they would be pre-loaded into the basket while it was positioned on its side and before the balloon was fully inflated (see the section titled *Passenger loading procedure*). The passengers were divided into two groups of five and allocated their positions in the basket. Due to the basket configuration, with the pilot and gas bottles occupying the centre area, passenger loading was only possible from either end of the basket (Figure 1).

¹ Central Standard Time (CST) was Coordinated Universal Time (UTC) + 9.5 hours.

Figure 1: Balloon basket passenger and pilot compartments



Source: ATSB

Following assessment that the wind speed was within the allowable limits, the balloon inflation process commenced at about 0700 using the cold-air inflation fan. Two of the passengers assisted with the inflation, under the supervision of the crew, by supporting the balloon's mouth (Figure 2).

Figure 2: Passengers assisting with the initial balloon inflation



Source: C and J Siviour

As the balloon inflated the ground crew member repositioned to take control of a long rope (crown line) that was attached to the top of the balloon envelope (Figure 3). The crown line ensured that the balloon envelope remained stable as it inflated and did not contact the basket, burner or inflation fan. Operation of the crown line resulted in the ground crew member being over 50 m away from the basket and out of sight of the pilot and passengers. The pilot remained at the basket to conduct pre-flight checks on the balloon and supervise the loading of the passengers.

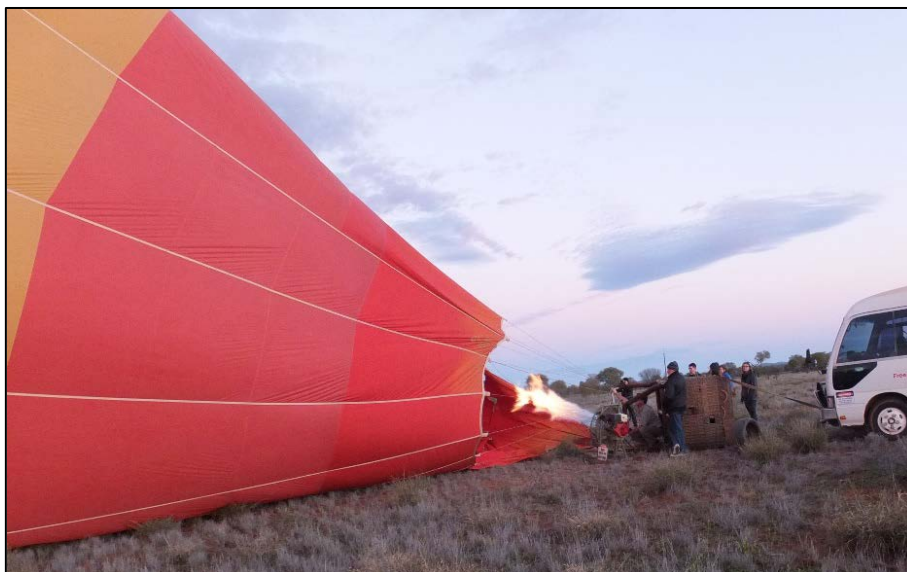
Figure 3: Example of a ground crew member controlling the balloon crown line



Source: ATSB

Once the balloon was inflated sufficiently for the balloon mouth to support itself, the assisting passengers moved to their allocated end of the basket ready for loading. Once they were clear of the mouth, the pilot accelerated the inflation process by using the burners positioned on the frame mounted above the basket to heat and expand the air within the envelope (Figure 4).

Figure 4: Balloon inflation was assisted by the application of burner heat once the assisting passengers had moved clear of the balloon mouth



Source: C and J Siviour

As the balloon envelope inflated it gradually rotated to the left and aligned itself with the wind. As a result of that movement, the basket connected to the balloon was pulled around closer to the inflation fan (Figures 5 and 6). In response, the pilot repositioned the fan away from the basket a number of times to ensure continued efficient inflation of the balloon.

Figure 5: Balloon basket originally positioned parallel to the front of the bus



Source: C and J Siviour

Figure 6: The basket orientation altered as the balloon increased in size and became affected by the wind



Source: R Bernoth

At around 0715, the pilot instructed the passengers allocated basket positions furthest from the inflation fan to commence pre-loading (Figure 7). After several of the passengers had entered the basket, the pilot directed the passengers assigned locations closest to the fan to begin pre-loading. The pilot reported that he monitored the passengers as they entered both ends of the basket. During the loading process he remained on the fan-side of the basket near to the balloon's burner frame, about 1.5 m to 2 m away from the fan. The passenger's recollection of the distance between the basket and the fan varied between 1 and 2.5 m.

Figure 7: Passengers pre-loading into the side of the basket furthest from the inflation fan (Note: the pilot on the left side adjusting the fan's position)



Source: N Poulsen

The first passenger who entered the basket on the fan-side stated that they gained access by moving through a gap between the fan and the basket as they did not wish to be subjected to the force of the air that would have resulted from passing in front of the fan. Several passengers situated close to the fan recalled that a second passenger then similarly moved between the fan and the basket to begin pre-loading. In contrast, the pilot recalled that both passengers approached the fan-side of the basket by walking around in front of the operating fan.

As the second passenger approached the fan, the scarf they were wearing was drawn into the operating fan and rapidly become entangled around the fan blades and driveshaft. As a result, the passenger was drawn into contact with the fan's steel guard and the scarf was pulled tightly around their neck. The pilot reported that, in response, he immediately shutdown the fan and called out to the ground crew member. He advised that he did not recall that the passenger had been wearing a scarf.

None of those present witnessed the initiation of the entanglement, nor what specific part of the fan guard the scarf was drawn into. The pilot reported having positioned the passenger at the basket prior to the scarf contacting the fan guard. However, other witnesses recalled that the accident occurred as the passenger moved between the fan and the basket.

Most passengers indicated that prior to the actual day of the flight they had been advised to wear warm clothes. Some passengers mentioned that items such as beanies, scarves and gloves had been suggested.

The passenger who became entangled in the fan wore a scarf that was wrapped twice around their neck and loosely knotted such that it could not be quickly removed if caught. The scarf had long, lightweight tassels on each end, some of which extended just beyond the bottom of the passenger's coat.

The ground crew member advised that, as a result of hearing the fan stop, he returned to the basket. On reaching the injured passenger he cut the scarf free and, with the assistance of the pilot, called for an ambulance.

Despite the provision of first aid and subsequent medical treatment, the passenger succumbed to their non-survivable injuries several days later.

Context

Pilot information

The balloon pilot held a Commercial Pilot (Balloon) Licence and a medical certificate issued by the Civil Aviation Safety Authority (CASA). The pilot had significant ballooning experience, having flown VH-FSR and other similar balloons in the Alice Springs area many times over a number of years. The pilot was also a qualified balloon instructor and held a number of overseas commercial balloon pilot licences.

The pilot complied with the operations manual recency requirement and had undergone a biennial balloon flight review with the operator on 13 November 2011. They had also completed a number of other flight reviews and checks as recently as 6 weeks prior to the accident.

Meteorological information

The pilot reported that a weather forecast for the intended flight was obtained from the Bureau of Meteorology. The weather was predicted to be fine with a northerly wind of 7 kt. Observations from Alice Springs Airport, about 6 km from the launch site, recorded a north-north-easterly wind from 4 to 7 kt at about the time of the accident.

The pilot assessed the actual wind direction at the launch site by releasing a number of small weather balloons. Their movement indicated an easterly wind at the surface that transitioned to the forecast northerly with height. The pilot estimated that the wind strength was between 6 and 8 kt. The passengers reported that the weather on the day was fine and 'breezy' or 'a bit of a surface breeze'. The operations manual had a requirement that flights were not to proceed when the surface wind exceeded 8 kt.

Cold-air inflation fan

Initial inflation of a hot air balloon envelope requires the use of a cold-air inflation fan. Efficient inflation relies on correct fan positioning relative to the mouth of the envelope. As a result, if the balloon envelope position changes due to the effects of the wind, the fan may need to be repositioned.

Once there is sufficient air inside the envelope to support the mouth, heat from the gas burners is applied. The application of heat expands the air and, as a result, the envelope. Expansion of envelope results in more air being drawn in via the mouth. The continued use of the cold-air inflation fan during the expansion stage assists the speed of the overall inflation process.

The occurrence fan

The occurrence fan consisted of a large two-bladed wooden propeller attached to the output shaft of a petrol-powered engine (Figure 8). The fan blades were enclosed within a welded steel mesh cage with square holes about 47 mm in width. The operator stated that the fan cages were made locally to their own specifications as they had found that previously-used production fans were not sufficiently robust. The fan also had two wheels at the bottom to facilitate positioning.

The fan assembly had a sign attached to one side that advised 'DANGER HIGH SPEED FAN KEEP AWAY' (Figure 9). The fan engine had a key switch located on a panel at the rear of the engine that could immediately stop the engine/fan.

Examination of the fan identified remnants of the woollen scarf caught around the blades and driveshaft. Both wooden blades had tip damage that also contained small strands of wool. The upper front part of the guard had minor damage that increased the size of the mesh opening (Figure 8). That damage appeared to pre-date the accident.

Figure 8: The cold-air inflation fan with remnants of the scarf (pre-existing minor cage damage highlighted)



Source: ATSB

Figure 9: Installed fan warning sign



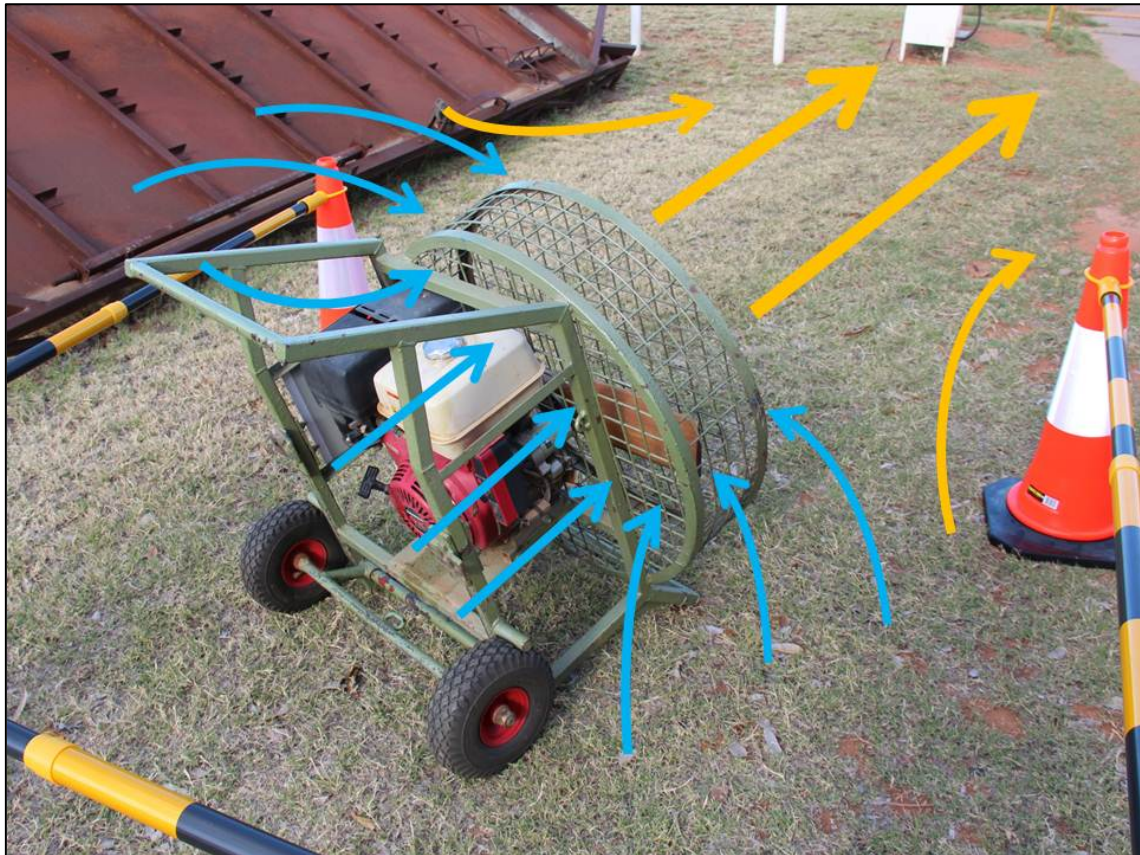
Source: ATSB

Fan testing

The ATSB tested the airflow around one of the operator's similar fans while it was operating at normal inflation RPM (Figure 10).

It was identified that air was drawn from the rear of the fan at a distance of 40 cm behind the guard, with significantly more suction within 15 cm of the guard. The fan also drew air in from the circular section of the guard from about 20 cm and from a region in front of the guard.

Figure 10: Cold-air inflation fan airflow (blue arrows show air being drawn in, yellow arrows show outflow)



Source: ATSB

Fan design and safety information

CASA is the regulatory body responsible for ballooning operations in Australia. CASA provides guidance for the commercial operation of balloons with regard to maintenance, passenger control and other safety-related issues. While CASA had not regulated or specified the design or use of devices such as cold-air inflation fans at the time of the accident, CASA subsequently advised that:

...as the new balloon regulation is developed Civil Aviation Safety Regulation 1998 Part 131 will include that balloon operators whether private, or commercial Air Operator Certificate (AOC) operators, must have adequate safety procedures for inflation fan use. AOC holders will need to describe their Standard Operating Procedures in their operations manual.

At the time of writing the making of Part 131 was estimated to occur in mid-2016, with commencement expected by the first quarter of 2017.

As part of this investigation, the ATSB identified the following information relating to the safeguarding of fans.

International Standard ISO 12499:1999 Industrial fans – Mechanical safety of fans – Guarding

Although not related specifically to balloon cold-air inflation fans, the International Organisation for Standardisation published a standard that provided 'information on the safety aspects of fixed guards for use with industrial fans'. The document identified that mechanical hazards from fans could result in severe or fatal injuries. Consequently, the standard advised that 'safeguarding measures shall be undertaken to minimize risk'.

The standard identified a number of means of safeguarding the fan, including:

- identification of the hazard(s) via warning labels
- elimination or avoidance of the hazard(s) through the use of safety distances
- the use of physical safeguards such as protective fixed guards.

In relation to the use of fixed guards, the standard stated that:

The guard shall, by its design, prevent access to the dangerous parts of the fan and associated equipment. It shall be of robust construction, sufficient to withstand the stresses generated by the operation of the fan and the environmental conditions...

...

Perforated material used for the manufacture of guards shall be perforated metal, woven mesh, welded wire, metal lattice or similar. The mesh size and distance of the guard from the danger point or zone shall be sufficient to prevent contact....

United States Department of Labor Occupational Safety and Health Standard 1910.212 Machinery and Machine Guarding

The United States Department of Labor Occupational Safety and Health Standard 1910.212 detailed the requirements for machinery and machine guarding in industrial applications.

Standard number 1910.212(a)(5) stated that when a fan is less than 7 ft (2.1 m) above the working floor, the blades shall be guarded and that the opening in the guard shall be less than half an inch (12.5 mm). An accompanying document clarified that the use of concentric rings (Figure 11) with spacing between them not exceeding half an inch was considered to be acceptable providing that sufficient radial spokes and firm mountings were used to make the guard rigid.

Figure 11: Concentric ring-style fan guard



Source: Ventry Solutions Inc.

United States Federal Aviation Administration Balloon Flying Handbook

In relation to the hazards associated with cold-air inflation fans, the United States Federal Aviation Administration (FAA) Balloon Flying Handbook (www.faa.gov) stated:

The inflation fan is one of the most dangerous pieces of equipment in ballooning...Fan blades have been known to shatter or break, throw rocks at high velocity, and inadequate cages or guards fail to protect fingers and hands...The fan should have a cowling of fibreglass or metal because a cage or grill alone is not sufficient to stop rocks or pieces of blade from being thrown.

...

Crewmembers, as well as the pilot, should be clothed for safety and comfort. Cover or restrain long hair. Scarves, hanging jewellery, or loose eyeglasses can interfere with smooth setup, and can potentially be very dangerous, particularly near the inflation fan.

The balloon operator advised that one of their inflation fans had a metal cowl around the periphery of the cage as recommended in the FAA handbook (Figure 12). The operator reported that the presence of the cowl significantly reduced the inflation airflow.

Figure 12: Shrouded fan design



Source: ATSB

That view was supported by an inflation fan manufacturer (www.ventry.com). A video demonstration conducted by that manufacturer compared the operation of a fan with a cowl around the periphery to one having only a mesh surround. The footage showed that operation of the fan with a cowl in place significantly decreased the fan's output while also increasing the amount of noise generated by the fan. The manufacturer's description on the airflow pattern around a mesh-enclosed fan were consistent with the findings of the ATSB testing.

Flight preparation

Passenger briefing

The company operations manual listed the various responsibilities and procedures to be followed during ballooning operations. The manual contained a requirement that a flight briefing was to be provided to all passengers detailing the:

- procedure to be followed by passengers during landing in order to minimise the risk of injury
- correct method to enter and exit the balloon basket
- requirement not to interfere with the flight controls in the pilot's compartment
- dangers of the inflation fan and smoking in proximity to the balloon.

In the event that the passengers had limited understanding of English, the briefing was required to include a physical demonstration and use a pictorial briefing card.

The operations manual also detailed the briefing to be provided to passengers assisting with the inflation of the balloon. That briefing was required to detail:

- '...where to stand, what to do and what to expect as the inflation progresses.'
- the process for holding the balloon envelope mouth open during cold and hot air inflation
- the method of handling the envelope to ensure that it was not damaged.

That section of the operations manual also stated that:

If a person is allocated the task of supervising the inflation fan they will not be wearing clothing that can be entangled in the fan. The importance of standing behind the line of rotation of the fan blade will also be emphasised.

Although detailed in the manual, the operator stated that passengers had not supervised the operation of the inflation fan for at least 15 years. Only company pilots and crew that had been trained in inflation fan management were permitted to operate the fan.

The passengers reported that they received two briefings prior to the start of the balloon inflation process. Those briefings identified the hazards of the fan indicating that it was noisy and could be dangerous. The danger sign on the side of the fan was also pointed out.

When interviewed by the ATSB shortly after the accident, the pilot reported that the passengers had been instructed not to stand too close to the fan. The pilot later advised that the danger posed by long hair or loose clothing had also been emphasised. None of the passengers reported that any mention was made of the hazards of long hair or of wearing clothing that could become entangled in the fan.

In addition to the hazard posed by the fan, the passengers recalled that the briefings also emphasised a number of other aspects, including the:

- requirement to remain clear of the gap between the bus and balloon basket once the inflation commenced
- potential for unrestrained cameras to cause injury during landing
- requirement not to smoke.

A number of the passengers did not speak English as their primary language. As a result, several of them advised that they had difficulty understanding parts of the briefings. However, those passengers further stated that there was sufficient understanding within the group for the message to be successfully explained. It was reported that the passenger who became entangled in the fan had a high level of English language proficiency.

Passenger loading procedure

Under conditions of little or no wind passengers would normally enter the basket once it and the balloon envelope were upright (Figure 13). Due to the wind conditions that existed on the morning of the accident however, the pilot decided to pre-load the passengers into the basket while it was on its side.

Figure 13: Passenger loading in calm conditions



Source: ATSB

Pre-loading is a widely used method of passenger loading that stabilises the balloon envelope against the effect of wind as it rises vertically. That method also ensured that the passengers did not have to enter a moving basket. The pilot reported having conducted pre-loading operations many times previously. Although a number of passengers recalled that the method of pre-loading

was discussed during the briefing provided by the pilot, no procedural guidance on that method of loading was provided in either the flight or operations manuals.

Civil Aviation Order (CAO) 20.16.3 *Air service operations - Carriage of persons*, contained requirements relating to the loading of passengers in hot air balloons. Specifically, subsection 6A of the order stated:

A manned balloon or hot airship engaged in charter operations need not carry a cabin attendant if:

(d) during passenger loading and launching operations, and as far as possible during landing and passenger unloading operations, at least the following are **available** [ATSB emphasis] to help the pilot with loading or unloading passengers:

(i) if not more than 16 passengers are carried – 1 ground crew member trained in accordance with the manual (a *trained ground crew member*)

The ATSB sought clarification from CASA in relation to the meaning of 'available' in the context of the ground crew member operating the crown line during passenger loading. The following advice was received:

The CAO required the ground crew to be available to help the pilot load the passengers at all times during the loading process. The ordinary dictionary meaning of the word 'available' required the ground crew to be at hand, of use or service. If the ground crew was engaged in a task that he or she could not readily stop performing, then that person was not available to help the pilot load the passengers.

The pilot stated that the CAO requirements were complied with as the ground crew member was at all times able to release the crown line and assist the pilot without jeopardising the safety of the balloon.

Related occurrences

In order to identify other accidents and incidents involving cold-air inflation fans, the ATSB conducted an extensive review of Australian and overseas occurrence databases. That review identified one similar accident to this occurrence in which a crew member was seriously injured when a rope they were handling became entangled in an inflation fan (www.nts.gov.au - National Transportation Safety Board reference FTW96LA140).

Safety analysis

Introduction

The results of a worldwide database search identified that this accident appeared to be a rare occurrence, with only one other fan-related accident identified.

This analysis will examine the factors that contributed to the accident, including the management of risks associated with moving around hot air balloons that are being prepared for flight.

Development of the accident

The passengers had been advised to wear warm clothing for the early morning balloon flight and all had worn attire consistent with that request. The passenger who became entangled in the fan had worn a long scarf, loosely knotted, on the outside of their clothing. Due to the way the scarf was worn, there was no opportunity for it to pull free as it was drawn in to the fan.

Pre-loading of the passengers during the inflation process, although appropriate in the wind conditions, resulted in the passengers entering the fan-side of the basket coming into close proximity to the operating inflation fan. The effectiveness of the following measures that were in place on the day to prevent fan entanglement will be examined:

- fan safeguarding
- passenger briefings
- passenger supervision.

Fan safeguarding

Although there was no specific standard identified relating to inflation fans, the occurrence fan did have two of the safeguards recommended for industrial fans: a warning sign and a fixed guard. The warning sign had been identified during the passenger briefing. However, as the sign was only on one side of the fan assembly, and accounts varied as to the path taken by the passenger to the basket, it may not have been visible to them. In that regard, and despite the warning sign having been identified by the pilot during the passenger briefing, the salience of the warning to the passenger as they approached the fan could not be determined.

The mesh and steel tubing guard positioned around the fan did not prevent the scarf tassels being drawn in to the fan blades as the passenger walked towards the basket. A review of the safeguarding of similar fans identified that the occurrence fan had a relatively large mesh size and no peripheral cowl. The mesh size on the occurrence fan was also larger than that recommended in the United States (US) Department of Labor Occupational Safety and Health Standard. Given the lightweight nature of the scarf tassels, it could not be concluded that a smaller mesh would have prevented the scarf from reaching the fan blades on this occasion. More generally however, safeguarding forms an important part of managing the risk associated with hazardous equipment such as fans. Therefore the ATSB recommends that balloon operators review the adequacy of fan guards, including the mesh size, in the context of the international and US standards for industrial fans.

None of the witnesses recalled whether the scarf was drawn in to the periphery of the fan guard. As ATSB testing identified that air was also drawn in from other areas of the guard, the fitment of a cowl may not have altered the outcome. Additionally, while the inclusion of a peripheral cowl provides additional safeguarding, it also appears to significantly reduce the fan output. That could result in a situation where an additional fan was required for efficient inflation, likely increasing the overall risk.

Given the limitations of the above safety measures, and the typical distances from which items can be drawn in to a fan, the most effective method of preventing entanglement would be through

isolation of the inflation fan. Recognising the reduction of overall inflation efficiency, that could best be achieved by shutting the fan down during passenger loading. The use of barriers or minimum approach distances may also be effective.

Passenger briefing

Prior to commencing the balloon launch preparation, the pilot briefed all of the passengers on a number of the hazards associated with the planned flight. While the passengers did not share the pilot's recollection that the danger of fan entanglement had been specifically identified, they did have a common belief that the cold-air inflation fan had been identified as noisy and dangerous. The passengers also recalled that the danger sign attached to the fan had been highlighted.

The passenger who became entangled in the fan was reported to have had a high degree of proficiency in English. As such, it was considered unlikely that they would have had difficulty understanding the briefing.

Given the adventurous nature of hot air ballooning, it is likely that the majority of passengers would be focussed on the impending flight rather than the launch site hazards. In that context, the danger posed by equipment such as inflation fans would be best managed by actively blocking access. Therefore, limited reliance should be placed on the effectiveness of hazard information conveyed via briefings.

Passenger supervision

The management of the crown line by the ground crew member resulted in the pilot alone supervising the passenger loading while also inflating the balloon. In the context of the Civil Aviation Order 20.16.3 requirement, the pilot stated that the ground crew member was at all times able to release the crown line and assist the pilot without jeopardising the safety of the balloon. That viewpoint is supported by the crew member's action in releasing the line and returning to the basket on hearing the fan stop.

The pilot reported that they did not recall that the passenger who became entangled had been wearing a scarf. That indicated that the pilot either did not specifically notice the scarf, recognise the potential for the scarf to be drawn in to the fan, or their attention was focussed on other activities at the time. While the presence of the ground crew member at the basket during loading would have provided additional supervision of the passengers, there was insufficient evidence to conclude that it would have prevented the accident.

Findings

From the evidence available, the following findings are made with respect to the flight preparation event involving Kavanagh E-260 balloon, registered VH-FSR, which occurred near Alice Springs, Northern Territory on 13 July 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- Pre-loading of the passengers during the inflation process, although appropriate in the wind conditions, resulted in them coming into close proximity to the operating cold-air inflation fan.
- The mesh and steel tubing guard positioned around the cold-air inflation fan was ineffective in preventing loose items of clothing from becoming entangled in the wooden fan blades and driveshaft.
- In preparation for loading, the passenger moved sufficiently close to the operating cold-air inflation fan for their scarf to be drawn into the fan blades, leading to their fatal injuries.

Safety actions

No safety issues were identified during this investigation. However, the following proactive safety action was taken by a number of organisations in response to this occurrence.

ATSB safety advisory notice to balloon operators

On 18 July 2013 the ATSB wrote to Australian balloon operators to advise the circumstances of this accident. Due to concern that other balloon operators may be similarly exposed to the hazard associated with cold-air inflation fans, that correspondence included the following safety advisory notice (SAN) AO-2013-116-SAN-003:

The Australian Transport Safety Bureau advises balloon operators to review their risk controls in relation to the safety of cold-air inflation fans, especially in relation to passenger proximity to operating fans, and the security of loose items, such as passenger clothing.

The SAN was forwarded to the Professional Balloon Association of Australia and the Australian Ballooning Federation (ABF) for dissemination to members of those organisations. In response, the ABF produced Pilot Safety Alert No 02 in July 2013 (appendix A).

The SAN was also distributed to all operators of balloons listed on the Civil Aviation Safety Authority's register.

Other safety action

Northern Territory (NT) WorkSafe

On 20 August 2013 Northern Territory (NT) WorkSafe issued a safety alert titled, *Preventing contact or entanglement with machinery or plant with moving parts*. That alert highlighted the ineffectiveness of the fan guard in this accident. NT WorkSafe recommended that barriers should be erected around the fan to prevent access. They also advised that the fan operation should be supervised in public thoroughfares or areas of high traffic (appendix B). This safety alert was reproduced by other safety related organisations in Australia and internationally.

Civil Aviation Safety Authority

In February 2014 the Civil Aviation Safety Authority (CASA) included an article titled *Spiralling Danger* in issue 96 of the Flight Safety Australia magazine. That article highlighted the hazards associated with cold-air inflation fans (www.casa.gov.au).

The balloon operator

Fan guard modification

The mesh size on the operator's cold-air inflation fan guards have been reduced in size to impede the ingress of items such as scarves and other items of loose clothing (Figure 14). Changes to the mesh size can be identified by comparison with the occurrence fan (Figure 8).

Figure 14: Modified fan guard with reduced mesh size



Source: Balloon operator

Operational changes

The operator introduced a number of operations manual requirements to reduce the risk posed by inflation fans. Specifically, a passenger exclusion zone was established around operating fans and detail on the danger of entanglement was included in the passenger briefing. On arrival at the launch site passengers are now required to leave any scarves on the bus.

The following procedure was also established regarding the operation of the fan:

The fans may only be operated by a 'fan' crew person trained to manage the fan. The fan crew person must remain within the exclusion zone and within 1 metre of the fan at all times the fan is running.

The fan person must wear a high visibility vest, ear plugs and carry a knife suitable for cutting any rope like material that may be entangled in fan.

The operator has produced new passenger briefing cards that highlight the hazards of the inflation fan and a 'keep clear' distance of 2 m. A new passenger exclusion zone between the front of the bus and the balloon is also illustrated (appendix C).

Finally, and although not required for balloon operations, the operator has introduced a safety management system to provide:

... an integrated set of work practices, beliefs and procedures for monitoring and improving the safety and health of all aspects of our operation. It recognizes the potential for errors and establishes robust defences to ensure that errors do not result in incidents and accidents.

General details

Occurrence details

Date and time:	13 July 2013 – 0720 CST	
Occurrence category:	Accident	
Primary occurrence type:	Flight preparation event	
Location:	near Alice Springs, Northern Territory	
	Latitude: 23° 49.53' S	Longitude: 133° 50.55' E

Pilot details

Licence details:	Commercial Pilot (Balloon) Licence, issued July 1993
Endorsements:	Balloon Class 1, 2, 3 and 4
Medical certificate:	Class 2, valid to 28 January 2014
Aeronautical experience:	Approximately 3,343 hours
Last flight review:	13 November 2011

Aircraft details

Manufacturer and model:	Kavanagh E-260 balloon	
Year of manufacture:	2009	
Registration:	VH-FSR	
Serial number:	E260-403	
Total Time In Service	311.7 hours (as of 8 July 2013)	
Type of operation:	Charter	
Persons on board:	Crew – 1	Passengers – 10
Injuries:	Crew – 0	Passengers – 1
Damage:	None	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- balloon operator, crew and passengers
- United States Federal Aviation Administration
- Civil Aviation Safety Authority (CASA).

References

Crew Training, A Guide to Working with Hot Air Balloons, <http://www.cazooee.com/crewing/> - retrieved 2 October 2014.

Balloon Life magazine article on inflation fan placement, http://www.balloonlife.com/publications/balloon_life/9801/9803/fanplace.htm – retrieved 2 October 2014.

International Organisation for Standardisation 1999, *International Standard ISO 12499:1999 Industrial Fans - Mechanical Safety of Fans – Guarding*.

United States Department of Labor Occupational Safety and Health Standard 1978, Defining Acceptable Guarding of Fan Blades, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=1718 - retrieved 2 October 2014.

Federal Aviation Administration 2008, *Balloon Flying Handbook*, United States Department of Transportation

Demonstration of fan shrouding effects, <http://www.ventry.com/fans/gallery/index.html#guard> - retrieved 2 October 2014.

Civil Aviation Safety Authority Flight Safety Australia magazine, issue 96, http://www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_101837 - retrieved 2 October 2014.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the balloon operator and crew, CASA and the passenger's next of kin.

Submissions were received from the balloon operator, CASA and the passenger's next of kin. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A – Australian Ballooning Federation alert

ABF Pilot Safety Alert

Issue 02, July 2013

Pilot Safety Alert No 02

Australian Ballooning Federation Inc

IN THIS ISSUE

Inflation Fans – IMMEDIATE ACTION REQUIRED

In light of a recent serious injury when a passenger's neck scarf was sucked into the inflation fan due to her proximity to the device, all pilots and crew should immediately adopt appropriate risk controls to mitigate this type of event.

It is recommended that pilots ensure passengers wearing loose items of clothing such as scarves remove and stow the apparel prior to approaching the basket for emplaning. Appropriate measures should also be taken for passengers with long, unrestrained hair and when apparel has dangling string and toggle fasteners. The pre-flight passenger brief should also make reference to this risk with emphasis that, as with all emergencies the likelihood is very remote.

Additional recommendations will likely result from the current ATSB investigation. These will be circulated to all members when available.

Pilot Safety Alert (PSA) is produced by the Australian Ballooning Federation Inc. It contains operational and safety information for all Australian balloon pilots and crew. All ABF members – from the newest student to the most experienced pilot, and to crew – are invited to contribute to PSA on issues they feel other members may wish to know about, to raise questions they would like information on, or to make general comment. Thanks in anticipation to all members who contribute.

Safety first, trust, honesty, openness, responsibility, and accountability.

1

Appendix B – Northern Territory (NT) WorkSafe alert



SAFETY ALERT

Preventing contact or entanglement with machinery or plant with moving parts

The purpose of this alert is to highlight the need for appropriate guards or barriers around machinery or plant with moving parts to reduce the risk of contact or entanglement that could lead to serious or fatal injuries.

Background

A female passenger was boarding a hot air balloon near Alice Springs when her scarf was drawn through the wire mesh at the rear of a cold air inflation fan powered by a direct drive 13 horsepower motor. The scarf became entangled in the fans blades and spindle causing fatal injuries to the passenger.

Air inflation fans (pictured below) are commonly used to inflate hot air balloons prior to loading passengers.

Contributing factor

- The guarding around the air inflation fan blades was not sufficient to prevent objects being drawn through them.

Action required

- Owners and operators of machinery or items of plant with moving parts should provide guarding that is sufficient to prevent the entanglement of loose clothing or hair of operators, passengers or people passing by.
- If machinery or items of plant are being operated in public thoroughfares or areas of high traffic, physical barriers should be erected to prevent access to the vicinity of the machinery or item of plant.
- The operation of machinery or plant in public thoroughfares or areas of high traffic should be supervised.



Further Information

- [Safety Alert: Go-Karts](#) (WorkCover NSW)
- [Safety Alert: Guarding for Powered Bin Tippers](#) (WorkSafe WA)
- [Safety Alert: Unguarded grain and fertiliser auger causes serious injury](#) (WorkSafe WA)

Contact Details

For further information, please contact NT WorkSafe on 1800 019 115 or go to www.worksafe.nt.gov.au

Disclaimer

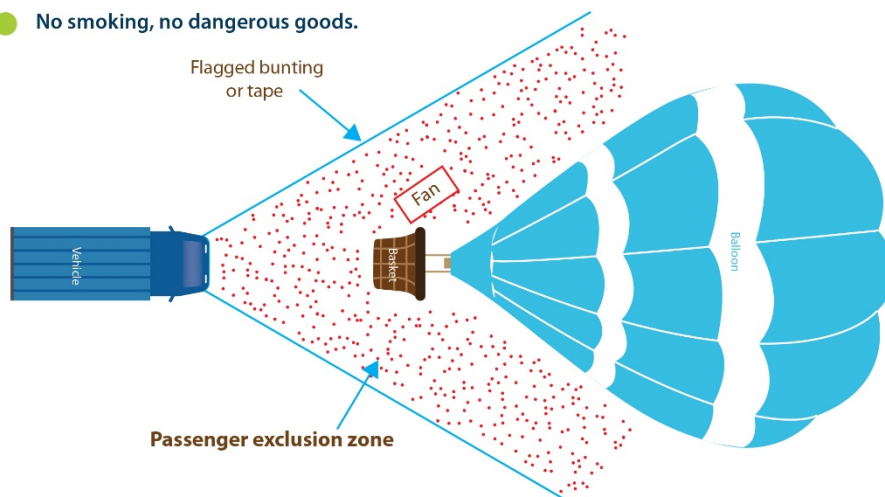
This alert contains safety information following inquiries made by NT WorkSafe about an incident or unsafe practice. The information contained in this Alert does not necessarily include the outcome of NT WorkSafe's action with respect to an incident. NT WorkSafe does not warrant the information in this Alert is complete or up-to-date and does not accept any liability for the information in this report or as to its use.

Appendix C – Passenger briefing card

OUTBACK BALLOONING PTY LTD **Passenger Boarding Pass & Balloon Safety**

Passenger Briefing

- Passenger exclusion zone during inflation – stay outside the roped off fan and basket area.
- Entry to the basket – use the steps.
- Landing position - feet together, knees slightly bent, body braced back (or sideways facing the pilot) towards the direction of travel and holding the rope handles until balloon has stopped.
- Get in the landing position before launch and landing.
- Do not leave the basket until the pilot says you can get out –passengers' weight is important. If there is a passenger exchange one in and one out at a time, keep clear of the front of the basket.
- Secure cameras and other articles before landing. No loose straps around necks.
- Fast landing – basket will lay on its side. Keep arms inside the basket holding on until stopped.
- Do not touch anything in the pilot's compartment or any hanging ropes or lines
- The inflation fan is dangerous – stay well clear, be aware of loose clothing and long hair, scarves must be left on the bus.
- Exit the basket only after pilot says you can – do not jump. Ask for crew assistance if required.
- No smoking, no dangerous goods.



Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

Enquiries 1800 020 616

Notifications 1800 011 034

REPCON 1800 011 034

Web www.atsb.gov.au

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Investigation

ATSB Transport Safety Report Aviation Occurrence Investigation

Flight preparation event involving Kavanagh E-260 balloon, VH-FSR
near Alice Springs, Northern Territory, 13 July 2013

AO-2013-116

Final – 9 December 2015