

Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION INVESTIGATION REPORT

A07P0295



HOT AIR BALLOON ACCIDENT

**SRP ADVENTURE TOURS
AEROSTAR S77A (HOT AIR BALLOON), C-GTRU
SURREY, BRITISH COLUMBIA
24 AUGUST 2007**

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

Hot Air Balloon Accident

SRP Adventure Tours

Aerostar S77A (Hot Air Balloon), C-GTRU

Surrey, British Columbia

24 August 2007

Report Number A07P0295

Summary

At about 1900 Pacific daylight time, the Aerostar S77A hot air balloon (registration C-GTRU, serial number 117) was being prepared to launch for a sightseeing flight from a field near the Hazelmere trailer park in Surrey, British Columbia. The balloon was operated by SRP Adventure Tours Limited under a Special Flight Operating Certificate from Transport Canada and was loaded with a pilot and 12 passengers in the balloon's basket. It was fastened to its trailer by a strap to prevent the balloon from ascending prematurely.

An intense, uncontrolled, propane-fuelled fire occurred. The pilot ordered the passengers to evacuate the basket and then proceeded to evacuate himself. The balloon rose to the limit of its tethering strap. Some of the passengers still onboard jumped from the burning basket as the balloon climbed. The fire affected the tethering strap and it failed from tensile overstress and the balloon climbed without control. The balloon continued to climb until the envelope collapsed and the burning wreckage fell into a nearby trailer park, setting three mobile homes and two vehicles on fire. Two passengers, who did not evacuate the basket, were fatally injured. Several other passengers suffered serious injuries, some with serious burns. The pilot suffered burns. No persons on the ground were injured. Three mobile homes, two vehicles, and the balloon were destroyed.

Ce rapport est également disponible en français.

Other Factual Information

Sequence of Events

In preparation for the flight, the pilot, the ground crewman, and the passenger agent assembled at the company's facility at Langley Airport at 1800 Pacific daylight time (PDT) ¹. After checking the weather conditions, the pilot and ground crewman attached the balloon trailer to their pick-up truck and departed for a local service station to fuel the balloon's propane tanks.

The passengers arrived at Langley Airport at 1830. They were advised of the positions they would occupy in the balloon basket and given a briefing on what to expect during the flight, including a safety briefing. This safety briefing consisted of reassurances that balloon flight was very safe, but did not specifically explain how they were to exit the balloon basket in the event of an emergency. The passenger agent then transported the passengers to the selected launch site near the Hazelmere trailer park.

At a local service station, the pilot and ground crewman refuelled five propane cylinders using a home-made manifold. For fuelling, the five fuel lines from the five cylinders were connected to five ports on the manifold and the tank valves opened. The manifold was then pressurized with propane from the service station source until the five cylinders were filled to the desired level. The five tank valves were then closed and the manifold pressure bled off by means of a relief valve located on the manifold for that purpose. In the process, a considerable quantity of propane gas was expelled into the atmosphere.

Upon arrival at the open-field launch site, the pilot and ground crewman unpacked the balloon, laid out the envelope with the basket on its side, fastened the basket to the trailer with a nylon strap, and began the initial envelope inflation procedure. This consisted of directing ambient air into the envelope by means of a large fan. Once the envelope was inflated with ambient air, the hot inflation procedure was begun. A 10-gallon ² auxiliary cylinder was connected to burner C and used to fill the envelope with hot air. As the envelope began to rise, the basket was pulled upright.

The passengers arrived as this process was taking place and some were encouraged to assist in the inflation process by handling the crown line. When the propane in the auxiliary cylinder was exhausted, the pilot disconnected its line from burner C and passed the empty cylinder to the ground crewman, who removed it from the basket. The pilot's practice was to coil the number 4 cylinder fuel line around the cylinder when not in use. The passengers boarded the basket while this process was taking place.

The pilot then connected the line from the number 4 cylinder (15-gallon), which had been installed by the pilot to provide supplemental fuel for the planned flight, to burner C, opened the tank valve, inspected the line and connections for leaks, and lit the pilot light. He then did a test burn by pulling the blast valve trigger to confirm that the burner was operating. At this

¹ All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

² All cylinder volume is indicated in US gallons.

time the pilot and ground crewman heard a pop, followed quickly by a hissing sound, then immediately by a loud boom and an intense fire. The fuel line whipped about. The pilot received immediate burns. He ordered the passengers to evacuate the basket and proceeded to evacuate himself. However, the pilot did not activate the emergency deflation system.

As passengers began to evacuate, the basket began to rise, forcing people to jump from a considerable height. The basket rose to a height of approximately 30 feet, forcing the trailer off the ground. As people continued to jump, some struck the trailer sustaining more serious injuries. The strap was made of a synthetic material that was susceptible to heat damage and it failed, releasing the balloon with two passengers still on board. The balloon climbed and drifted to the north. As the fire progressed, the number 2 cylinder fell from the basket. The balloon envelope collapsed and the burning wreckage descended into a residential trailer park. The two passengers remaining in the basket were fatally injured. Three mobile homes and some vehicles were destroyed.



Photo 1. Balloon lifting trailer

Pilot Information

The pilot held a valid balloon pilot licence, issued by Transport Canada (TC) and endorsed for all non-power driven balloons, and a valid medical certificate. He had been the owner/operator of SRP Adventure Tours for 14 years. During that time, he had piloted all of the company's flights and had accumulated a total of 2000 hours of balloon flight; 1075 hours on the Aerostar S77A.

Balloon Information

The balloon was originally manufactured with two burners and three 23-gallon capacity propane cylinders installed in the basket. The pilot/owner had replaced the two burners with a three-burner installation which was approved by the manufacturer as part of the type design of the aircraft. He had also installed a fourth cylinder, of 15-gallon capacity, in the basket. This modification was not approved by the manufacturer as part of the type design, nor was it approved by TC. No documentation was produced by the operator to show that this installation was performed or signed-off by an aircraft maintenance engineer (AME). The pilot had instituted the practice of using an auxiliary 10-gallon portable cylinder for initial filling of the envelope with hot air. It was not installed, but placed in the basket for the hot inflation, and removed when its propane was exhausted. The manufacturer was not aware of this practice.

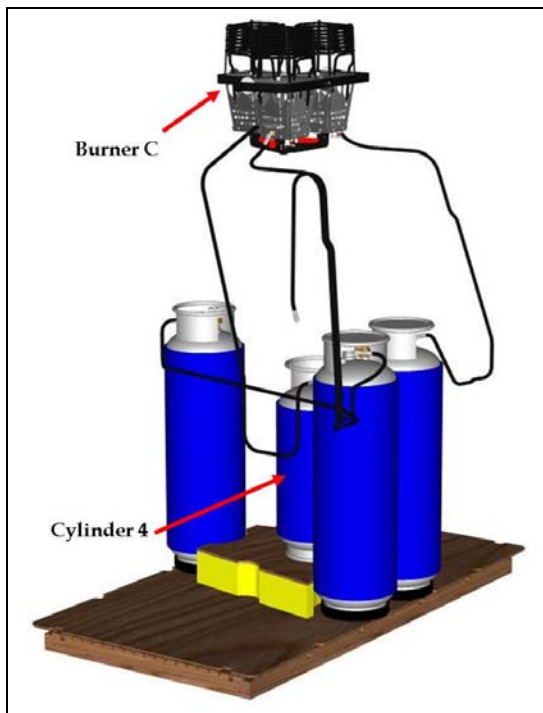


Figure 1. S77A modified configuration

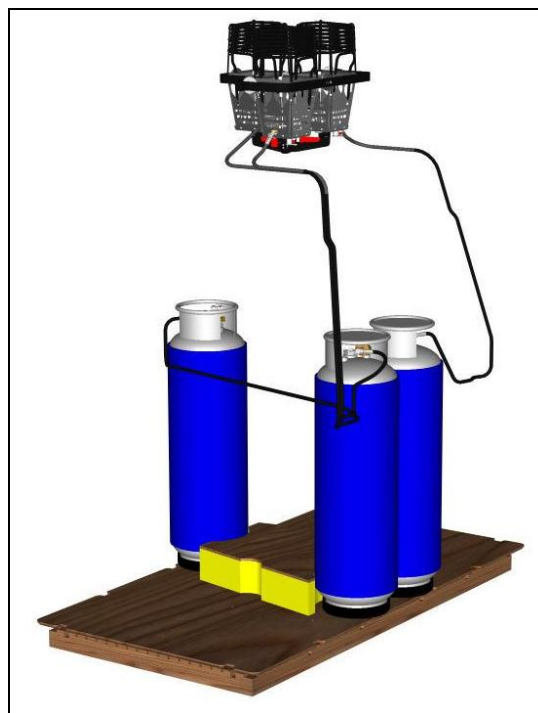


Figure 2. S77A manufacturer's three-burner configuration

The gondola/basket was the largest available for the S77A envelope. The maximum gross weight for the accident envelope and basket combination is 2800 pounds. Using the original weight of the major components when manufactured (envelope, basket, burners, and cylinders) and standard passenger weights and fuel, it was calculated that the balloon's gross weight was about 1000 pounds in excess of the maximum allowable gross weight.

According to information supplied by the operator, the fuel line from the number 4 cylinder, which was connected to burner C, was purchased in 2003, but no documentation could be found to establish that this particular fuel line was installed.

The only means of stopping the flow of propane from a cylinder was by closing the tank valve, which required 5½ half turns to completely shut off the fuel flow. There was no emergency shut-off to isolate the fuel systems.

The aircraft journey log indicated that the balloon had flown approximately 1272 hours since manufacture. The balloon was being maintained by an AME who had been performing the 100-hour inspections for the past 14 years. If the balloon required maintenance as a result of these inspections, it was sent to a repair facility. The AME who performed the 100-hour inspections was unable to provide any documentation of work performed during the past 14 years.

Weather Information

At the time of the accident the weather was clear with a light southerly wind. Weather is not considered to be a factor in this accident.

Technical Examination

Three of the four fuel cylinders installed in the balloon basket were recovered from the impact site, as was the basket framework, the remains of the burner assembly, and various small items, including the remaining metallic parts of some fuel lines. During the balloon's brief flight, the number 2 cylinder fell from the basket and landed in a miniature golf course about 100 yards from the launch point. All four cylinders had been exposed to fire and exhibited damage due to ground impact. It was not possible to identify all of the cylinders by serial number due to damage, so they were numbered as one to four. The 15-gallon cylinder was identified as number 4.

The wreckage was examined at the TSB regional examination facility and then shipped, with the exception of the envelope, to the TSB Engineering Laboratory for further analysis. The main tank valve was still in place on each cylinder, although the valve handle on each cylinder was melted down or missing. It was determined that all the tank valves were closed, except for the number 4 tank valve, which was open. All three burners had metallic remains of fuel lines connected to them. The metallic remains of the fuel line from the number 4 cylinder to burner C were full length.

The balloon envelope landed some distance away from the basket and was not significantly affected by the fire. It was examined at the TSB regional examination facility and the following discrepancies were noted:

- Envelope suspension cable set numbers 41-43, consisting of aluminum swedges, had two crimps instead of the standard three, with frayed ends of cable protruding from the swedges.
- The outer perimeter of the deflation panel was found sewn with a two-inch unknown type webbing, instead of the one-and-one-half-inch factory webbing.

- The centring lines and confluence lines used in the manoeuvring vent in the top area of the envelope were tied with non-standard cord.
- Load-tape termination loop splices attached to the apex ring were sewn in a non-standard configuration.
- The envelope fabric was found to be mostly diamond weave rip-stop nylon, (in excess of 65 per cent), rather than the square weave rip-stop nylon with which the envelope was originally manufactured. Although the manufacturer indicates that this is an acceptable alternative fabric, replacement of fabric in excess of 65 per cent is contrary to the airworthiness limitation in the manufacturer's *Continued Airworthiness Instructions*.

Regulatory Oversight

SRP Adventure Tours Limited was operating under a TC Special Flight Operating Certificate (SFOC) that authorizes the carriage of fare-paying passengers in balloons. The *Aeronautics Act* defines a balloon as an aircraft. This type of aircraft is used by balloon operators for hire and reward, thus the operator is an air carrier and provides a commercial air service as defined in the *Aeronautics Act*. Although this S77A balloon was equipped with a basket that can carry up to 12 fare-paying passengers, balloon operators are not regulated to the same standard as other air carriers. In order to obtain its SFOC, the operator provided basic information that included a list of the balloons to be flown, their registration, make, model, and size. TC then issued the SFOC. The SFOC states that the balloon operator is adequately equipped and able to conduct a safe balloon operation carrying fare-paying passengers. No inspection of the company was ever made to support this statement. The SFOC has no expiry date and there are no audits of balloon operators.

Analysis

The number 4 cylinder fuel line was not secured, unlike the standard fuel lines which were routed along the basket uprights and placed inside leather sleeves to minimize their exposure and stresses. The tank valve of the number 4 cylinder was the only tank valve determined to be open, therefore the number 4 cylinder was the fuel source for the fire. As burner C had metallic remains of the full length of the number 4 fuel line connected to it, the number 4 fuel line must have become disconnected at the number 4 cylinder tank valve. The pop and hiss sounds heard by both the pilot and ground crewman are explained by the fuel line disconnecting and propane under pressure being expelled. Ignition was probably provided by the test burn which had just been made or by the pilot light, as the loose fuel line whipped around and propane discharged from the number 4 cylinder under pressure.

The pilot's practice was to coil the number 4 cylinder fuel line around the cylinder when not in use. That practice, in addition to the practice of connecting and disconnecting the line during every flight, probably led to more stress on the tank valve/fuel line connection. This extra wear and tear likely led to the hose pulling out of its end fitting.

As the number 4 cylinder was the source of the propane fuelling the fire, closing that cylinder's tank valve would have removed the fuel source and likely extinguished the fire. However, considering the ferocity of the fire, this was not practical. An emergency fuel shut-off, such as is generally provided in other aircraft fuel systems, was not fitted.

The basket was the largest available for this balloon and calculations indicate that the gross weight, with twelve passengers on board, was substantially greater than the maximum allowable gross weight. This increased weight meant more lift was required. More fuel would therefore have to be burned to create the hot air for the added lift. The original configuration of the fuel system did not provide sufficient fuel at the increased weight for the average flight duration. The operator had modified the balloon with a fourth fuel cylinder to provide greater lift and flight time.

Contrary to the airworthiness limitation in the manufacturer's *Continued Airworthiness Instructions*, envelope repairs comprised more than 65 per cent of the envelope.

Although the operator was operating under a valid TC SFOC stating that it was adequately equipped and able to conduct a safe balloon operation carrying fare-paying passengers, no inspection of the company was ever made to support this statement. The SFOC has no expiry date and there are no audits of balloon operators. Had there been periodic inspections by TC, the owner's modifications to the balloon's configuration and variations from the manufacturer's *Continued Airworthiness Instructions* may have been raised as safety concerns.

The following TSB Engineering Laboratory report was completed:

LP 100/07 – Burner System Examination

This report is available from the Transportation Safety Board upon request.

Findings as to Causes and Contributing Factors

1. The fuel line connecting the number 4 cylinder to burner C became disconnected at the tank valve connection, probably due to a combination of age, wear, handling, and allowing propane under pressure to be expelled. The propane was ignited either by flame from the test burn just made from burner C or from the pilot light.
2. As there was no emergency fuel shut-off and the number 4 tank valve was open, propane continued to be expelled through the number 4 tank valve, thus feeding the fire.
3. Modification of the balloon from the manufacturer's configuration by the addition of cylinder number 4 and the use of an additional auxiliary cylinder (number 5) for initial envelope hot inflation contributed to the likelihood of hose/valve discontinuity because of extra wear and handling.
4. Operation at a weight greater than the maximum gross weight required more fuel which resulted in modifications being made to the balloon's configuration.

5. Lack of oversight by the regulator allowed the modifications to the balloon's configuration and variations from the manufacturer's continued airworthiness limitations to go unchallenged.
6. The strap securing the balloon to the trailer was made of a synthetic material which was susceptible to heat damage and failed in tensile overstress, releasing the balloon with two passengers still onboard.
7. During the initial envelope inflation, the balloon was fastened to its trailer, which was in turn attached to a pick-up truck. When the fire started and people began to evacuate the basket, the balloon began to rise because the emergency deflation system had not been activated. As people continued to evacuate the basket, they had to jump from a considerable height. Some suffered more serious injuries as a result of striking the trailer.
8. The safety briefing given to passengers prior to their boarding the balloon did not adequately explain how they were to exit the balloon basket in the event of an emergency.

Finding as to Risk

1. The use of a home-made manifold to refuel all five cylinders at once allowed the escape of a significant amount of propane once the tank valves were closed, after the tanks were filled. This posed a risk of fire at the service station.

Other Finding

1. Repairs to the fabric of the balloon envelope were in excess of 65 per cent, contrary to the airworthiness limitation in the manufacturer's *Continued Airworthiness Instructions*.

Safety Action Taken

On 11 August 2007, a Firefly 12B hot air balloon was attempting to land in strong winds in a field near the northern outskirts of Winnipeg, Manitoba. As the balloon touched down, the basket was dragged on its side for about 700 feet and tipped over far enough for the burners to strike the ground as the balloon came to a stop. A propane fuel leak occurred and an intense uncontrolled fire ensued as the passengers were beginning to exit from under the partially inverted basket. All occupants escaped; however, the pilot and two passengers suffered serious injuries in the intense fire. The TSB investigation (A07C0151) is ongoing and the Board has released two Interim Aviation Safety Recommendations as follows:

While some commercial balloon operators in Canada have fare-paying passenger loads equal to those of commuter and air taxi operators, their passengers are not assured of the same level of safety and oversight by regulations and standards. The Board is concerned that, without adequate standards and regulations for balloon operators, balloon passenger safety will be compromised. Therefore, the Board recommends that:

The Department of Transport ensure that passenger-carrying commercial balloon operations provide a level of safety equivalent to that established for other aircraft of equal passenger-carrying capacity.

A08-01

While some commercial balloon operators in Canada have fare-paying passenger loads in the range of those of commuter and air taxi operators, their passengers are not assured of the same level of safety and oversight by regulations and standards. The inability to quickly shut off the fuel supply during landing or in an emergency increases the risk of a fire and/or explosion, compromising balloon passenger safety. Therefore, the Board recommends that:

The Department of Transport ensure that balloons carrying fare-paying passengers have an emergency fuel shut-off.

A08-02

Transport Canada responded to these two recommendations on 18 June 2008:

To address the subject of the level of equivalent safety of passenger-carrying commercial balloon operations, Transport Canada is conducting a risk assessment of commercial passenger-carrying balloon operations. This study will address the special flight operations certificate process and commercial passenger-carrying balloon operation oversight. Once the review is complete, should regulatory changes be required, Notice of Proposed Amendments will be developed and submitted to the Canadian Aviation Regulation Advisory Council for consultation.

To address the subject of an emergency fuel shut-off for balloons carrying fare-paying passengers, Transport Canada is conducting a risk assessment to determine whether regulatory or non-regulatory solutions would be appropriate to address this issue. Once the review is complete, should regulatory changes be required, Notice of Proposed Amendments will be developed and submitted to the Canadian Aviation Regulation Advisory Council for consultation.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 30 July 2008.

Visit the Transportation Safety Board's Web site (www.tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.