GENERAL INFORMATION

Occurrence:	2008123
Classification:	Accident
Date and time[1] of occurrence:	25 October 2008, 17.00 hours
Place of occurrence:	Near Otterlo, the Netherlands
Registration:	PH-ATN
Aircraft model:	Cameron Z-350
Type of aircraft:	Hot air balloon
Type of flight:	Commercial passenger flight
Phase of operation:	Inflation of balloon
Damage to aircraft:	None
Operating crew:	One
Number of passengers:	Fifteen
Injuries:	One seriously-, five slightly injured
Further damage:	None
Lighting conditions:	Daylight

SYNOPSIS

During inflation of the hot air balloon with registration PH-ATN, with some passengers already positioned in the basket, the launch restraint[2] connecting the balloon to a vehicle, failed. The balloon, with its basket attached, was dragged across the field by the wind, causing the passengers being tossed around inside the basket and two passengers being thrown out. Of the six persons that sustained injuries during the accident, one was seriously injured.

The Dutch Safety Board did not conduct an investigation at the accident site. This report is based on the statements provided by the pilot, as well as by some persons involved in the accident and a number of bystanders. Furthermore the rope of the launch restraint has been subjected to an investigation.

FACTUAL INFORMATION

The accident

On the day of the accident the PH-ATN was prepared for a commercial balloon flight with fifteen passengers, at an open farmland near Otterlo, the Netherlands. The wind at the take-off location

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1 All time indications in this report are in local time, unless indicated otherwise.

2 A launch restraint consists of a rope with a loop, weaved at each end for the purpose of attaching a karabiner (ref. to figure 4).

initially appeared to be gusty and therefore departure was postponed. Around 17:00 hrs, when the gusts almost had subsided, the pilot decided that a take-off could be accomplished safely.
In order to inflate the balloon with air, the basket was positioned on its side with the balloon spread out across the field in front of it. A rope connecting the basket to a car, the launch restraint, was intended to keep the balloon in position during inflation.

During inflation six passengers were instructed by the pilot to position themselves already, on their knees, in the basket. According to the pilots statement, this was done to provide them with an easy manner of boarding the basket since they were middle-aged. Furthermore the additional weight in the basket facilitates keeping the balloon in position and therefore provides for an easier inflation procedure. Inflation of the balloon with cold air went normal, however during the filling of the balloon with hot air, the launch restraint failed. At that moment the balloon was inflated to less than half of its capacity.

The balloon was dragged along by the wind with the basket being pulled behind. The basket did not leave the ground but bounced up and down over the uneven soil of the farmland and crossed two ditches. The passengers were tossed around inside the basket and two passengers were thrown out. The pilot, who was sitting on the edge of the basket, made attempts, by pulling the rip line, to open the parachute of the balloon in order to release the air from the balloon. After being dragged along for about 200 meters, the balloon finally came to a stop in a cornfield.

The passengers being thrown out of the basket were injured; one of them seriously. Two passengers of those who stayed inside the basket have stated that in a later stage they had consulted a medical doctor, since they had experienced continuous or increasing pain. According to the statement of a witness, another male person was attended to burns in his hand, probably caused by the rope he was holding had slipped through his hands. This male person was not among those present in the basket at the moment the launch restraint failed.

The hot air balloon
The hot air balloon involved was manufactured in 2003. It was equipped with a passenger basket to accommodate a maximum of 18 persons. The last maintenance inspection had been conducted on 10 April 2008. On that occasion the following components had been inspected: the envelope (balloon), the burner, the basket and the gas cylinders.

The pilot
The pilot was a male of 40 years of age. He possessed a valid commercial balloon pilots licence (CPL-FB) allowing him to operate the flight. His CPL-FB expired at 28 December 2008 and included a qualification for radiotelephony as well as for instruction. The pilots medical certificate class I, was valid until 9 December 2009.

	Experience in hours
on type involved	50
during last three months on all types	80
total on all types	2621

Table 1: balloon flying experience of pilot

The weather
The weather report of the Royal Netherlands Meteorological Institute (KNMI) provided the following information: visibility more than 10 km with a south westerly wind, force three, and one- to two

octa's of cloud coverage. Table 2 shows the weather situation according to the sequence of meteorological aerodrome reports (METAR's) as issued at the nearby military aerodrome Deelen, during the period of time prior to the accident. These METAR weather reports did not mention any wind gusts. This means that the difference between the gusts and the average wind did not exceed ten knots.

Time	Wind		Clouds		Visibility (km)
	Direction (deg)	Speed (knots)	Coverage	Altitude (feet)	
16.07	190	7	1/8 – 2/8	2400	> 10
16.25	200	9	1/8 – 2/8	2600	> 10
16.55	210	8	1/8 – 2/8	2300	> 10
17.10	210	10	1/8 – 2/8	2100	> 10
17.25	220	10	1/8 – 2/8	2800	> 10

Table 2: the actual weather situation according to METAR reports as issued at military aerodrome Deelen during and after the accident

The KNMI ballooning weather forecast for the central- and eastern parts of The Netherlands at the afternoon of the day of the accident, as produced at 15.37 hrs, shows a forecasted wind varying between a surface wind of eight knots, and fifteen knots at an altitude of two thousand feet. No gusts or other warnings were forecasted. The ballooning weather forecast did not provide a negative ballooning advise.

INVESTIGATION AND ANALYSIS

The decision to take-off

The flight manual (*Cameron Balloons Hot Air Balloon Flight Manual*)[3] provides that take-off with the hot air balloon is not allowed if the surface wind is more than fifteen knots or gusts are exceeding ten knots (difference with average wind). The METAR weather reports of the military aerodrome Deelen show that the actual wind values at the aerodrome were within these limits. It is likely that the wind values as measured at Deelen were representative for those at the accident location. The KNMI ballooning weather forecast for the afternoon at the day of the accident is confirmed by the observations made at Deelen.

The pilot stated that an earlier attempt to inflate the balloon had been abandoned due to the gusting wind. After consultation with the KNMI he had decided to postpone departure for a while, before attempting another take-off. After the gusts had subsided he had decided to take off with the balloon. The weather situation was not unfavourable nor critical and the pilot seems to have made his considerations regarding the weather situation with adequate caution before deciding to start with the flight preparations.

The inflation procedure

The inflation procedure of the hot air balloon is shown in figure 1. The basket is turned on its side and the balloon is spread out over the ground as much as possible. The inflation procedure starts with filling the balloon with cold air, after it has been prepared as mentioned. When the balloon has been inflated sufficiently, filling the balloon with hot air is started. During inflation one or at the most two persons, depending on the size of the balloon, hold the crown line.

[3] Amendment 5.

The purpose of holding the crown line is to counteract excessive swinging of the balloon during inflation, to prevent the balloon to raise prematurely and to guide the balloon during its process of changing to an upright position.

During inflation the mouth of the balloon is held open by two persons in order to facilitate the inflow of air into the balloon. They also tighten the control cables to keep them outside the mouth area and prevent them of being burnt in the hot air stream. For personnel controlling the crown line as well as for personnel at the balloon mouth, the flight manual provides clear instructions with regard to their duties and responsibilities and the appropriate (protective) clothing.

During the final stage of the inflation procedure the balloon raises and, in the process, pulls the basket in an upright position. According to the flight manual (chapter 4.4.2), passengers should be loaded after the balloon has been raised, the basket is in an upright position and checks are completed. The passengers must be provided with a briefing before flight. In the flight manual, in particular the body position during landing is discussed in detail in this connection.

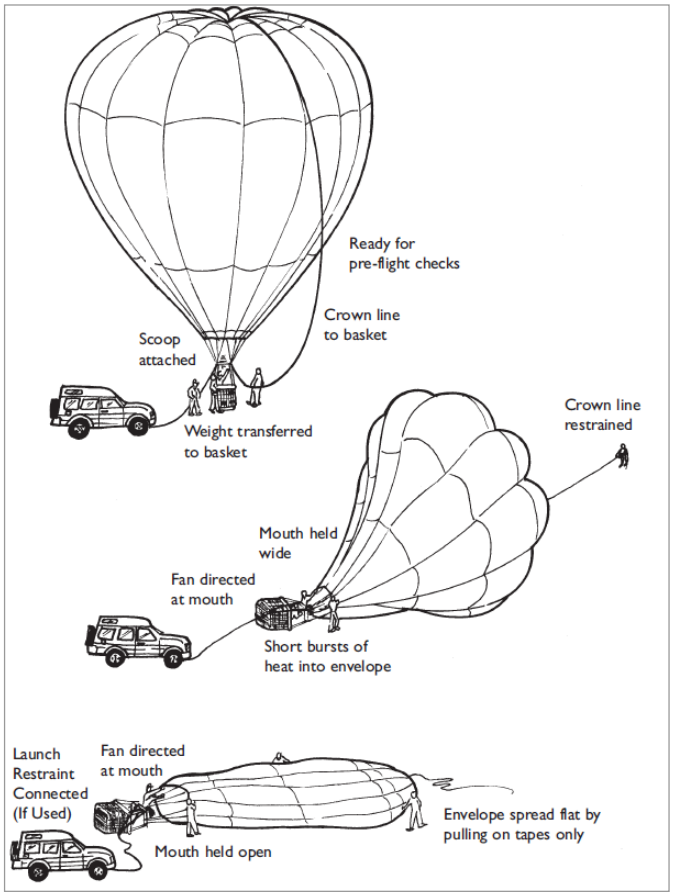

Figure 1: inflation procedure (source: Cameron Balloons Hot Air Balloon Flight Manual)

With regard to utilisation of the launch restraint the flight manual is ambiguous. In figure 1 the text "If Used" is shown in brackets below the depiction of "Launch Restraint". This implies that utilisation of the restraint is voluntary and is left to the judgement of the balloon operating crew.

Chapter 4 of the flight manual (*Normal Procedures*) however is based on the presumption that the launch restraint is used on every occasion. In paragraph 4.3.5 is mentioned that the launch restraint must be connected before the balloon is removed from its storage. In paragraph 4.4.1, in the *Pre-Inflation Checklist,* is indicated: *Launch Restraint – Connected to fixed point.*

Chapter 6.5.5 of the flight manual (*Balloon and Systems Description*) is describing the Quick release. The term quick release is in this case synonymous with launch restraint. In this paragraph is mentioned, amongst others, that *"the quick release is designed to restrain the balloon during inflation and heating up for take-off"* and *"use of the quick release is recommended to ensure that the balloon does not drag during inflation or leave the ground prematurely."*

During the accident the launch restraint was used and connected to a ballooning company car. According to figure 1, a car is considered to be an adequate fixed point. The maximum take off mass of this type of hot air balloon amounts 3175 kg. That implies that the forces on the launch restraint and the fixed point might be considerably.

Statements of witnesses indicate that the ballooning company staff mainly was engaged in preparing the balloon for departure during the arriving of the passengers. The staff involved included two persons, the pilot and an assistant. The passenger briefing was concise and did not include the emphasis on the body position during landing as described in the flight manual.

Furthermore it appears from statements that during inflation of the balloon, several passengers acted as assistant in the balloon mouth area. Apparently assistance of passengers and bystanders in preparing the balloon, during inflation with cold air as well as with hot air, was reckoned with. According to the statement of the pilot, also the crown line was held by a passenger during the accident. The pilot stated to have instructed the passengers involved with regard to their respective duties, but the accompanying protective clothing for assistance during inflation as described in the flight manual, was not made available.

During the inflation procedure, before starting to fill the balloon with hot air, the pilot instructed some passengers to position themselves already, in a kneeling position, in the basket (which at that moment still was on its side). The pilot stated that this was done to provide the passengers, being middle aged, with an easy manner of boarding the basket. Also the extra weight in the basket would facilitate the inflation procedure.
The flight manual does not provide for any indication that, making the basket heavier will have a similar favourable effect. According to chapter 4.4.2 of the flight manual, the passengers board the basket only after it has been raised to an upright position, the balloon has been filled with hot air completely and operation of the rapid deflation system has been checked to function properly.

Investigation shows that also other ballooning companies apply the practice of boarding their passengers into the basket (when still on its side) before the balloon envelope has been inflated with hot air.

The failure of the launch restraint
The rope has been subjected to further investigation by the manufacturer. It appeared that the rope was of the Marlowbraid type and had a diameter of 14 mm. The rope met the specification of this product. It had failed at an unusual spot by a tensile force, but without an extremely high tensile stressing being exerted. The failed loop of the launch restraint is shown in figure 2.

The manufacturer states that during regular tensile tests the rope did not fail at the back side of the loop, as did occur during the accident with the PH-ATN. By splicing the rope in order to weave the loop, a weak spot is created at a distance of approximately 40 cm from the loop. The rope normally will fail at that spot first and at a high tensile stressing.
By using a karabiner (ref. to figure 4) with a bending diameter of approximately 10 mm, as used for the PH-ATN, the rope is folded around a diameter that is too small, causing the tensile strength

at the back side of the loop being affected because the threads of the rope will be compressed. Figure 3 shows the degree of wear of the launch restraint in the loop at the other end. A tensile test with a new rope, connected to a ring with a bending diameter of approximately 10 mm, showed that then the rope failed at the backside of the loop indeed. By using the karabiner concerned, the tensile strength of the rope as a whole was reduced slightly.

Furthermore the manufacturer states that the normal picture of the tips of a failed rope show traces of transient high temperatures, caused by fibres being melted together. The results of the tensile test with the new rope were in compliance with this picture, but the rope involved in the accident with the PH-ATN did not show a similar merging. This suggests that the rope had failed at a considerably lower tensile stressing.

The investigators that inspected the rope state that the condition of the rope showed a frequent utilisation, which undoubtedly has contributed to a reduction of the tensile strength of the rope.

Figure 2: failed loop of the launch restraint

Figure 3: wear in loop at other end of launch restraint

Figure 4: karabiner used in launch restraint

Maintenance and inspection of the launch restraint

In the maintenance manual of the balloon (*Cameron Balloons Hot Air Balloon Maintenance Manual)*, chapter 6.16, the launch restraint falls under the category 'supporting equipment'. For such equipment, as for all balloon equipment, a maintenance inspection interval of one hundred operational hours or one year, whichever is first, applies. Inspection of the launch restraint is to include a visual inspection on damage, wear and tear. Specifications in terms of applicable material, diameter or tensile strength, are absent. In the summary of maintenance inspection items the text "IF FITTED" is added in brackets to the item 'supporting equipment'. This text could refer to the moment the inspection is conducted, but also could mean: depending on regular utilisation of such equipment during operation of the balloon.

It seems that in practice this text is interpreted as meaning: "if attached at the moment of inspection". The launch restraint exclusively is used during the inflation procedure and is left behind on the ground, after take-off of the balloon. After departure, ground personnel stows the launch restraint into the company following car, between the other launch restraints. At the next occasion another one is taken at random from the pile of ropes and used as a launch restraint.
A launch restraint is not physically connected to a balloon and also in terms of administration the restraint is not included in the equipment of an individual balloon. As a result, also no launch restraint is attached to the balloon during maintenance inspections. The combination of the practice of dealing with launch restraints and the interpretation of the text "IF FITTED" as indicated in the maintenance manual, causes the launch restraint never being subjected to an inspection during the periodical maintenance inspections. Furthermore a date of manufacture and/or introduction, printed on the launch restraint, is absent.

The maintenance manual also provides, apart from those regarding the regular maintenance inspections, several requirements regarding the inspection of balloon components during preparation of each flight. A similar provision regarding to the launch restraint is absent.

In the introductory part of the flight manual three levels of safety indications are defined:

- WARNING Means the non-observation of the corresponding procedure leads to an immediate or important degradation of flight safety.
- CAUTION Means the non-observation of the corresponding procedure leads to a minor log-term degradation of flight safety.

- Note Draws attention to any special item not directly related to safety, but which is important or unusual.

A “Note” in paragraph 6.5.5 of the flight manual provides for an indication that the strength of the launch restraint and its accessory connection equipment, can be reduced considerably by the impact of sunlight (UV radiation). Regular checks should be made to the launch restraint for wear and loss of strength. No instructions are mentioned how and when this should be done.

Taken actions by the manufacturer “Cameron Balloons”
The manufacturer took the following actions as a result of the accident:
- The balloon manufacturer is investigating the possibility to change the karabiner and the rope connection to prevent chaffing of the rope in the karabiner.
- The manufacturer supplied restraint ropes are now marked with the maximum breaking load, date of manufacture, serial number and part number.
- The practice of pre-loading passengers is commonplace throughout the ballooning world. The balloon manufacturer has no objection to this practice. The flight manual guidance on this subject is being updated.

CONCLUSION

This accident has been caused by the failure of the launch restraint during inflation of the hot air balloon. The tension causing the failure of the restraint has not been extremely high. The bending diameter of the karabiner used was too small, causing a reduction in the normal tensional strength of the rope. Furthermore the absence of information regarding age and utilisation history of the launch restraint prevents verification of compliance with the desired standard.

Additional to the cause and gravity of the accident are:
- The absence of a requirement for, or the discipline to check the condition of the launch restraint.
- Allowing passengers to board the basket while still on its side, without the balloon being inflated to its maximum capacity. Following a similar procedure deviates from the requirements as provided in the flight manual.

Furthermore the following safety deficiencies have been established:
- The flight manual is unclear with regard to the issue whether utilisation of the launch restraint is mandatory or not.
- Passengers were allowed to assist in preparing the hot air balloon for departure without being trained properly and without appropriate protective equipment being made available.

RECOMMENDATIONS

As a result of the investigation the Board reached the following recommendations:

Cameroon Balloons is recommended to modify the Hot Air Balloon Flight Manual in order to:

- Describe univocal use of the launch restraint;
- Guarantee the necessary strength of the launch restraint at all times;
- Protect passengers for any risk during inflation of the hot air balloon.

The interest groups for ballooning in the Netherlands are recommended to draw up guidelines for:

- The use and maintenance of launch restraints.
- The role of passengers during flight preparation.