



⁽¹⁾Hot air balloon.

Accident to the Ultramagic T180⁽¹⁾
registered **F-GTBL**
on 25 June 2017
at Sandillon (Loiret)

⁽²⁾Unless otherwise stated, all times given in this report are in local time.

Time	Around 07:30 ⁽²⁾
Operator	Les ballons de Loire
Type of flight	Commercial air transport
Persons on board	Pilot and eight passengers
Consequences and damage	One passenger seriously injured, one passenger injured, pilot and six passengers unharmed

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation published in December 2019. As accurate as the translation may be, the original text in French is the work of reference.

**Tree strike at end of approach,
go-around, emergency descent,
hard landing, basket upset**

1 - HISTORY OF THE FLIGHT

The pilot, accompanied by eight passengers, took off from Jouy-le-Potier (in Loiret) at around 6:42 am for a flight of one hour. After flying for half an hour, he observed that the air mass in which the balloon was flying showed signs of instability. Thinking that there would be a hard landing and before looking for an accessible landing site, he prepared the passengers for a firm touchdown by recalling the safety instructions that he had given to them at the beginning of the flight. In particular, the pilot had the passengers repeat the position to be adopted for the landing⁽³⁾.

⁽³⁾Cf. para. 2.4 Other information.

The field chosen for the landing was situated just after a wood. At low height during the approach, the balloon was subjected to a sudden downdraft and struck tree tops. Surprised, the pilot activated the burners to clear the basket from the trees. The balloon rapidly gained height and while flying over the edge of the wood, the pilot opened the RDS⁽⁴⁾ valve in order to land as quickly as possible and avoid getting too close to a power line situated at right angles to its path at the end of the field. The balloon made a hard landing and the basket turned over onto the long side before being dragged along the ground for a few metres. Two passengers were transported to the regional hospital. One, seriously injured, had a fractured ankle and the other, back pains which subsequently proved to be a herniated disc.

⁽⁴⁾Rapid Deflation System.

2 - ADDITIONAL INFORMATION

2.1 Pilot's experience

The pilot, holder of a Balloon Pilot Licence (BPL) and Flight Instructor (Balloon) FI(B) rating and the company manager, had logged around 800 flight hours in hot air balloons, 12 hours in 15 ascensions in the previous three months of which eight on F-GTBL.

2.2 Impact of meteorological conditions on flight

The pilot had the necessary meteorological information to carry out the flight.

It forecast, in a flat low crossed by a weak disturbance, an estimated west-south-westerly wind of 10 kt at ground level with a risk of scattered showers between 08:00 and 13:00, a temperature of 14°C and a QNH of 1,017 hPa.

This information was confirmed by the Météo-France analysis.

The balloon flight manual states that the landing may be hard⁽⁵⁾ if there is a strong wind and that the flight must not be undertaken if the ground wind exceeds 15 kt.

A member of the FFAé⁽⁶⁾ and instructor also said that when the wind was above 8 kt, it was highly likely that the basket would tip over on landing unless a valley or hedge of trees was found for protection.

2.3 Information on aircraft and protection of occupants

The Ultramagic T180 balloon is composed of an envelope and a basket. When in flight order, its height is 30 m and its maximum take-off weight is 1,650 Kg⁽⁷⁾. The assembly is certified as complying with the EASA Certification Specifications for Hot Air Balloons CS31-HB.



Source: BEA

Figure 1: Ergonomy of compartments of F-GTBL basket

⁽⁵⁾In general, a hard landing is when the landing speed is considered as high and more precisely a "heavy" landing is when there is a high vertical speed and a "quick" landing when there is a high horizontal speed.

⁽⁶⁾Fédération Française d'Aérostation (French aerostation federation).

⁽⁷⁾The greater the weight and volume of the balloon, the greater the inertia of the balloon's reactions, the more the pilot must anticipate his piloting inputs.

⁽⁸⁾AMC31HB.59 (f):
each passenger
must have a
minimum surface
area of 0.25 m².

⁽⁹⁾AMC31HB.59 (h):
each passenger must
have a handhold
to hold onto
during a landing.

The wicker basket (Figure 1) is rectangular in shape with a maximum carrying capacity of nine people. It is composed of two lengthwise compartments which can each accommodate up to four passengers⁽⁸⁾ and a compartment at right angles to these, reserved for the pilot, the flight controls and the fuel tanks.

The passenger compartments are equipped with four handholds⁽⁹⁾ on the long side, which can be held onto during the landing.

The importer of Ultramagic balloons in France said that the Ultramagic manufacturer's manual did not recommend a particular position to be adopted by the persons on board during landings.

The company's operations manual specifies that the passengers must turn their backs to the direction of travel of the balloon before landing without specifying the "tandem" or "side-by-side" position.



Source: BEA

Figure 2: Operator demonstration



Source : BEA

Figure 3: Operator demonstration

The left photo (Figure 2) shows one of the company pilots demonstrating the position that passengers must adopt before landing (in the direction of the arrow). This demonstration is carried out during the pre-flight preparation, this position is then repeated by the passengers during the flight and adopted on the pilot's command before landing.

The right photo (Figure 3) shows that four adults of a standard size do not have room to press their backs in full against the longitudinal wall of the basket.

2.4 Other information on passenger safety position

- According to the French *Manuel de pilotage des montgolfières* (Hot air balloon flight manual)⁽¹⁰⁾ (para. 3.4.1 Landing instructions), passengers must position themselves for landing with their legs slightly bent and hold onto the inside handholds. The manual specifies that in the event of an emergency landing (para. 6.4), the passengers must remain standing with their knees slightly bent and their feet together. If there is a risk of a dragged landing, the passengers must put their backs firmly against one of the longitudinal walls of the basket and turned to the direction of travel of the balloon, without letting their head or any limb protrude.

⁽¹⁰⁾Work of reference
for pilots, published
by Cépaduès.

- ❑ The EASA Certification Specifications for Hot Air Balloons, and the Acceptable Means of Compliance, AMC 31HB.59(e), evoke a landing position by mentioning by default that *“No more than two occupants may be positioned in the landing direction without means to prevent them from falling on top of each other.”*
- ❑ The French Ultramagic balloon importer, in the scope of its balloon operation activity, uses a new basket made by the manufacturer which is more recent than the one in the accident. Being longer, it allows the four passengers in each compartment to press their backs in full against the partition.
- ❑ Other baskets belonging to the operator had a safety instructions panel for the passengers (Figure 4), recalling, in particular, the position to be adopted for landing. This instruction panel shows in a basket with several passenger compartments, a side-by-side position, with backs pressed against the partition.



Figure 4: Information panel displayed in a basket belonging to the operator

- ❑ A professional pilot, who is also an instructor-examiner, and uses a basket with compartments said that his method was to have feet slightly apart with the back pressing against the partition, knees bent and both hands on the handholds. A demonstration is carried out before the flight during the briefing and the passengers try the position during the flight.

⁽¹¹⁾<https://vimeo.com/219523735>

⁽¹²⁾Direction de la Sécurité de l'Aviation Civile (French civil aviation safety directorate).

⁽¹³⁾The basket used as an example resembles the baskets without compartments which require the pilots to have different passenger position priorities to those of pilots with baskets with several passenger compartments.

⁽¹⁴⁾Civil Aviation Authority United Kingdom.

⁽¹⁵⁾https://publicapps.caa.co.uk/docs/33/Paper2006_06RFS.pdf

- The federation's reference aviation physician, also an instructor-examiner, said that a person made better contact with the ground with their feet slightly apart and knees half bent. The support polygon is then greater, making it easier to keep balance, the hips and knees being aligned.
She added that it was not recommended to have passengers positioned in tandem during the landing, in a basket with several passenger compartments. The rear passenger of the tandem would have to carry the weight of the front passenger on their bent lower limbs, with the possibility of this weight being increased by the vertical and horizontal speeds on impact. This position is therefore likely to lead to significant trauma risks.
- The BEA's expert physician shares this view.
- A video⁽¹¹⁾ about the aerostation accidentology published in 2017 by the DSAC⁽¹²⁾, in coordination with the FFAé and the BEA, was produced in order to make aerostat pilots aware of the specific risks linked to aerostations, illustrated by different events. It presents, in particular, the positions which must be adopted by the passengers on landing. In this example⁽¹³⁾ using a basket which only has one passenger compartment, it is suggested that the pilot positions the passengers two by two in tandem, with knees bent and back turned to the direction of travel. The exact position of the feet is not, however, specified.
The basket in the accident is different to the one in the example: it has two passenger compartments.
- After consulting the FFAé about the position to be adopted by passengers before landing, the least risky position seems to be the "side-by-side" position in baskets with several passenger compartments for basket configurations which allow each passenger to press their back against the basket partition wall on the side of the balloon's direction of travel.
- Section 5 "Recommendations" of the CAA UK⁽¹⁴⁾ study⁽¹⁵⁾ shares this point of view about the "side-by-side" position so that the back is pressed against a wall.

2.5 Statistics about balloon collisions and hard landings

At the time of writing this report, the BEA had been notified of 76 ballooning accidents in France since 2000. Six of these accidents were fatal leading to the death of 13 people.

Collisions with power lines and hard landings constitute the two main types of accident.

The BEA has recorded 29 collisions with power lines. They represent 38 % of the accidents and contribute to 70 % of the fatalities and 22 % of the injuries. Fifteen of these accidents occurred during commercial flights involving a public not necessarily familiar with this activity. In this specific area of operation, the collisions with power lines represent 60 % of the fatalities and 20 % of the injuries.

The BEA has recorded 34 hard landings. They represent 44 % of the accidents and contribute to 15 % of the fatalities and 68 % of the injuries. Nineteen of these accidents occurred during commercial flights involving a public not necessarily familiar with this activity. In this specific area of operation, the hard landings represent 40 % of the fatalities and 73 % of the injuries.

Lastly, in 44 % of the hard landings, the wind was considered as a probable or proven contributory factor.

2.6 Accident site

The accident site was situated on the edge of the Sologne regional forest. In this area, the forest starts to give way to cultivated fields, vineyards and scattered housing. The field of stubble chosen by the pilot is 200 m long in the balloon's direction of arrival. It is bordered upwind by a 300 m long wood whose trees have an average height of ten metres. Downwind, at the edge of the field, at right angles to the balloon's arrival path, there is a medium voltage power line whose height does not exceed the tree tops. Just behind is another wood and then less suitable spaces for landing.

2.7 Balloon's flight path in vertical plane taken from balloon's portable GNSS⁽¹⁶⁾ receiver

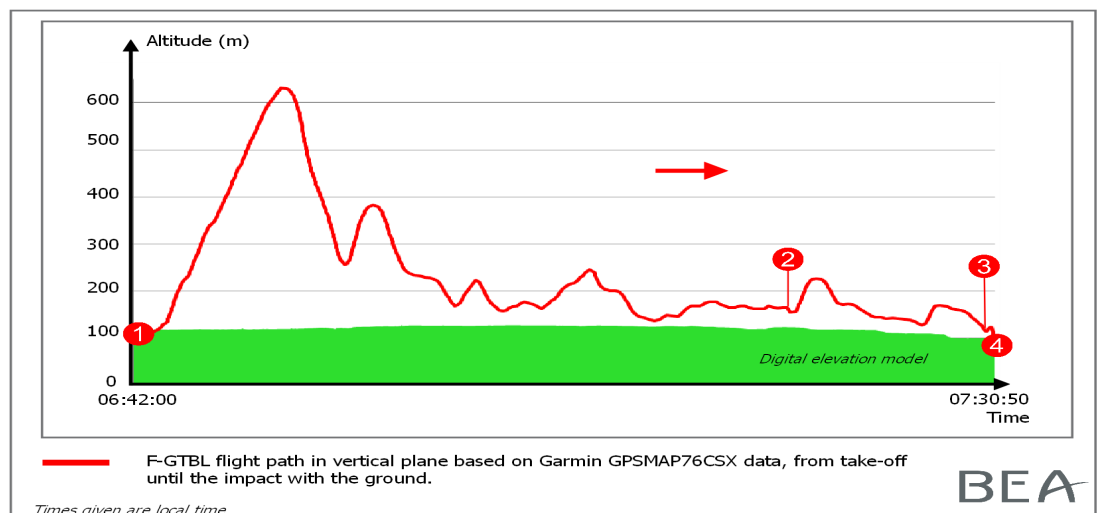


Figure 5: Path of F-GTBL

The data has the following characteristics:

- points 1 and 4 correspond to the take-off and landing;
- during the second half of the flight, the horizontal path is more erratic;
- two more significant descents⁽¹⁷⁾ (points 2 and 3) are visible. The last one (point 3), at the end of the approach, is followed by the climb corresponding to the activation of the burners and quickly stopped by the opening of the RDS valve.

⁽¹⁶⁾Global Navigation Satellite System.

⁽¹⁷⁾The considerable drop rate in these descents is due more to the vertical air flows experienced by the pilot in the air mass surrounding the balloon than to a standard controlled descent.

2.8 Passenger statements

The passengers interviewed said that on the ground, they had been given the instructions for landing. In flight, the pilot had them repeat the position to be taken. Towards the end of the flight, he told them it would be a hard landing.

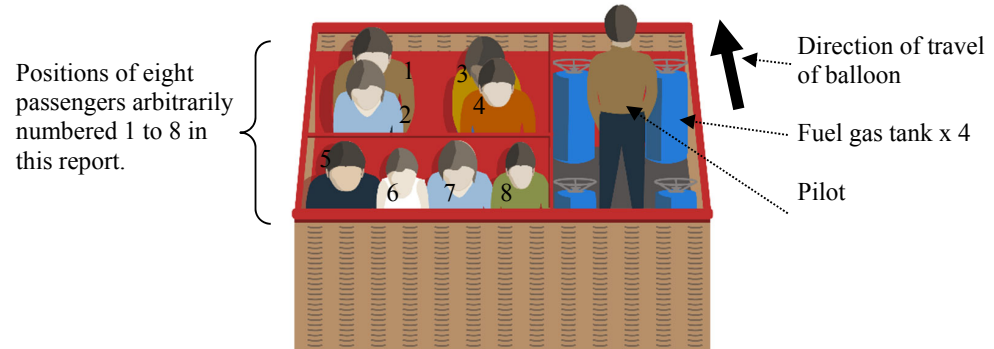


Figure 6: Diagram of situation in basket at time of landing

⁽¹⁸⁾ Designated 1, 2, 3 and 4 in the figure above.

Passenger 8 specified that before landing, the passengers of the front compartment⁽¹⁸⁾ were positioned two by two, one behind the other and those in the rear compartment, next to each other.

Passenger 1 said that for the landing, he had his arms around passenger 2, with his legs apart whereas passenger 3 had his arms around passenger 4, with his legs together. He added that he thought that this tandem position better protected the passenger, embraced in the event of the basket tipping over, in comparison to the side-by-side position.

Passenger 3 said that he had shoes which protected his ankles, he said that he broke his ankle when the basket collided with the ground. He added that the pilot called out twice, just before landing, "squat down, it's going to hit hard."

One of the passengers of the rear compartment, who had pains in his back and leg subsequent to the accident, underwent examinations which found a herniated disc. In his statement, he said that his back was against the basket wall during the landing.

2.9 Pilot statement

The pilot said that he systematically gives a briefing to his passengers at the beginning of the flight, which covers a practical demonstration of the different landing positions, including those for a hard landing and a basket upset, and the instructions for their adoption.

He explained that at the end of the approach, he was surprised by a high degree of instability which prevented him from holding the initial approach slope. Although he wanted to land just after the wood and thus avoid getting too close to the power line, the collision with the trees obliged him to activate two burners making the balloon climb a significant distance while overhead the wood edge. To descend as quickly as possible, the pilot opened the RDS valve with the risk of landing heavily.

He specified that during this very dynamic phase between the tree strike and the landing, he did not have time to pay attention to the “side-by-side” or “tandem” positions of the passengers. He added that sometimes certain passengers know each other and take up the tandem rather than the side-by-side position for space reasons.

Lastly, he is not convinced that in the event of a hard or emergency landing, the side-by-side position provides better protection than the tandem position. He thus leaves the passengers the possibility of adapting between these two positions, notably according to their morphologies.

3 - LESSONS LEARNED AND CONCLUSION

3.1 Position taken by passengers during landing

The position to be adopted during the landing was shown to the passengers. This presentation was carried out on the ground, accompanied by a demonstration. These same instructions were given again in flight. The tandem position taken by certain passengers seemed acceptable for the pilot.

The side-by-side, back to the basket and feet together safety position is recommended by the French hot air balloon flight manual. The investigation showed that according to the basket's size and compartment configuration, this position cannot always be adopted by all the passengers onboard, in accordance with the EASA Certification Specifications for Hot Air Balloons (CS31-HB) which mention a tandem position for two passengers maximum.

When the basket collided with the ground, a passenger broke his ankle, he had adopted a tandem position with legs together, another passenger was situated in front of him.

3.2 Hard landing

The wind speed forecast of over 8 kt increased the probability of a hard landing. The signs of instability of the air mass observed by the pilot after a flight time of 30 minutes meant that he foresaw that the landing would be hard. The chosen field seemed to him to be the first suitable landing area after the regional forest. He had detected the power line at the end of this field and had as a consequence, planned the aiming point of his approach for the beginning of the field.

During the final approach, exposed to an aerological instability generating a sudden acceleration in the descent speed, the pilot's use of the burners did not counter the high inertia of the balloon at its maximum capacity and thus prevent striking the tree tops.

After the collision with the trees, the balloon climbed again due to the hot gases in the envelope.

To land in the field initially chosen while avoiding getting too close to the power line, the pilot quickly used the RDS to empty the envelope and resume the descent which then accelerated.

The firm touchdown was the result of this emergency manoeuvre. The basket then turned over onto its long side after landing.

3.3 Conclusions

The accident was the result of the combination of the following factors:

- ❑ The wind speed on the arrival site, generating turbulence on approaching the tree tops, probably contributed to the instability of the approach slope.
- ❑ The field envisaged for the landing, of a length of 200 m and situated between two woods, with a power line running along its far end, obliged the pilot to have an aiming point at the beginning of the field.
- ❑ In order not to defer the landing to another site, the pilot accelerated the descent by immediately using the RDS so as not to approach the power line.
- ❑ Lastly, the legs-together tandem position adopted by a passenger for the landing, with another passenger in front of him, probably contributed to the injury despite wearing suitable shoes. In this position, during the acceleration experienced on the basket coming into contact with the ground, an excess load may have been applied to the ankles of this passenger because of the transfer of part of the weight of the other passenger.

3.4 Lessons learned

The recurrence of injuries incurred during landings mentioned in various accident reports (see § 2.5) is significant.

The pilot's explanations and the repeating of the safety instructions to be complied with during the landing have been shown to be not sufficiently adapted to correctly protect the integrity of the passengers.

The investigation showed that different interpretations of the European regulations in force can still be made by operators/pilots with respect to the best position to be adopted before any landing according to the circumstances of the moment, the morphology of the passengers and the geometrical characteristics of each basket.

The certification of baskets includes aspects regarding the safety of the occupants, in particular the minimum volume per passenger and the presence of a sufficient number of holding points. It ratifies balloons on the basis of safety positions with *"[...] two occupants [...] positioned in the landing direction without means to prevent them from falling on top of each other"*, i.e. in "tandem".

The operational regulation, in particular Commission Regulation No 2018/395⁽¹⁹⁾ adopted after the accident, has no additional instructions concerning the safety position to be adopted by passengers in anticipation of a hard landing.

The investigation brought out a consensus between different actors of the FFAé concerning the optimal safety position for landing in baskets with several passenger compartments which are the ones most likely to be used for commercial air transport. This recommended consensual position is "side-by-side", back pressed against the basket partition wall on the side of the balloon's direction of travel, feet slightly apart, knees bent and both hands on the handholds.

⁽¹⁹⁾Commission Regulation (EU) of 13 March 2018 laying down detailed rules for the operation of balloons.

⁽²⁰⁾<https://www.bea.aero/en/investigation-reports/notified-events/detail/event/accident-du-schroeder-fire-balloons-g5024-immatricule-f-hccg-survenu-le-05102014-a-cazes-mondenar/>

The investigation revealed that the European regulations do not formally prohibit the selection of the “tandem” safety position, and that the geometry of certain baskets, used to their maximum capacity, does not systematically allow passengers, whatever their build, to adopt the safety position considered optimal to prevent serious injuries to lower limbs during a hard landing.

Given the acceptance of this risk by the current regulations, the BEA reminds the reader of the analysis made in the report published following the accident to the Schroeder Fire Balloons registered F-HCCG operated by Quercy Pluriel on 5 October 2014 at Cazes-Mondenard⁽²⁰⁾: *“...balloon flight may be perceived by unwary passengers as being an activity as such which holds little danger whereas experience shows that the safety level is very much below the commercial air transport safety level to which the general public has become accustomed.”*