ACCIDENT

Aircraft Type and Registration:	Lindstrand LBL 210A hot air balloon, G-BZDE
No & type of Engines:	None
Year of Manufacture:	2000
Date & Time (UTC):	16 April 2006 at 1814 hrs
Location:	Near Bordon, Hampshire
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 10
Injuries:	Crew - None Passengers - None
Nature of Damage:	Scorching and abrasion damage to balloon envelope
Commander's Licence:	Commercial Pilot's Licence (Balloons)
Commander's Age:	49 years
Commander's Flying Experience:	827 hours (of which 141 were on category B balloons) Last 90 days - 12 hours Last 28 days - 6 hours
Information Source:	AAIB Field Investigation

Synopsis

The hot air balloon carried one pilot and 10 passengers on an evening pleasure flight. After several attempts to find a suitable landing site, the pilot decided to land the balloon in a field containing high voltage power lines. The pilot was forced to climb to avoid a tree a short distance before the power lines, after which there was insufficient distance either to land safely or to guarantee clearing the power lines in a continued climb. The pilot therefore initiated a rapid descent, but the balloon envelope contacted the power lines whilst the basket was still airborne. The basket then sank to the ground, with no reported injuries to its occupants.

History of the flight

The hot air balloon was being operated by a company which specialised in balloon pleasure flights and had been operating since 1985. On this occasion 10 passengers were to be carried on a flight departing from a site about 7 nm north of Winchester for a flight which was planned to last for between 45 and 75 minutes.

On the day of the accident flight, staff at the operator's headquarters checked the weather conditions and decided they were suitable. This decision was passed to the pilot, who also checked the latest weather reports on the internet at his home and made a note of the relevant details. The pilot then drove to the company's headquarters where he met the two-man ground crew who were to assist with the launch and recovery of

the balloon and who would remain in visual and radio contact with the balloon during the flight.

The pilot and ground crew had arrived at the launch site and met their passengers by 1600 hrs, and the pilot conducted a safety briefing which took about 15 minutes. The briefing included the correct positions to adopt during landing, and all passengers practised adopting the positions before the flight. After satisfying himself that the weather remained suitable and there were no showers approaching from upwind, the balloon was launched at 1653 hrs.

The flight progressed normally in an east-south-easterly direction and the pilot was able to confirm from his on-board GPS receiver that the actual winds were very close to those forecast. Altitude varied, to a maximum of about 1,500 ft. About 35 minutes into the flight, the pilot announced to the passengers that he was looking for a suitable landing site. The passengers were prepared for a landing on a few occasions, and were aware of the pilot discussing possible sites with the ground crew by radio, but each chosen site was deemed unsuitable on closer inspection and each time the landing was abandoned.

As the balloon approached the town of Bordon in Hampshire, the pilot was aware that the balloon had already been airborne longer than planned, and he thought the countryside beyond the town would offer fewer suitable landing sites. He identified two fields which he considered suitable for landing and briefed his ground crew accordingly. The chosen fields were a short distance before the town, and immediately before an industrial site which effectively formed the far boundary of the fields. A broken tree line formed the near boundary in the direction of approach, and what appeared to be a fence separated the two fields, though it later became apparent that only the posts were present. The further field had high voltage power lines running approximately north-south through it.

The pilot decided to land in the nearest of the two fields, which was also the larger of the two. However, as he neared the field he noticed a track crossing the further field and, as this suggested better access for the ground crew, the pilot decided to adjust his approach to land in the further field instead. He stated that he was aware of the power lines crossing the field, but considered that there was adequate space to land, provided that the balloon could be landed at the near edge of the field.

The balloon crossed the edge of the first field, passing very low over the boundary trees. The pilot stated that he then became aware that the balloon was drifting to the left, towards a large prominent tree on the edge of a wooded area that adjoined the fields. The pilot initiated a climb to clear the tree, aware as he did so that there would be much less space available on the far side to bring the balloon down safely before the power lines were reached.

When it became clear that the balloon would contact the tree, the pilot warned the passengers who were by this stage in their landing positions, seated within the basket with their backs to the direction of travel. The basket hit the right side of the tree some way below the top and passengers had the impression that the balloon's speed was considerably reduced by this contact. Immediately after it hit the tree, the pilot attempted to bring the balloon down into the field before the power lines, using maximum deflation of the envelope. He was aware that the power lines now represented a serious hazard to the balloon and he had rejected the possibility of climbing over them, fearing that this might lead to the basket itself hitting the wires. He warned the passengers to expect a hard landing and

initiated maximum deflation by operating the control which allowed rapid deflation of the envelope.

The pilot was unable to land the balloon before the envelope contacted the power lines. The basket was still an estimated 20 to 50 ft above ground at this point. There was an initial bang and a flash as it did so. Most of the passengers, who were seated within the basket facing rearwards, were unaware of the power lines until this point. As the deflating envelope slid off the wires, the balloon's basket descended gently to the ground, coming to rest upright. There was a further loud bang and flash, probably as the metal crown ring at the top of the canopy made contact with the wires.

Most of the balloon envelope drifted away from the basket, though part of it did land across some of the passengers. The pilot instructed the passengers to remain in the basket while he assessed the situation, but could see that the motion of the power lines overhead was reducing and there appeared to be no reason not to allow the passengers to disembark. Those passengers under part of the envelope were hindered slightly in their exit from the basket, but were able to do so unassisted. The emergency services arrived shortly afterwards, alerted by local residents; it was established that none of the passengers or the pilot had suffered any injury.

Accident site

The accident events centred on two adjoining fields on the western outskirts of the town of Bordon (Figure 1). Originally a single field, it was divided into two by fence posts. Although this gave the appearance that the fields were physically separate, there were in fact no wires between the posts. The westerly field was the larger of the two, bounded at its western edge by a hedgerow which contained a number of moderately sized trees. A wooded area protruded into the two fields from the north, forming a 'V' shape, at the point of which was the large tree which the balloon basket struck shortly before contacting the power lines. The distance from the tree to the centreline of the power lines, in the direction of flight of the balloon, was 89 m. The protruding wooded area formed a 'neck' across the fields divided by the fence posts.

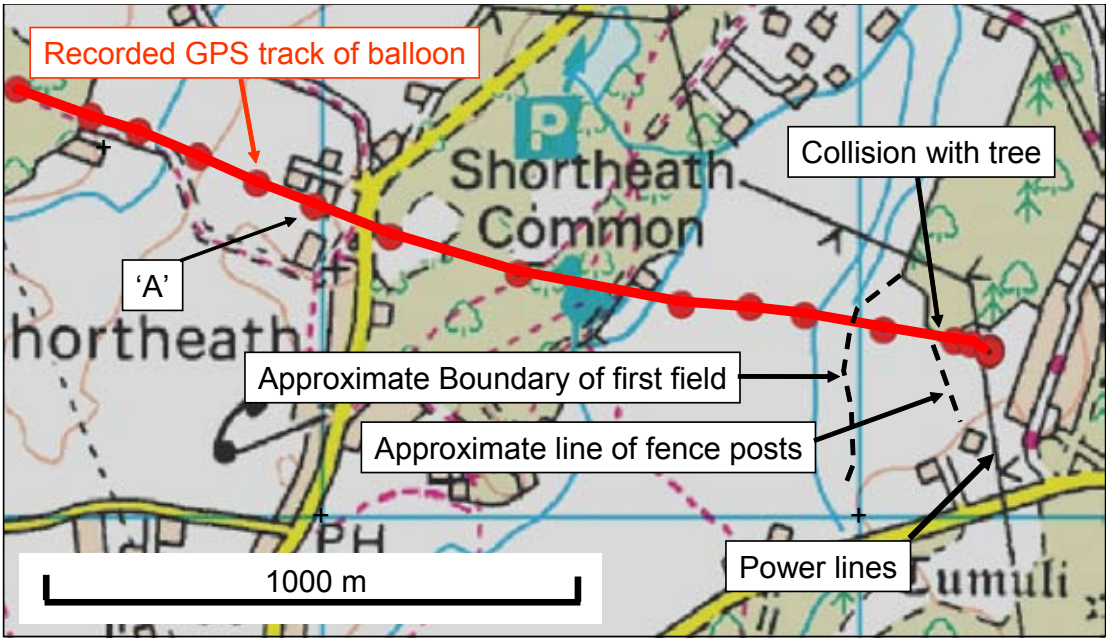

Figure 1

The two fields were of very different appearance, with the larger field to the west containing light coloured stubble and the smaller field to the east being mainly grass. The smaller field contained the 132 kV power lines, running approximately north-south. They were supported by one tower in the field at 32.3 m height, and another in the wooded area to the north. Immediately behind the power lines was an area of industrial buildings which formed the eastern boundary of the site. A track led into the easterly field from a minor road to the south.

GPS-derived information

The pilot was equipped with a hand-held GPS receiver which recorded time, position, groundspeed, and track. GPS altitude was not recorded. The data showed that after launch at 1653 hrs the balloon made good an average track of 110º(M). Groundspeed during the first half of the flight peaked at 17 kt but was generally between 10 and 15 kt. Overall, the groundspeed reduced as the flight progressed and in the last 14 minutes of flight did not rise above 10 kt. As the balloon approached the accident area it was tracking an average 114º(M) with a ground speed of 6 to 8 kt, which took the balloon towards the centre of the pilot's chosen field. Then, at 3 minutes and 30 seconds before the balloon struck the tree, the track drifted some 11º to the left, and became an average 103º(M). The new track took the balloon directly towards the tree which it was to hit. The tree was still 500 m away once the track had changed, and the boundary of the first field was about 325 m away. The new track still crossed the first field, but did so at a narrower point, as the field itself was irregularly shaped.

Eyewitness information

Several witnesses saw the balloon at low level in the accident area, though no one reported seeing the actual moment when the balloon struck the tree or the power lines. One witness under the balloon's track (Position 'A' at Figure 1) saw the balloon pass directly overhead at low altitude. The witness reported hearing the balloon's burner, and had the impression that it had climbed slightly to clear the narrow low ridge on which his house stood. After passing, it continued at low altitude in the direction of the accident site before disappearing from view behind trees.

Balloon description

The balloon envelope of G-BZDE, with a nominal volume of 210,000 cu.ft, was constructed from 28 gores, each of which was made up from smaller panels. Between the gores ran 28 vertical load tapes, which came together at the top of the envelope at a crown ring made from aluminium alloy. Three different fabrics were used in the construction of the envelope. The top third was of 'Hyperlife', a high-strength silicon-coated nylon fabric, and the panels at the bottom nearest the burner were of flame-resistant Nomex. The bulk of the envelope was of ripstop nylon coated with polyurethane. The overall height of the balloon from the bottom of the basket runners to the crown ring at the top was 25.44 m.

The basket was attached to the lower end of the load tapes via stainless steel wires and was divided into five compartments in a 'double T' arrangement. This created a centre section, occupied by the pilot, his flight equipment, four fuel cylinders and associated pipework, and four passenger compartments, two either side of the pilot. In addition to the burners, control of the balloon was achieved by four control lines. Two lines operated rotational vents in the envelope, while the remaining two lines operated the 'parachute' in the top of the envelope to control the escape of hot air. Of these two lines, one was intended for use in the air, while the other, controlled by a red line, operated a 'Q-vent' rapid deflation system. This system was intended for use only after landing and its use whilst airborne was prohibited.

The balloon was equipped with a triple burner fed by four 60 litre fuel tanks. Each tank should have lasted for up to 30 minutes, providing for a maximum 90 minute flight duration and about 30 minutes reserve. When examined, the fuel tanks contained fuel for up to a further 25 minutes flying at an average fuel consumption.

Damage to the balloon

The balloon was examined at the manufacturer's facility. Damage to the envelope was separated into three distinct areas and affected 20 panels. The three areas were the crown ring, the 'Hyperlife' fabric and the ripstop nylon fabric.

The crown ring showed evidence of conduction damage on its outer edge and on the inside face. Several of the load tapes attached to the ring had hardened and become discoloured, caused by either conduction or heat generated within the metallic ring. The 'Hyperlife' fabric showed signs of melting and burning, with numerous horizontal lines close by, consistent with it having come into contact with at least one power line. This damage was 4.8 m in vertical extent, about a line 22.3 m above the basket base. There was also some tearing of the fabric. The polyester load tapes did not show any obvious signs of damage.

The lower ripstop fabric damage was mainly in a horizontal line 7.65 m above the basket base, with both melting damage and tearing of the fabric. Again, there was no evidence of load tape damage.

Meteorological information

The pilot had viewed the latest meteorological report and noted the wind information given in the ballooning forecast for the afternoon of the accident. This forecast a 2,000 ft wind from 300º(M) at 15 kt and a surface wind from 290º(M) at 8 kt .

The Met Office provided an aftercast for the period of the flight. The synoptic situation at 1800 hrs showed an unstable north-westerly airflow covering much of the British Isles, with rather cloudy weather and isolated slight showers. The surface wind would have been generally from 300º(M) at 3 to 6 kt, the 1,000 ft wind from 300º(M) at 10 kt and the 2,000 ft wind from 310º(M) at 13 kt. A weak cold front was crossing the accident area at about the time the accident occurred. It is possible that the winds just ahead of the front varied by about 20º from those quoted, though the wind speeds across the front appear to have been unchanged.

Effect on power supplies

At 1814 hrs the envelope contacted the 132 kV power lines and two protection circuits within the electrical distribution network operated, isolating the power and affecting the supply to 62,500 customers. The protection circuits were designed to re-close automatically after 15 seconds if the fault had cleared. One of the circuits did so, but the other immediately re-opened, closing again after 30 seconds had passed. Normal electricity supply was then restored to all but about 600 homes, which were without power for about 30 minutes. Technical staff from the electrical distribution company attended the scene and established that the power lines were undamaged, though small pieces of fabric remained adhered to the upper earth cable. No further action was required on site.

Manufacturer's flight manual

The flight manual provided by the manufacturer covered all the balloon types it produced. The manual contained the following information under the heading *'low level obstacles'*:

"Care must be used when flying close to the ground, in order to anticipate and correct changes in flight direction which could cause a collision. It is important to make the decision to ascend or descend and keep to the decision. It is always better to maintain or increase a vertical direction of motion than to reverse it. So if a balloon is in danger of a collision and is already going down, a quicker response will be achieved by pulling the parachute to increase the rate of descent.

Do not fly into powerlines. If powerlines are to be overflown, then it is good practise for the balloon to be ascending whilst the crossing is made. If contact is unavoidable, then descend as fast as possible so that any contact is with the envelope and not the flying wires or basket assembly. If the envelope is suspended in the wires, do not try to remove it until the power has been switched off. Do not allow crew to touch the basket if it is suspended above the ground and the power is still on."

Analysis

The pilot had attempted to land on a number of occasions, but the possible landing sites had proved to be unusable. He considered that opportunities for finding suitable landing sites were becoming fewer and, being aware that he was using 'reserve' fuel, would have felt under a degree of pressure to land the balloon without much further delay. It is probable that the repeated, aborted landing attempts had resulted in a higher fuel consumption than normal.

At first, the balloon was tracking towards the centre of the first of the two possible fields, and the one chosen initially by the pilot. His recollection that the balloon drifted to the left at a relatively late stage, which forced him to initiate a climb to avoid the tree, is not supported by the recorded GPS data. Although a change of track did occur, this took place whilst the balloon was still some way from the first field and more than three minutes away from the contact with the tree. As the balloon crossed the trees at the boundary of the first field, it was steady on a track towards the tree which it was to hit and also the eventual point of contact with the power lines.

The track on which the balloon crossed the first field not only took it over the highest trees on the field boundary but also presented a shorter distance in which to land, compared with the distance which would have been available had the balloon maintained its original track. The combination of a shorter available distance and high obstacles on the approach would have reduced the chances of a successful landing in the first field, and the tree which the balloon was to strike later would have presented a hazard to the envelope if it had overrun or blown onto the tree after landing.

From the accounts of those on board, and an eyewitness over which it passed shortly before the collision, the balloon was maintaining a relatively low height as it approached the eventual landing area. This probably also accounted for the reduced overall groundspeed in the latter part of the flight, as the wind strength closer to the ground was less than that aloft. With reduced height, an accurate, steep final descent would not have been practicable, and judgement of the final descent path would have been more difficult, such that the risk of overshooting the desired landing point would have increased. Additionally, it would have been more difficult for the pilot to readily assess distances available and clearances from potential hazards in the landing area.

The pilot reported that he had rejected a landing in the first field at a relatively late stage in favour of the second field because of its better access, and he was confident

that the balloon could be landed safely before the power lines, provided it could be landed at the beginning of the field and immediately after the fence posts. Because it was a late change of intention, this must have been when the balloon was tracking towards the tree and not, as the pilot perceived it, towards the clearer area to the right of the tree.

Once it became clear to the pilot that the balloon was tracking towards the tree and unlikely to land and stop before it, he initiated a climb. Crossing the first field at low level, the tree may have presented a more obvious hazard than the power lines beyond, and it would have been difficult for the pilot to judge whether sufficient distance was available to land beyond the tree and before the pylons.

It is likely that the balloon's true proximity to the power lines only became clear to the pilot after the basket had struck the tree. The balloon was ascending at this point, and the general guidance to pilots faced with obstacles at low level was not to attempt to reverse the balloon's vertical direction. The pilot was aware of this but was not confident that the basket would clear the power lines so immediately took the decision to initiate a descent. By this stage the pilot was clearly aware that the balloon would contact the power lines, so he took the action to use the 'Q-vent' rapid deflation control. Although use of this control in the air was normally prohibited, the pilot was complying with the guidance in the manufacturers flight manual to *"land as soon as possible"* if contact with power lines was unavoidable.

Once the pilot had committed to reversing the vertical direction of the balloon, contact with the power lines was inevitable. However, his actions to bring the basket down as rapidly as possible may have saved the basket or its metal support wires from contacting the power lines, thus reducing the risk to the basket and its occupants.