ACCIDENT

Aircraft Type and Registration:	Cameron Z-250 Balloon, G-CDIN
No & Type of Engines:	3 Cameron Shadow burners
Category:	3
Year of Manufacture:	2005
Date & Time (UTC):	12 June 2005 at 0643 hrs
Location:	Dunkirk, near Faversham, Kent
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 12
Injuries:	Crew - 1 (Serious) Passengers - 3 (Serious, 8 Minor)
Nature of Damage:	Distortion of basket and frame
Commander's Licence:	Commercial Pilot's Licence (Balloons)
Commander's Age:	47 years
Commander's Flying Experience:	392 hours Last 90 days - 8 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

Summary

The flight was planned as a pleasure flight of around one hour duration. At a low height, while the pilot was searching for a suitable landing site, the balloon encountered an area of sinking air on the lee side of a hill. The basket and frame contacted a concrete and brick bunker, hit the ground and then lifted off again. The pilot brought the balloon back down and it eventually came to rest against a large tree some 230 m further on. There were a number of injuries sustained amongst those on board. It was suspected that most of the injuries occurred during the initial impact.

History of flight

On the evening before the accident the pilot checked the ballooning forecast and general weather conditions on the Meteorological Office website and also discussed the conditions on the telephone with the operator's Chief Pilot. The decision was made for the pilot to meet his passengers at Leeds Castle and to fly from there providing the weather in the morning was suitable.

In the morning the pilot released a weather balloon from Leeds Castle and saw that there was too much northerly drift in the wind to allow a safe flight from there. He decided to move the balloon and the passengers to an alternative site further south at Lashenden (Headcorn)

Aerodrome. At Headcorn the pilot sent up another weather balloon; he observed that the wind was very calm with the aerodrome windsock hanging vertically down, and thereby made the decision to fly. The balloon was prepared for flight with the assistance of the chase crew and some of the passengers. The pilot gave the passengers a briefing on the flight and landing procedures.

At 0536 hrs the balloon lifted off and drifted slowly, at 0 to 4 kt, north across the aerodrome at around 20 ft agl. As the balloon ascended the direction of travel became north-easterly and at 1,000 ft the pilot reported that the wind was from the south-west at 10 to 15 kt. This was stronger than he had anticipated and was taking the flight towards the Lenham area at the foot of the North Downs[1], an area that he knew had limited landing opportunities. The pilot decided to climb to 2,000 ft and at that altitude he could see another balloon to the east of his position at a height of around 3,000 ft. He decided to climb up to see if the wind was more favourable at that level but when he reached 2,500 ft he realised it was still from the same direction but the speed had increased to between 15 and 20 kt so he stopped climbing.

Not wanting to fly over the North Downs, the pilot decided to find a suitable landing area and thought that he might be able to land at Challock Airfield. However the wind took him to the west of Challock so he looked for an alternative landing site. He made several descents to lower levels but when he did so he experienced 'curlover', sinking and turbulent air close to the ground, such that he needed to keep the burners lit to maintain level flight. The balloon was travelling across the ground at speeds varying between 12 and 20 kt while the pilot continued unsuccessfully to try to find a landing site.

Footnotes

[1] A ridge of elevated terrain aligned north-west to south-east which rises to over 600 feet amsl.

Shortly after crossing the A2 trunk road and at a fairly low height, with coastal towns and the sea 5 nm ahead, the pilot felt the balloon sinking. He ensured that all the burners were on but the balloon continued to descend. The balloon basket and burner frame hit hard against a concrete and brick bunker and the passengers were thrown about. It then hit the ground and lodged momentarily against a tree before lifting off again. The pilot called out to the passengers to get into the landing position and to stay in the basket. He could see a clear area of field and playing fields ahead and pulled the ripcord to bring the balloon down. The balloon made a landing some 210 m further on, hit the ground once more and then got caught against a tree in a hedgerow, where it came to rest.

Post-landing actions

The pilot turned off the fuel supply and the burners and ensured that the balloon was secure. He then checked the condition of his passengers and asked those who were able to do so to get out of the basket and to assist the others. He used his mobile telephone to call the recovery crew and in turn asked them to call the emergency services. There was a short delay before he could give them his exact position because the batteries in his GPS had run out at the end of the flight and he had to replace them.

The pilot was himself injured having suffered a dislocated shoulder but he continued to assist the passengers until the emergency services arrived. The air ambulance and the local ambulances arrived and their crews helped the remaining passengers out of the basket with the exception of two who could not be safely lifted out. When the fire service arrived their commander realised that the passengers would need to be cut free from the basket and asked the pilot if this was in order. The pilot advised him to proceed and briefed him on the location of the fuel supply lines which he thought might contain some remaining gas.

The pilot, a full time fire service officer, was then helped away to a nearby ambulance but he continued to watch what was happening. He saw that the fire crew were attempting to cut the basket in a place close to the fuel lines and shouted for them to stop. They stopped cutting and he re-briefed them on the areas where it was safe to cut. The remaining two passengers were then freed from the basket and taken to a local hospital.

Injuries to persons

The initial impact against the bunker was at around 16 kt forward speed and it is at this time that the most serious injuries are thought to have occurred. The majority of the passengers did not anticipate the impact, although one person was able to brace himself at the last moment and did not suffer any injury. There were three passengers detained in hospital for more than 48 hours, two of whom had suffered broken or crushed vertebrae. The other injuries were principally heavy bruising, particularly to legs, ribs and knees and a number of broken fingers. Subsequent impacts with the ground and trees caused some further injuries, in particular scratches and cuts.

Pilot experience

The pilot had been flying balloons for some 12 years, initially as a private pilot and then as a commercial pilot for the previous 5 years. He had accumulated just under 400 hours total flight time and had flown two flights on the day before the accident. He flew on a part time basis for the operator, making himself available two or three days a week. Although most flights were planned for one hour duration the pilot reported than on some occasions he had needed to land earlier because of adverse conditions. He was familiar with the Kent area having carried out many of his previous flights there but he had not previously flown across the location where the accident occurred.

For navigation the pilot used a 1 to 50,000 scale Ordnance Survey map annotated with significant features, including good and bad landing areas. He also carried a handheld GPS which he could use to determine his speed and also to relay his position to the recovery crew.

The aircraft

This Cameron Z-250 balloon had been supplied new to the operator in March 2005. The balloon had an envelope volume of 250,000 cu/ft and was equipped with three burners mounted above a twelve place double T-partition basket. The four vertical supports of the frame were each fitted with protective padding. There was space for three passengers in each partition, rope grab handles were supplied inside the basket. Passengers were briefed to face rearwards and crouch down in the basket holding the grab handles when instructed to adopt the landing position.

On the morning of the accident flight the ambient weather conditions gave a maximum lift capability of 2,093 kg. The actual mass at lift off was calculated at 1,774 kg which gave an underload of 319 kg.

Meteorological information

The Ballooning Forecast

The pilot accessed the online service from the Meteorological Office Internet website on the evening before the accident. This enabled him to check the general weather conditions and the ballooning forecast for the south-east region. The Meteorological Office Ballooning Forecast is funded by the Civil Aviation Authority and provided as a free service to pilots.

A preface page on the website contains a note on the purpose of the ballooning forecast. The note states:

These forecasts, issued daily, should be used in conjunction with AIRMET or forms F214 and F215.

Note that the forecast surface wind is an estimate of the wind speed and direction averaged over a ten-minute period, followed by the probable maxima (gusts) that may be experienced over flat, open countryside. The surface wind speed, and individual gusts, over variations in topography, trees and buildings, may be higher.

The forecast issued at 2130 hrs on the day preceding the accident contained the following information (see below):

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NOTE

THIS FORECAST IS PROVIDED AS A SUPPLEMENT TO AND NOT A SUBSTITUTE FOR, AIRMET OR CHART FORMS 214 OR 215.

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AREA: SOUTHEAST

PERIOD: DAWN TO MIDDAY, 12 JUNE 2005

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SURFACE WIND (DEGREES TRUE): 220/03-06KT, LOC 08KT NE, BECMG 290/10-12KT IN NW BY 09Z, 310 BY 12Z, AND GEN INCREASING 10-12KT BY 12Z.

THERMALS: NIL OR WEAK AT FIRST, BECMG MOD BY 09Z.

INVERSIONS: NIL.

SEA BREEZES: LOC DEVELOPING ALONG S COT BY 11Z.

LEE WAVES: NIL.

LOWEST PRESSURE (QNH): 1006MB E LATER.

SURFACE AIR TEMPERATURE:
0600: PS10, LOC PS12 S.
0900: PS14, LOC PS16 SW.
1200: PS15, LOC PS19 SW.'

OUTLOOK UNTIL DUSK:
MOD SEA BREEZES ALONG S COT DYING OUT BY LATE AFTERNOON. NW SURFACE WINDS GEN LIGHT, LOC MOD INLAND UNTIL EARLY EVENING, BECM N IN NE BY EVENING. OCNL RAIN OR SHOWERS IN NE DYING OUT DURING EVENING, OTHERWISE GOOD VISIBILITY AND VRB CU SC.

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ISSUED AT 2130 UTC 11 JUN 2005

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Ballooning forecast issued at 2130 hrs 11 June 2005

Other sources of meteorological forecasts

Forms F214 and F215 referred to in the note preceding the ballooning forecast contain some graphics and take longer to download than the plain text of the ballooning forecast. Using a domestic telephone line and modem it took approximately two minutes to access the website and to download the ballooning forecast; each 214/215 form took an additional minute. To cover a typical morning flight a total of four forms would be required.

Form 215 lists the weather fronts, cloud, visibility, freezing level and precipitation for the entire UK but does not provide wind information. Form 214 is the UK Low-Level Spot Wind Charts for the UK. It was produced at 21:06 hrs the evening before the accident, valid for the period between 0000 hrs and 0600 hrs UTC. It did not illustrate a spot wind for Kent. The nearest spot winds were for 50º00'N 02º30'W (the English Channel 35 nm north of Guernsey) 50º00'N 02º30'E (in France) and 52º30'N 00º00'E (near Peterborough). Interpretation of the form's wind tables for the 1,000 ft and 2,000 ft altitudes suggested that the winds at those altitudes over Kent would be either variable in direction or west-south-westerly at speeds of 5 to 10 kt. The updated version of F214 issued at 02:57 hrs on the morning of the accident showed similar wind directions but interpolation of the tables suggested that the wind strength would be nearer 10 kt at both altitudes.

The AIRMET forecasts for the seven UK regions (including one for south-east England) were available from the same Meteorological Office website and have no graphics. Typically each can be downloaded by modem in 15 seconds immediately after the balloon forecast has been downloaded. These forecasts contain wind and temperature information for the altitudes of 1,000, 3,000 and 6,000 ft for the specific region. The pilot did not use these forecasts when considering whether or not to launch on the morning of 12 June and a copy of the specific forecast was no longer available to the AAIB when it was requested.

The operator also subscribed to a commercial meteorological service. For a morning flight the general procedure was for the Chief Pilot to telephone the forecaster the evening before to obtain a specific forecast for the proposed flight area. He would then contact any other pilot flying for the operator and discuss the weather conditions. The decision whether or not to call the passengers in for the flight would be based on these forecasts and the passengers would then be advised during the evening. In the morning the local conditions at the take-off site would be assessed by releasing one or more weather balloons and the final decision whether or not to fly would then be made.

The forecast from the commercial source on the evening before the accident was summarised on the flight paperwork as follows:

> SURFACE WIND FROM 360º AT 2 TO 4 KT, WIND AT 2,000 FEET FROM 290º AT 5 TO 10 KT, VISIBILITY MORE THAN 20 KILOMETRES, NIL WEATHER, CLOUD SCATTERED OR BROKEN AT 3,000 FEET, TEMPERATURE 9ºC AND PRESSURE 1021 HPA.

The pilot commented that it had been his custom in the past to watch the BBC weather forecast on the evening news to obtain an overview of the weather situation but that he no longer did so because the synoptic picture including isobars was no longer provided.

Accuracy of the meteorological forecasts

The observed surface wind conditions at both Leeds Castle and Headcorn were described as very light or calm. The weather balloons launched at Leeds Castle and later at Headcorn both moved away in a northerly direction.

An aftercast for the period covering the time of the accident was obtained from the Meteorological Office which gave a best estimate of the likely conditions. The synoptic situation showed low pressure over Scandinavia and high pressure over France and Germany which was feeding a light west to north-west flow over south-east England. A table was provided which is reproduced below:

Height amsl	Wind direction (°T) & speed (kt)	Temp (°C)
Surface	210-240 / 7-10	+12.5
1,000 ft	250 / 10-15	+9.8
2,000 ft	270 / 15-20	+7.5

Table 1

Winds/Temperatures

The aftercast further provided an assessment of the accuracy of the forecast, which is summarised as follows:

> The 1,000 and 2,000 foot winds (Form 214) had been 5 to 10 kt stronger than forecast. The Low Level forecast (Form 215) had given good guidance and the morning ballooning forecast had also given good guidance with the exception that the increase in wind strength had occurred 1 to 2 hours earlier than forecast.

Recorded data

Data was recovered from the pilot's GPS which gave the time, speed and direction of flight until approximately the point of impact with the bunker, at which time the batteries appear to have run out. Altitude information was not recorded. The recorded data allowed the track of the flight to be overlaid on a map (see Figure 1).

Accident site

The accident site was in an area of agricultural fields, woodlands, abandoned buildings and structures from a second world war military installation, the former RAF Dunkirk Chain Home Radar Station. There were also two tall radio masts, the tops of which are 686 ft amsl. The nearest of these two masts was approximately 200 m to the east of the flight path taken by the balloon. The accident site, which was about 340 ft amsl, was on the northern boundary of a medium sized hay field. To the north of the hay field was a large cattle grazing field in which were a number of individual substantial trees. The boundary between these two fields consisted of a substantial hedge/small tree row with an embedded post and wire fence. To the south-south-west of the accident site the land ascends to a ridge, the top of which is, on average, 370 ft amsl and 500 m distant from the accident site. The ridge was covered with trees that were 60 to 70 ft in height. To the north-north-east of the accident site the land descends, over a distance of 4 km, to the residential area of Chestfield which is on the outskirts of the Thames Estuary coastal town of Whitstable. Large areas to the east and north-east were heavily wooded.

Impact sequence and parameters

The first impact was between the long side of the balloon's burner frame and the upper north-west corner of an abandoned bunker. The corner of the building was about 230 m to the north-north-east from the top of

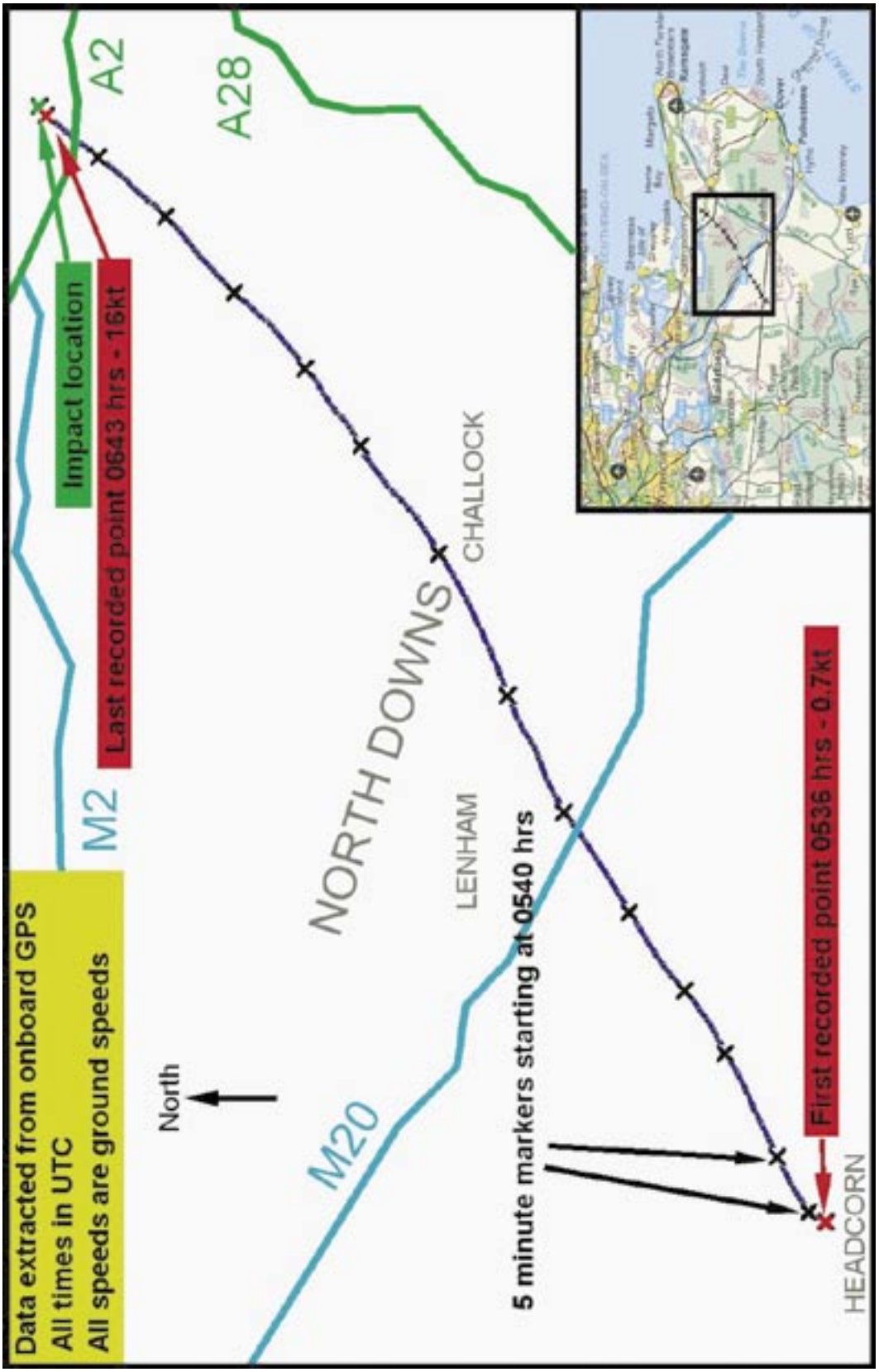

Figure 1

GPS recorded ground track.
(Accident to G-CDIN on 12 June 2005 at Dunkirk)

the ridge and 25 ft above ground level. At the time of this impact the balloon was travelling at approximately 20 mph, on a track of about 035ºM and descending at a rate in excess of 400 ft/min. Immediately following this impact a lower corner of the balloon's basket struck the top of a grass-covered solid embankment that was 2 m from and 8 ft below the corner of the bunker. After this second impact the basket slid in a north-north-easterly direction down the side of the embankment coming momentarily to rest in the side of an elderberry tree. Evidence from marks within the elderberry tree indicated that after momentarily coming to rest, the basket was pulled almost vertically upwards out of the tree's branches. After ascending from the elderberry tree the balloon continued to travel on a track of about 035ºM for approximately 210 m before the bottom of the basket impacted the ground in the hay field some 30 m south of the field's northern hedge with embedded fence boundary. The lower corners of the basket made further ground impacts within the hay field prior to it coming to rest in an upright attitude embedded in a small tree within the field's boundary hedge. The balloon's envelope draped itself over the top of the tree and into the next field to the north. The bottom of the basket came to rest about 6 to 12 inches above the ground.

Engineering examination

No disconnections or incorrect rigging of the balloon's envelope, basket or burner systems were found. A detailed inspection of the fabric of the balloon's envelope found two minor tears both of which showed good evidence of having occurred either during the impact with the elderberry tree and/or the tree in the hedge row. Sufficient fuel (gas) was found in the connected gas tanks for a further 15 to 20 minutes of flight. All three burners were tested using the gas contained within the connected tanks and found to function satisfactorily. The balloon's basket, which was of wicker construction, had suffered minimum damage during the ground impacts. The material and type of construction of the basket absorbed a large amount of the ground impact forces.

Operator information

The operator held an Air Operator's Certificate (AOC) issued by the Civil Aviation Authority. The company operated two balloons in the local area, flown from two different locations, and employed a full time Chief Pilot, who would normally pilot one balloon. If two balloons were scheduled to fly at the same time then a freelance pilot was employed. The Chief Pilot would normally be involved in pre-flight discussion and decisions on the suitability of the weather for both flights until each balloon was prepared for flight.

Analysis

The ideal conditions for balloon flights are smooth stable air with light winds. While conditions at surface level may be good, stronger winds at higher levels can give rise to steep wind gradients with associated turbulence. The direction of travel and distance covered by a balloon are also dependent upon the prevailing wind. Therefore an understanding of the winds above the surface is essential when planning a flight.

There are several difficulties when planning a balloon flight. The calmest conditions are usually found in the early morning and late evening. For a morning flight the conditions will tend to deteriorate as time passes because the air will be heated and mixed as the day progresses. Therefore, for a morning flight an early start is required but in order to be allow both passengers and crew to have a night's rest, a decision in principle regarding the flight has to be made some hours before the flight takes place. This means that the forecast also has to be

obtained some hours before the flight with an associated reduction in accuracy. Thus there will be occasions when flights have to be cancelled in the morning even though all the passengers have arrived. Also, because the actual conditions may only become apparent or can change while a flight is in progress, there will be times when a pilot has to decide to land earlier than intended.

The pilot had access to a number of different sources of weather information, although it is not known precisely what information he did obtain. There were some differences between the different forecasts but the indication generally was there was a good chance of being able to fly in the morning. The decision to invite the passengers to fly was based on this information.

On the morning of the flight the surface winds were almost calm but the direction of drift was to the north, meaning that Leeds Castle, with the Downs rising nearby to the north, was not a good take-off site. The launch site was moved to Headcorn from where it was expected that a reasonable length of flight would be possible. The conditions for takeoff were good and it was only as the balloon climbed through 1,000 feet that the pilot realised that the wind direction did not favour a full one-hour flight.

The balloon's track, as shown in Figure 1, was initially about 060º and then later backed towards 040º. These tracks are not consistent with the commercial forecast issued the previous evening but they were reasonably consistent with the Met Office Ballooning forecast. They were also consistent with the observed northerly direction of travel of the weather balloons launched by the operator from Leeds Castle and Headcorn. However, the wind at 2,000 ft was stronger than any of the forecasts. The balloon was, therefore, taken more quickly than expected towards the North Downs. The pilot recognised this and hoped to land at Challock, an airfield just on the Downs. However he was not able to do so and as the balloon crossed over the 600 ft amsl ridge, the air would have become more mixed leading to the less calm conditions he experienced. Although he was searching and made several descents to a lower level, the pilot was not able to find a landing site. As the coast got nearer there would have been increasing pressure upon him to find a site and perhaps to accept a less favourable landing environment.

The accident site was close to the top of a small ridge which rises steeply to 400 ft and runs in a north-south direction. As the balloon came across the top of this ridge the pilot experienced a downdraft and although he tried to maintain his height by using all three burners, he was not able to prevent the impact with the concrete and brick bunker. By flying at a low height the balloon was particularly vulnerable to such local wind effects but balanced against that was the pilot's desire not to miss a suitable landing site. The pilot's dilemma had really arisen earlier when the balloon had crossed up and over the North Downs area.

After the impact with the bunker the pilot's main concern was to get the balloon down onto the ground as soon as he could and he used the ripcord to bring the balloon down quickly.

Safety action

Since the accident, the Operator has reviewed the suitability of its take-off sites for southerly wind conditions. The company is considering using sites further to the south in such conditions to reduce the possibility of inadvertently crossing over the North Downs.

Sources of meteorological information

The ballooning forecast includes a note which emphasises the need to consult other sources. In practice a number of different pages and charts may need to be viewed, all of which can be time consuming, particularly for those without high-speed internet access and printing facilities. It is possible that some pilots do not take enough trouble to collect the full information and rely principally on the 'ballooning forecast'. It would be helpful therefore if this forecast contained some additional information about the wind that could be expected in the lower levels.

The spot wind chart Form 214 is not optimised for ballooning but the AIRMET forecasts for the seven UK regions have regional wind information for the altitudes 1,000, 3,000 and 6,000 ft. These forecast winds could usefully be repeated in the ballooning forecasts. However, the UK CAA, which funds the forecasts, does not consider it appropriate to include only the wind information from the AIRMET forecast into the ballooning forecast. Consequently, balloon pilots may have to rely on the AIRMET forecast or on commercial sources for suitable low-altitude wind forecasts. The additional time incurred in downloading the AIRMET forecast is negligible.