Cameron A-210, G-OJWE

AAIB Bulletin No:3/98 Ref: EW/C97/7/4 Category: 3

Aircraft Type and Registration:	Cameron A-210, G-OJWE
No & Type of Engines:	Two Double Shadow and one Single Stealth burner
Year of Manufacture:	1997
Date & Time (UTC):	20 July 1997 at 0927 hrs
Location:	North Ferriby, Humberside
Type of Flight:	Public Transport
Persons on Board:	Crew - 1 - Passengers - 12
Injuries:	Crew - 1 serious - Passengers - 1 fatal - 7 serious
Nature of Damage:	Balloon destroyed
Commander's Licence:	Commercial Pilot's Licence (Balloons)
Commander's Age:	42 years
Commander's Flying Experience:	See text
Information Source:	AAIB Field Investigation

History of flight

The departure point was HesslewoodCountry Park which is on the north shore of the River Humber,just to the west of the Humber Bridge; on the previous day fromthe same location the pilot had conducted a flight which had crossedthe River Humber and landed to the south of it. The passengersand pilot met at 0530 hrs, for the flight which was planned tolast about one hour. There was one more passenger than originallymanifested which made the total twelve. However, the weatherwas unsuitable due to low cloud and poor visibility and departurewas delayed until conditions improved. Meanwhile to assess thewind profile, the pilot released several helium balloons; he alsodiscussed the general weather with ATC at Humberside Airport andwent onto the Humber Bridge to assess the wind and visibility.

It was not possible to determinethe vertical profile of the flight with any accuracy, however,interrogation of the Global Positioning System (GPS) device carriedby the pilot enabled track and time to be determined with a highdegree of accuracy (see Figure 1). The pilot was unable torecall any significant detail of the flight.

The balloon eventually took off atabout 0831 hrs and tracked north west for a short time. As itclimbed the track became south west. It continued to drift slowlysouth west over the Humber

estuary at an altitude of about 600feet amsl. By 0853 hrs, it was still only about 270 metres fromthe north shore. The pilot had made radio contact with the recoveryvehicle and told the crewman that he would not be crossing theriver. The balloon then descended and began to track north west.

As the balloon approached the land,it appeared to fly parallel the shoreline for a short time beforelanding on the foreshore at 0908 hrs. A man who was walking hisdogs had seen the balloon flying at low level along the shoreand, when it landed on the mud just above the water line, he approachedto offer assistance. The pilot asked him from which directionthe wind appeared to be coming and he indicated that it was fromthe southern tower of the bridge. He was then given a line whichhe was told to tie to the outside of the basket. The pilot madea short burn to lift the balloon off the ground and, with theassistance of three passengers who had disembarked, he pulledthe balloon over a rocky area and onto the shore path. The pilotasked him if the area was accessible by vehicle and was told itwas. The pilot then got out of the basket and looked around theimmediate area before getting back in and asking the man to holdthe line until the basket was about 6 feet of the ground and thento release it.

At 0918 hrs, the balloon took offagain and flew north west at relatively low level. By 0924 hrsit had covered about 450 metres and was seen stationary, at lowlevel, over the southern end of the rear garden of a house inNorth Ferriby. It then climbed and turned left to track approximatelysouth.

A video recording made by a localresident showed the balloon descending into an adjacent field. As it passed over a 33 kVA power line it appeared to stop anddescend almost vertically, possibly even backwards. A short burnof about 2 seconds was heard followed immediately by a continuousburn of about 13 seconds which lasted until the basket short circuitedthe cables and burst into flames. The envelope and burners separatedfrom the basket, which tilted, spilling the passengers out ontothe ground some 30 feet below. The last relevant recorded GPSposition was at 09:26:40 hrs and the power line interrupt wasrecorded at 0926:35 hrs.

Meteorology

An aftercast from the MeteorologicalOffice at Bracknell indicated that there was a ridge of high pressureestablished over eastern England. Low cloud and poor visibilityhad been extensive along the coastal strip but by 0900 hrs ithad begun to clear and the visibility was around 7 Km with scatteredor broken cloud base between 700 and 1,000 feet. The surfacewind was variable/5 kt or less and the temperature was 16°C. At 2,000 feet, the wind was from 010° to 020°/8 to10 kt. The following METAR observations were made at HumbersideAirport:

0820 hrs Surface wind Calm

Visibility 3,000 metres in mist

Cloud Broken base 300 feet

Temperature +13°C

Dew point +13°C

0920 hrs Surface wind Calm

Visibility 6,000 metres in mist

Cloud Broken base 700 feet

Temperature +14°C

Dew point +13°C

A report from the Humber Observatorysaid that the surface wind speed at the time and location of theballoon's take off was probably 1 to 1.5 metres/sec (2 to 3 kt),decreasing as the flight progressed. The direction was probablynorth east to east north east at the take off point veering toeast or east south east at the estuary water surface. The surfacetemperature at take off was probably about 13C rising to about15 to 16C as the flight progressed.

Performance

The company used a combined documentknown as the 'Technical Log Sector Record Page Load sheet andPassenger Manifest'. There were eleven passengers plus the piloton the manifest and, with the balloon, propane cylinders and propanegas, the total lift required was calculated to be 1,507 Kg. Thepermitted lift calculation assumed a datum temperature of 10°Cwhich gave a total permitted lift of 1,772 Kg, 265 Kg more thanrequired. If, as recorded by Humberside Observatory, the temperaturewas 13°C when the balloon eventually took off at 0834 hrs,the total permitted lift would have been about 1,650 Kg, 143 Kgmore than required. However, the extra passenger's weight was71 kg, and even with the addition of the extra passenger, theballoon would still have been below its maximum permitted liftfor take off.

Recorded Data

The GPS equipment foundon the site was working throughout the accident flight. The equipmentuses satellite navigation to establish its position and displaysit on a small screen. More importantly, the equipment has a loggingfacility, which saves position, time and date information intonon-volatile memory periodically when there is a significant changein direction or speed. The equipment was found to operate satisfactorilyafter the accident.

The data stored inthe non-volatile memory was downloaded into a computer. Assessmentof the orbital position of the navigation satellites in view ofthe GPS equipment over the period of the accident flight indicatedthat the accuracy of individual points could not be guaranteedto better than 175 feet; this may have been degraded further bythe balloon occupants occasionally obscuring the GPS aerial. However, there was a very close correlation between the positionsplotted and the known positions of the balloon at takeoff andat the accident site.

Pilot's flying experience

It is believed thatthe pilot's licence and log book were in the basket and were destroyedby fire. Licence and medical summaries were obtained from theCAA.

The pilot was granteda PPL (Groups A/B) on 17 August 1994; the licence has a lifetimevalidity. On 20 January 1997 this was upgraded to a CPL (GroupB) which is valid for 10 years from the date of issue. He helda Class 2 medical certificate which was valid until 30 November1997.

The Company Chief Pilotconverted the pilot to Group B balloons between 6 December 1996and 14 May 1997; the course was completed successfully andabout 5:25 hours were flown. It was not

possible to determinethe pilot's total flying experience with any accuracy, however,he estimated that he had about 300 hours balloon flying of which20 were on type.

The company

The company operatingthe balloon held a current Air Operator's Certificate which wasmost recently re-issued on 4 May 1997, valid for 12 months, followingan inspection by the CAA on 9 April 1997. G-OJWE was addedto the company's Operations Manual on 19 June 1997.

General Descriptionof the balloon

The Cameron A210 hotair balloon had a sewn nylon fabric envelope with a volume of210,000 cu ft. The envelope was constructed from 20gores, each comprising 23 panels and was fitted with a type 210TTmodel 'double T' partitioned basket. A leather covered steelframe was attached to the top of the basket, giving extra rigidityand dividing it into a central area for the pilot and four 60litre gas cylinders, and an area at each end, subdivided to providea total of four passenger units each capable of holding threepassengers.

The balloon was equippedwith three burners, each attached to the burner frame which wassuspended below the envelope. The burners were each connectedto a gas cylinder by two hoses, one carrying liquid propane, andthe other carrying propane vapour. The basket was also connectedto the burner frame by two loops of 6 mm stainless steel cable,which ran around the basket through the wickerwork structure.

For in-flight ventinga candy striped vent line was used; this opened the parachutein the crown of the envelope to release hot air. For final deflationa red rip line pulled the centre of the parachute down towardsthe basket, causing it to collapse into a column in the centreof the parachute aperture. The parachute panel could be madeto refill the aperture by pulling on the candy striped ventingline.

G-OJWE had been manufacturedin April 1997 and had flown for 15.30 hrs total time before theaccident flight.

Accident Site

The burnt out remainsof the balloon basket were found in a grass field immediatelyto the west of a hedge consisting of a line of small trees alignedon a heading of 280_M. A three-wire 33 kVA power line ran approximatelyeast/west over the hedge and a few yards south of the basket,with a pole support positioned close to the eastern side of thehedge. The power wires were approximately 8m above ground level,and the southernmost pair of wires showed some slight damage towire strands within their respective bundles.

The basket wickerworkhad been burnt out except for some small areas on the undersurfacewhich were resting on the ground. The stainless steel basketframe had survived, but was bent and showed signs of arcing. The basket suspension cables had sustained multiple breaks dueto overheating, both under the basket and where the cables hadpassed close to the steel basket frame. The four gas cylinderswere found amongst the remains of the basket and showed signsof extreme heat which had melted their aluminium fittings. Thehoses of the three cylinders which had been connected to the burnershad separated at one or other of their swaged end fittings. Thesethree cylinders showed no signs of expansion due to internal pressure. However, the fourth cylinder had no hose fittings attached andhad vented gas through its pressure relief valve.

Subsequent Inspection

The balloon envelope,still attached to the burners on the burner frame, had separatedfrom the basket and drifted away, finally sinking in the Humberand partially inflating under water. The recovery of these itemsfrom the water was a difficult operation which resulted in extensivedamage to the balloon envelope and some damage to the burners. The balloon envelope, burner frame and metallic components fromthe accident site were examined by the AAIB and the manufacturer.

Due to the damage doneto the burners and their pilot lights during their immersion insea water, it was not considered possible to determine their serviceabilitybefore the accident. Although the audio track of the video recordeda burner application prior to the wire contact, the number ofburners in use could not be determined. The burner valves wereeasily toggled on/off and the positions found after the recoverywere not necessarily considered to represent the selections inuse before the accident.

The envelope was takento the manufacturer's premises where it was inspected:

Panels Approximately half of the 460 panels had been damaged by tearingbut no seams had come undone. The damage was assumed to havebeen produced during recovery from the River Humber.

Temperature Tape Both temperature strips inside the top of the balloon indicatedthat their maximum temperature of 150_C had been exceeded, althoughthe effects of immersion in salt water was not known. A temperatureindicating flag, which would have been dropped at 128_C by a lowmelting point solder, had not been released.

Pulleys Seven of the 20 black plastic pulleys on the parachute showedsigns of melting produced by cord burns, this was most likelyto have occurred during the release of the envelope after thecontact with the power line. If the temperature strip indicationswere valid the pulley plastic could have been softened by excesstemperatures. One of the cords running over the pulleys had failedunder loading.

Candy striped andRed Rope Both ropes had detached from their steel clips at the lower ends,these clips were normally attached to the burner frame, and theeyes in the ropes which had held the clips had been subjectedto sufficient tension to permanently change the cross sectionof the rope.

The freed rope endon the candy striped line had torn the intermediate pulley fromits nylon loop attached to the envelope and had ended up jammedin the top pulley. The red rope had also pulled out a nylon attachmentand was jammed in a pulley.

Probable Sequenceof Events

A video recording showedthe last few minutes of the flight and the contact with the wires. Two of the electricity wires had short circuited through thetwo 6 mm suspension cables fitted round the basket and the basketframe; this had caused multiple breaks in the cables which transferredthe loads to the six burner hoses. The burner hoses parted, releasingthe balloon and the burner frame to drift back over the Humber;the basket then fell to the ground with the four gas cylindersand the passengers. It is probable that the three in-use tankshad their valves open and were venting liquid propane at around100 psi into a propane fire. It is also possible that some ofthe passengers were tipped out of the basket and so escaped theworst of the conflagration.

In view of the uncontrolledrelease of liquid propane caused by the failure of the basketsuspension cables it is recommended that the CAA require UK balloonmanufacturers to review the integrity of their balloons in similarcircumstances.

During the video recordingrope(s) could be seen extending from the envelope to the basketas the envelope rose in the air. It was assumed that these ropeswere the red and candy striped ropes, their effect on the parachuteduring the accident sequence could have been:

The envelope detached,having about 1000 kg excess lift, with both ropes fastened tobasket at their lower ends.

As the red rope cameunder tension it released the parachute, further tension torethe pulley from the envelope and eventually released the clipattached to the basket rail.

The candy striped rope,which was longer because it had a double fall then closed theparachute and eventually it's clip released from the basket railin the same way as the red rope.

During the initialascent of the freed envelope the bottom LHS appeared to partiallycollapse. This appeared to have been caused by the hot air risingfrom a propane fire beneath it.

Safety equipment

Because the regionof operation for United Kingdom balloon operators does not extendbeyond any point to seaward more than 1 nm from the Spring Tidehigh water mark, the carriage of crew and passenger lifejacketsis not addressed in either the Operation manual or related legislation. There are other popular ballooning area, for example the BristolChannel where, like the River Humber, balloons can spend a significantpart of their flight over water. It is therefore recommendedthat the CAA consider the requirement for the provision of lifejacketsfor the occupants of balloons which, although within the regionof operation, spend a significant part of their flight over water.

CAA Database

The CAA Mandatory OccurrenceReport (MOR) database contained 45 other reports of wirestrikesinvolving UK registered balloons since 1977. Of these 45, 19were reported to have been in the Passenger category, and theyhad resulted in four serious injuries and seven minor injuries.

Discussion

Early morning fog andmist normally clear when the surface temperature increases andthermal activity mixes the air near surface with the warmer airabove it. Both the temperature rise and the turbulence generatedby surface warming can adversely affect a balloon's performance. This is why they are normally flown in the 2 to 3 hours aftersunrise and the 2 hours before sunset. Rather than disappointthe passengers by cancelling the flight at 0530 hrs, the pilotelected to wait until the visibility improved and then reassessthe situation. When the visibility did improve enough to makethe flight viable he evidently decided that the prevailing conditionswere such as not to cause concern about the balloon's performance.

It would have beenevident to him that the wind near the surface was from the southeast becoming north east with increasing altitude. In other words,related to the north shore of the River Humber, the wind directionwas onshore at low level becoming offshore with increasing altitude;a normal

situation. The stronger wind at 2,000 feet would havecaused the balloon to track between 190° and 200° at8 to 10 kt which would have taken it across the estuary in reasonabletime. Although the wind was light, generally less than 3 kt,it should be borne in mind that a balloon has a very limited surfacewind domain and would not normally be operated in surface windspeeds exceeding 8 kt. It would have been reasonable to assumethat these wind velocities would be relatively stable for thewhole of the rescheduled flight, possibly with the speed increasingslightly with time.

The balloon driftedslowly south west as altitude was gained. Although it would havegiven the pilot the advantage of a more favourable wind, the balloondid not climb above about 600 feet amsl. This was almost certainlybecause the pilot was obliged to conduct the flight in VMC andhe would have been reluctant to enter the layer of cloud, thebase of which was reported to be about 700 to 1,000 feet amsl. His progress was slow and, at about 0854 hrs, he descended, touse the onshore wind at low level to bring him back to land.

When the pilot decidedto land on the foreshore, at 0908 hrs, it is possible that heintended to terminate the flight at this point. However, afterthe balloon had been manhandled over the rocks onto the shorepath, the pilot may have considered that the proximity of a railwayline would have proved a hazard to the deflation of so large aballoon and it was also apparent that access would have been lessthan ideal for the recovery vehicle. The balloon was not shortof fuel and its occupants were in no immediate danger so whenhe sensed a slight onshore breeze the pilot took off again, probablywith the intention of flying inland for a while before findinga suitable field in which to land. It was evident that any attemptedincrease in height led to the balloon tracking back towards theestuary which forced the pilot to descend again. The balloooncontinued across a field towards a row of houses where it cameto a halt, probably because the light airflow had been modifiedby the presence of the buildings; this prevented him passing overthem at a safe height. Again, the balloon was not short of fueland its occupants were in no immediate danger.

He subsequently climbedagain into the north easterly airflow and tracked towards thefield over which the accident occurred. The field was suitablefor a landing and the consensus of informed opinion is that thepilot was attempting a landing when the balloon struck the electricitycable. At this point the cable crossed the narrow northern edgeof the field almost at the fence line. The balloon's approachtrack certainly changed at a critical stage in the descent, makinga safe landing unlikely. The pilot therefore aborted the landingbut despite the continuous burn he was unable to arrest the rateof descent. It was not possible to determine how many burnershe used in this attempt.

Safety recommendations

Recommendation 98-21

It is recommended that the CAA considerthe requirement for the provision of lifejackets for the occupantsof balloons which, although within the region of operation, spenda significant part of their flight over water.

Recommendation 98-22

It is recommended that the CAA requireUK balloon manufacturers to review the integrity of their balloonsso that separation of the basket from the envelope does not resultin uncontrolled release of gaseous or liquid propane.