ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BNDE
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1979 (Serial No: 38-79A0363)
Date & Time (UTC):	20 August 2014 at 1834 hrs
Location:	Near Padbury, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	3,027 hours (of which more than 80 hrs were on type) Last 90 days - 28 hours Last 28 days - 13 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was flying in the vicinity of the town of Buckingham when it entered a spin from which it did not recover. The pilot sustained fatal injuries in the impact.

History of the flight

Background

The pilot had leased the aircraft, a Piper PA-38 Tomahawk, G-BNDE, for a period of three months, commencing in early June 2014. He kept the aircraft at Elstree Aerodrome and flew it regularly on local flights, landing away at a number of different airfields. Global Positioning System (GPS) data later showed that on some flights he would fly directly to the destination whereas on others he would spend additional time en-route, flying around an area. Since the lease had started he had flown approximately 20 hours in this aircraft.

Flights on 20 August

At 0933 hrs on 20 August 2014 the pilot departed in G-BNDE from Elstree on a flight to Turweston Aerodrome, where he landed at 1126 hrs. He spent about half an hour on the ground there, during which he spoke with several acquaintances and refuelled the aircraft with 40 litres of Avgas (10.5 USG). At 1156 hrs he departed and flew in a southerly direction, landing at White Waltham at approximately 1300 hrs.

The pilot spent some time at White Waltham and then 'booked out' in the airport office for a flight to Elstree. The time of departure shown on the booking-out sheet was 1800 hrs local (1700 hrs UTC). However, at 1655 hrs, just before he left, he made a telephone call to 'Elstree Tower' to advise them that he would not be returning with the aircraft that day.

The pilot went out to the aircraft and tried to start it but discovered that the battery was flat. He returned to the airport office to seek assistance, advising them he had left the Master switch ON and the battery was flat. A locally-based maintenance organisation were able to assist him and used a battery booster starting aid to start the aircraft. The pilot, in conversation, asked the maintenance personnel how long they thought it might take for the battery to charge. They replied that, typically, after about an hour of flight time the battery would be fine.

The pilot took off from White Waltham at 1708 hrs and headed in a northerly direction. South of Buckingham he started flying in an approximately circular pattern with a 2 nm to 3 nm radius and continued for almost an hour, remaining between 2,500 ft and 4,700 ft amsl (the base of controlled Class A airspace in the area is 5,500 ft amsl). During this time the pilot made a number of calls on his mobile telephone. A plot of the track of the aircraft, from White Waltham to Buckingham, is shown in Figure 1.

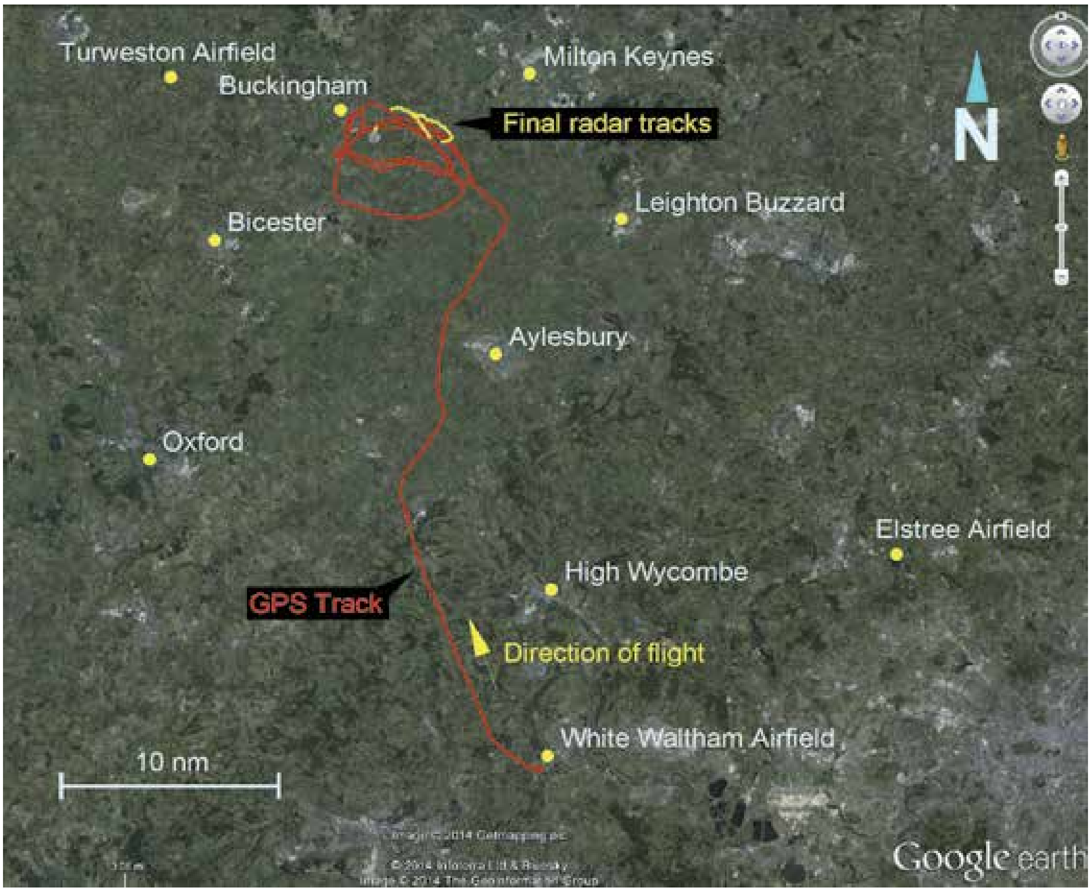

Figure 1

Combined GPS and radar track of flight from White Waltham

At 1831 hrs the pilot attempted to make a telephone call to a relative but it did not connect. Twenty-five seconds later a text message was sent to the same relative, stating that control of the aircraft had been lost and it was “going down”. Some two minutes later the pilot broadcast a MAYDAY call on the Farnborough Radar North frequency, stating that the aircraft had gone into a spin. Farnborough responded to the MAYDAY call but the reply crossed with a further communication from the pilot, giving his position and ending abruptly.

A number of witnesses near Padbury saw the aircraft descend rapidly, spinning or spiralling until it went out of view. The subsequent impact with the ground destroyed the aircraft and the pilot sustained fatal injuries.

Meteorological information

On the 20 August 2014 the weather conditions for visual flight were good. There was a weak pressure pattern across the United Kingdom with a light north to north-westerly airflow. An aftercast from the Met Office indicated the 2,000 ft wind was north-westerly (approximately 315°) at 10-15 kt and at 5,000 ft approximately 280º at 12 kt.

Pilot information

The pilot was an experienced fixed-wing general aviation pilot and held a helicopter licence, which he had recently renewed. He had held a UK PPL (A) since 1982 and a CPL(A) since 2005. It was recorded in his logbook that within the last two years he had undertaken some aerobatic training, mainly in a Cessna 150 Aerobat. He had in the past owned and flown a Cessna Citation aircraft as well as a variety of light single and twin piston-engine aircraft. Most recently he had owned a share in a Bölkow Bo 209 Monsun aircraft, which has an aerobatic capability. He was in current flying practice.

Pathology information

A post-mortem examination was performed on the pilot by a forensic pathologist and his report was reviewed by a pathologist with additional aviation expertise. This concluded that the cause of death was multiple injuries sustained in the impact. There was no evidence that disease, drugs or alcohol could have caused or have contributed to the death, or to loss of control of the aircraft.

Witness information

A number of people had met and spoken with the pilot through the course of the day. They described his behaviour as unremarkable; he appeared chatty, friendly and relaxed.

There were several witnesses who saw and heard the aircraft just before the impact. Two witnesses saw it enter into a descending spiral from apparently normal flight, several others first noticed it when it was already in a descending spin or spiral. They commented that it went though a number of turns before going out of view. The engine was heard to be running by several witnesses; they mentioned that it cut in and out during the spin.

Accident site

When the emergency services arrived at the accident site they reported a "sputtering" noise emanating from the aircraft. This apparently ceased after a member of the fire crew turned off switches, probably the combined Battery Master/Alternator switch, the anti-collision beacon and the fuel boost pump.

Aircraft impact

The aircraft had come to rest in an upright attitude on a grassy area at the edge of a field. There were no marks on the ground other than faint impressions from the wing leading edges; it was clear that the aircraft had rotated slightly to the left after the impressions had been made. The tail of the aircraft was lying against a hedge that bordered the field and the nature of the damage to the foliage also indicated a left rotation of the aircraft as it came to rest. This, with the damage to the airframe, was consistent with the aircraft having struck the ground in a left spin, with a wings-level nose-down attitude of 20º to 25º. The landing gear had been flattened against the aircraft underside and the mass of the empennage had caused a crippling failure of the rear fuselage during the impact. This was indicative of a high vertical descent rate, typical of a spin, in which any horizontal velocity component is small.

Fuel tanks

The fuel in this aircraft type is carried in integral tanks in the inboard wing sections, in front of the main wing spar. These areas were punctured in the impact, allowing the tank contents to drain into the ground around the nose of the aircraft. There was an odour of Avgas at the site. The fuel selector was found halfway between OFF and the LEFT tank and the gascolator and carburettor had sustained severe damage in the impact, allowing the fuel to drain into the ground beneath the engine.

Propeller and engine

The propeller had come to rest in a horizontal position such that neither blade had penetrated the ground to any significant depth. The blades were undamaged apart from diagonal scuff marks, suggesting that the engine had been developing little or no power at impact. Very little oil was found in the engine and it was apparent that the casing had fractured around the base of the oil filler tube, allowing the oil to escape into the ground.

The mixture lever was found set to fully rich, the throttle lever was found at a mid-to-low setting and the carburettor heat control was approximately midway between hot and cold.

Aircraft structure

Examination on-site by the AAIB established that the aircraft had been structurally complete at impact, with all the extremities accounted for. It also established, after examination of the doors, latches and doorframes, that both cabin doors had been closed at the time of the impact.

Electrical system

Inside the cockpit, the only 'tripped' circuit breakers were the transponder and the alternator field supply. The transponder was set to 'STANDBY'. The magneto switch was in the OFF position; it is possible it was placed there by the first responders.

Recorded information

Sources of recorded information

Recorded information was available from two mobile phones[1] and one tablet computer[2] recovered from the aircraft (all three devices belonged to the pilot), ground-based primary[3] (without altitude information) radar records from sites at Bovingdon, Debden, Heathrow Airport and Stansted Airport and a ground-based radiotelephony recording of the MAYDAY transmitted by the pilot on the frequency of 132.800 MHz. A record of the mobile phone network logs was also obtained, providing timings of calls and messages sent and received from both of the recovered phones. The two mobile phones in total contained in excess of 1,000 voice call records and 10,000 Short Message Service (SMS) messages.

Tablet computer

The tablet computer contained a track log of the accident flight, with aircraft GPS-derived position, track, altitude and groundspeed recorded at a rate of once per second. The record started at 1653 hrs with the aircraft parked at White Waltham Airfield and ended at 1822:54 hrs, 11 minutes before the final radar record. The navigation software enables a pilot to enter routes. No active route had been selected for the accident flight.

The track log will end under the following conditions:

1. the navigation software application is closed by the pilot
2. the pilot manually exits from the moving map function within the navigation software
3. the tablet computer internal battery supply is depleted resulting in the device turning itself off
4. the pilot manually powers off the tablet
5. the navigation application closes due to an error.

Testing was later carried out on a tablet computer of the same model and the same version of operating system. It was found that, when the internal battery became depleted and the unit turned itself off, a particular data file would be updated with the corresponding date and time. This data file on the accident tablet was dated 22 August 2014, two days after the accident, indicating the tablet computer was 'on' at the time of the impact.

Footnote

[1] Apple-manufactured iPhone 5 model A1429 and iPhone 5S model A1457. The iPhone 5 was recovered from within a bag inside the aircraft. The iPhone 5S was found loose within the aircraft.

[2] Apple-manufactured iPad mini model A1490, operating a SkyDemon flight navigation software application.

[3] The aircraft transponder had not been selected by the pilot to transmit secondary radar Mode A or Mode C information.

Radar record

The radar records covered the time period from 1711 hrs to 1834:02 hrs, with data from Bovingdon, Debden, Heathrow Airport and Stansted Airport recorded once every five, six, four and four seconds respectively. There were several periods during the latter stages of flight when no radar records for G-BNDE were recorded. This can occur where the radar's computed groundspeed of a target aircraft reduces to less than 50 kt, at which point the radar system applies logic[4] to filter out the signal from being displayed and recorded. The absence of radar records can also occur when the radar return signal is weak or the aircraft descends below radar coverage. The radar coverage in the area near Buckingham was calculated to be approximately 1,450 ft amsl (about 1,200 ft agl).

Headset communications

The aviation headset[5] worn by the pilot incorporated wireless Bluetooth® technology that enabled voice calls to be made using a mobile phone, in addition to supporting ATC communications, using a wired connection to the aircraft radio system. The investigation established that the headset was 'paired'[6] with one of the pilot's mobile phones (iPhone 5S, model A1457) recovered from the cockpit. Call logs for the phone indicated that the pilot had been making and receiving voice calls during the accident flight and that he had sent an SMS text message from the same phone several minutes before the aircraft crashed. The headset enabled the pilot to accept incoming calls hands-free, but did not support either voice-activated dialling or dictated SMS text messaging. Accordingly, all outgoing phone calls and SMS messages would have required the pilot to access the phone physically.

Shortly after takeoff from White Waltham the pilot had attempted to make a phone call, but no network connection was available. Several minutes later, at an altitude of 2,200 ft amsl, he made several phone calls lasting a total of about two minutes. At 1734 hrs the aircraft was about 5 nm west of Leighton Buzzard and had climbed to an altitude of about 2,800 ft, when it started to manoeuvre in a series of turns, predominantly to the left (Figure 2).

At 1746 hrs, the pilot phoned the same person that he had spoken to earlier in the flight, with the call lasting about 90 seconds. The pilot then phoned someone else. Several of the calls to this person were connected for a brief period before the calls ended[7]; this is most likely to have occurred due to connectivity problems with the ground-based mobile phone network.

(Note: A Bulletin Correction was issued in the October 2015 Bulletin concerning the headset communications and can be found at the end of this report.)

Footnote

[4] If the radar computed groundspeed of a target reduces to less than 50 kt a 'low speed flag' is set. After three consecutive low speed flags, the target is dropped. To re-establish the target and resume recording, the radar requires three consecutive periods where the low speed flag has not been set. The period is dependant on the scan speed of the radar.

[5] Bose® manufactured model A20.

[6] When wireless Bluetooth® communications are established between two devices, they are referred to as 'being paired'.

[7] The recipient advised that the connections were lost shortly after having answered the call. The recipient tried to call the pilot back, but the calls were diverted automatically to voice mail.

Interpretation of recorded data

Although the radar data was incomplete, the tablet computer track log and radar tracks predominantly aligned, corroborating the accuracy of the two independent data sources. From the four radar heads, the one located at Bovingdon provided the most comprehensive coverage and closest correlation with the tablet computer track log. It was established that all data sources utilised the same UTC time base, which was acquired from GPS satellite signals. All times referenced are UTC (local time was UTC+1) and altitudes are above mean sea level (amsl).

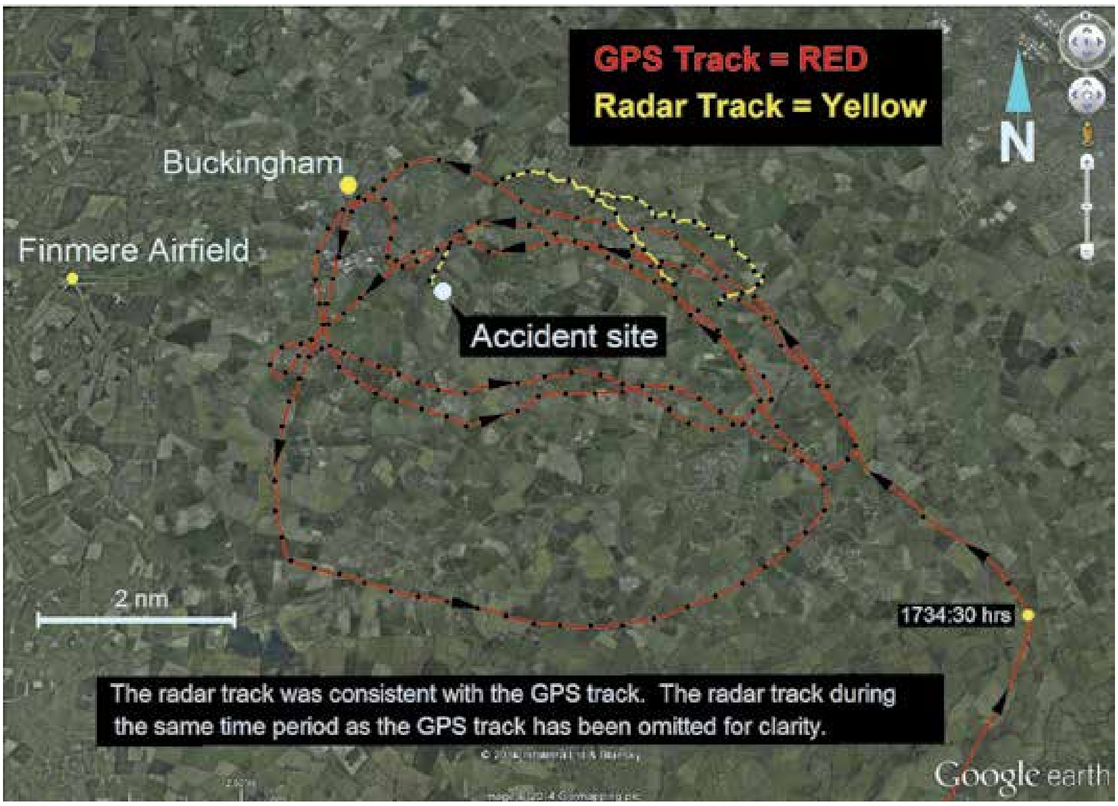

Figure 2

GPS and Bovingdon Radar track to the south and south-east of Buckingham

Final 12 minutes of flight

At 1822.54 hrs, the track log ended (Figure 3), with the aircraft recorded at an altitude of 4,360 ft and on a track of 319° T. Its airspeed based on an estimated wind at 5,000 ft of 280° at 12 kt would have been 52 kt. About 30 seconds prior to this the radar record had also stopped, probably due to a computed groundspeed below 50 kt. At 1825:10 hrs the radar record was re-established. Shortly after, at 1831:03 hrs, the pilot attempted to phone a relative's mobile phone, but the outgoing call failed[8] to connect with the mobile network[9].

Footnote

[8] Cellular radio antenna signals may extend in vertical lobes up to several thousand feet above the ground. The shape of the lobes means that an aircraft may transit in and out of signal coverage.

[9] There was no record that the pilot had previously called this relative from either of the two mobile phones or computer tablet although a number of SMS text messages had been exchanged.

Twenty-five seconds later, at 1831:28 hrs, an SMS message from the pilot's phone was sent to the relative's mobile phone, the text included the words *'… I'm in a plane out of control and it's going down …'.* The whole message consisted of 148 characters. At this time, the aircraft was positioned 1.8 nm to the north of where it later impacted the ground.

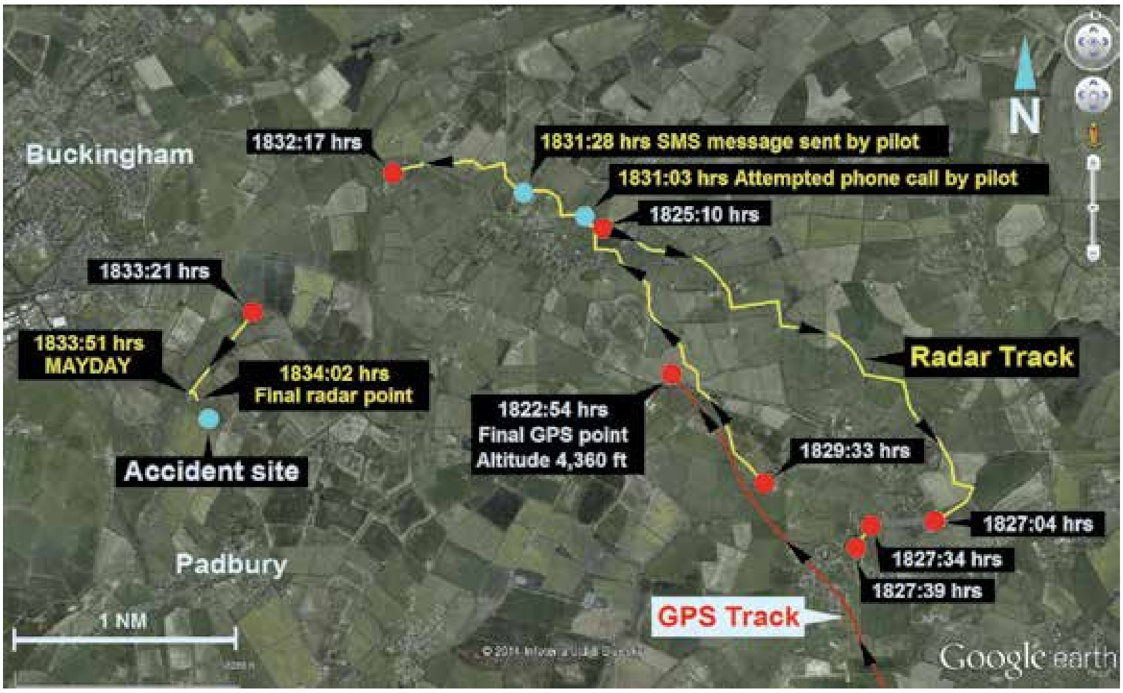

Figure 3

Final GPS and Bovingdon Radar track

The radar indicates that when the SMS message was sent, the aircraft's track was about 293° T and its average groundspeed was approximately 64 kt. Based on an estimated wind from 315° at 12 kt, the aircraft average airspeed would have been about 74 kt[10]. During the next 49 seconds the aircraft gradually turned to the left, onto a track of about 240° T. At 1832:17 hrs there was a further gap in the radar record.

At 1833:21 hrs the radar track recommenced with the aircraft positioned 0.9 nm to the south-west of the previous radar position. The aircraft remained for the next 25 seconds on a relatively constant track of about 210° with an average airspeed of approximately 64 kt.

At 1833:46 hrs the radar track deviated about 90° to the left, which was almost coincident with the pilot declaring a MAYDAY, stating "MAYDAY MAYDAY MAYDAY ER GOLF BRAVO NOVEMBER DELTA ECHO ER LOST CONTROL OF THE AIRCRAFT AND ITS GONE INTO A SPIN". The transmission lasted 8 seconds. The controller responded immediately, asking the pilot to set 7700 on the transponder. The pilot responded by confirming his approximate location before stating "I CANT CONTROL IT". This transmission was timed at 1834:07 hrs and lasted 1.4 seconds. No further radio transmissions were received from the pilot.

Footnote

[10] This is based on the aircraft being in level flight.

The final radar data point was recorded at 1834:02 hrs (during the period that the controller was responding to the MAYDAY), close to where the aircraft impacted the ground.

Calculation of airspeed

To estimate the airspeed of the aircraft during the final phase of flight, the radar data was corrected for the effect of the wind. This data is presented in Figure 4, which plots both the variation in calculated groundspeed and the corresponding aircraft track as individual points and five-point averages. The plot shows the estimated horizontal component of the aircraft's airspeed, based on the five-point average groundspeed, corrected for a wind from 315° at 12 kt. Given the lack of altitude information, a vertical speed component could not be included because there was no information as to whether the aircraft was climbing, descending or in level flight. Due to the variation in the recorded data, a consequence of the limitations of primary radar, the calculated airspeeds are not accurate enough to demonstrate airspeed at any specific point, but do show that, in general, the aircraft was flying at airspeeds below typical cruise speeds.

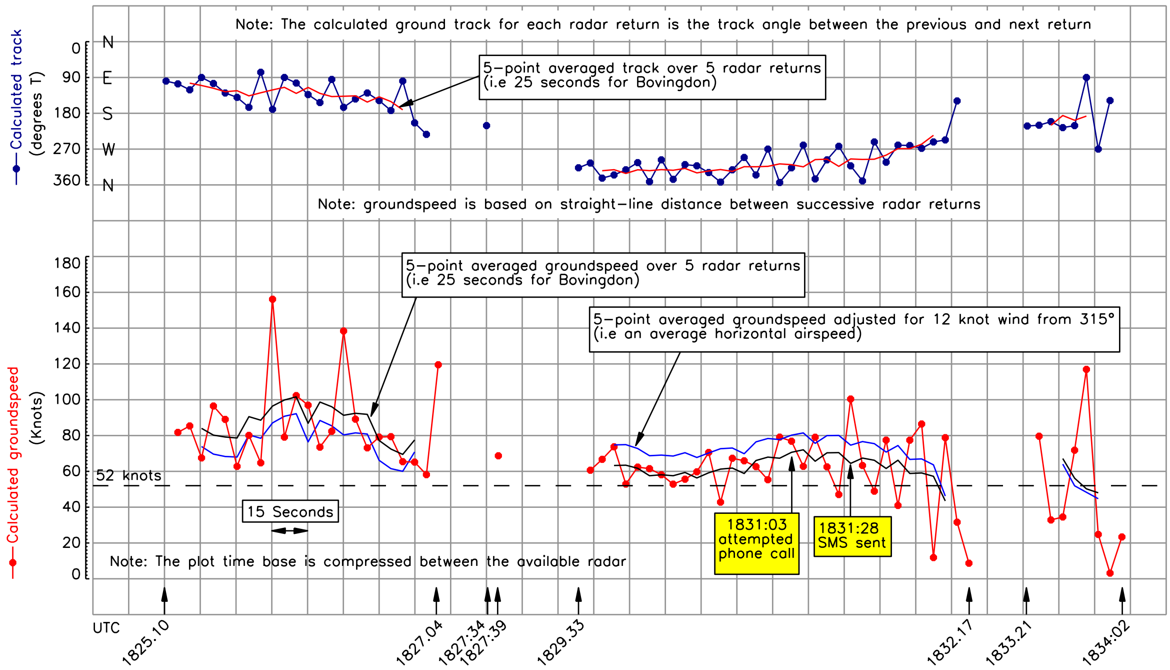

Figure 4

Calculated airspeed of G-BNDE based on radar data from Bovingdon

Previous flight records

In addition to the accident flight, the tablet computer contained track log records of 34 previous flights[11], which included the two flights prior to the accident on 20 August 2014. None of the track logs ended prior to the aircraft having landed. From the pilot's use of the navigation software, it was evident that he was familiar with the track log recording function.

Footnote

[11] The flights were between 6 June 2014 and 20 August 2014 and were to airfields and helicopter landing sites located in the south-east of England, with an average flight distance of about 60 nm. There was a good correlation of flight records, between the pilot's log book and the computer tablet.

During the flight from Elstree to Turweston on the morning of 20 August 2014, the pilot had flown circling manoeuvres just to the south of Buckingham, similar to those flown during the latter stages of the accident flight.

Previous use of mobile phones whilst in flight

There was no evidence that the pilot used either of the two telephones recovered from the wreckage for calls during the 34 flights contained on the computer tablet. There was one record of an SMS text message (consisting of 23 characters), sent during the flight from Elstree to Turweston on the morning of 20 August 2014. The message content was not related to the operation of the flight.

Aircraft information

General

The Piper PA-38 Tomahawk is a two-seat, all-metal aircraft, first produced in 1977. It was designed specifically for flight instruction but has also been widely used as a touring aircraft. Part of the design brief was to build in realistic spin recovery behaviour by requiring specific pilot input to recover from a spin. A spin may be entered unintentionally or intentionally, as an outcome of unbalanced flight close to the aerodynamic stall. The PA-38 is cleared for intentional spins provided that a full four-point shoulder harness is fitted and the flaps are fully retracted. A series of flight tests were carried out October 1979 by NASA Langley Research Center, to evaluate PA-38 Tomahawk spin behaviour and recovery.[12] From these tests, the average rate of descent was calculated to be of the order of 5,000 ft/min to 6,000 ft/min.

Airworthiness Directive, 83-14-08, issued in September 1983, mandated an additional pair of stall strips to be added to the inboard leading edge of the PA-38 wing to "*standardize and improve the stall characteristics*". G-BNDE had these strips installed.

An Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation (ASF) review of stall-spin accidents in 2001 reported that the Piper PA-38 Tomahawk, was involved in proportionately more such accidents than other training aircraft.[13] However, the report noted that a high percentage of these were from an entry height of 1,000 ft or less, they were therefore unlikely to have been recoverable and were not related to any spin recovery characteristics.

This PA-38-112 has a Maximum Takeoff Weight (MTOW) of 1,670 lbs (758) kg. The fuel tanks have a usable fuel capacity of 30 USG (113.5 litres) when full, which gives in excess of 4 hours endurance. According to the approved Flight Manual, the stall speed of the aircraft in clean configuration at the MTOW, with inboard and outboard stall strips fitted, is 52 KIAS and with full flap, 49 KIAS. The speed for the best glide angle, to be adopted for a power-off landing, is 70 KIAS.

Footnote

12 Available at https://www.youtube.com/watch?v=xzFgqtPVCZ0
13 Available at http://www.aopa.org/asf/ntsb/stall_spin.html

Aircraft history

G-BNDE was owned by an aircraft maintenance company that had been approached by the pilot with a view to renting the aircraft for several months. This was agreed and the aircraft was given a 50 hour Inspection on 4 June prior to being handed over to the pilot two days later. The agreement stipulated that the aircraft should be returned within 50 flight hours or three months, whichever occurred first. The renting pilot based the aircraft at Elstree in Hertfordshire for this period.

In addition to the 50 hour check, the aircraft documentation included an Airworthiness Review Certificate valid until 27 December 2014. The aircraft and engine log books contained no entries after 2 May 2014, although approximately 6 hours were recorded on Technical Log sheets subsequently found in the aircraft, the last on 15 June. The pilot's log book indicated that he had flown approximately 20 flight hours since he took the aircraft on 6 June. This took the total time achieved by the aircraft and engine to 9,235 and 2,325 hours respectively.

The log books indicated that the aircraft had not flown between March 2011 and January 2014. During this period the engine underwent a repair, with this and an Annual Inspection being signed off on 20 December 2013. No defects had been recorded in the Technical Log.

Detailed examination of the wreckage

Flying controls

An examination of the primary flying controls revealed no evidence of a pre-impact disconnect. The manually operated elevator trim system, which moves the elevator against a bias spring, was similarly intact, although it was not possible to establish a trim position.

In the PA-38, the manually operated trailing edge flaps can be set at one of three detented positions (retracted, mid and full) by means of progressively raising a lever located between the seats. A spring-loaded button on the end of the lever operates a ratchet mechanism at the lower end of the lever. This essentially comprises a spigot which, when displaced by pressing the button, allows movement of the lever (and hence the flaps) by lifting the spigot out of its detent. Each detent consists of a hook-shaped cut-out in a slot and is shaped such that it prevents flap (and hence lever) movement, under pressure of air loads, towards the retracted position. The profile of the cut-out in the flap extension direction allows the spigot to ride out of the detent towards the next position, without having to depress the button when moving flap lever to (further) extend the flaps.

Examination of the mechanism revealed that the flaps were at the 'mid' position. Although a considerable degree of airframe distortion had occurred in the impact, it was still possible to move the flap lever and the flap operating linkage between the retracted and mid positions. Had the flaps been retracted prior to the accident, the lever would have been at its lowest position, close to the floor. Raising it to the 'as-found' position would have required the lever to have been struck by an object from underneath. Since there was nothing around the lever, either on the floor or on the lower part of the instrument panel that could have achieved this, it was concluded that the flaps had probably been at their mid position at impact.

Stall warning system

The aircraft was fitted with outboard and the additional inboard stall strips on the leading edges of the wings. It was equipped with a conventional 'vane-type' stall warning system, in which a vane-operated microswitch on the left wing leading edge causes a buzzer to sound in the cockpit when the local airflow exceeds a pre-determined angle of attack.

When electrical power was applied to the circuit, the buzzer did not sound on moving the vane. It was then found that the vane casing had been distorted in the accident such that it restricted the vane movement. After removing the casing the vane could be moved through its full range, which permitted physical and electrical confirmation of the microswitch's operation. The buzzer still failed to sound so, after establishing electrical continuity of the system wiring, the buzzer was removed from its location behind the instrument panel and a 12 volt power source applied across its terminals. The unit did not respond until it was tapped sharply on the bench; operation was, however, still intermittent. The buzzer comprised an electromagnet which, when energised by closure of the vane microswitch, acted on a thin metal diaphragm. It was observed that the casing displayed a small dent where it had come into contact with adjacent instruments that had partially detached during the ground impact. Opening the unit indicated that the distortion in the casing had slightly impinged on the diaphragm. This appeared to account for the intermittent operation during bench testing but the possibility of a fault in the stall warning system in flight could not be ruled out. A test of the stall warning forms part of the standard preflight check of the aircraft.

Airspeed indicator

The pitot head, which was located on the underside of the left wing, had been severely crushed as a result of the ground impact. However, the remainder of the system appeared intact and it was possible to attach a pitot tester to the pipe-work immediately aft of the pitot head; this allowed a basic calibration of the airspeed indicator (ASI). This test showed the instrument over-reading by up to 10% across the range. It was also observed that there was an off-set with zero pitot pressure applied, which suggested that the ASI internal mechanism had been damaged in the impact.

Electrical power supply to the cockpit

A charger and its associated cable were found connected to the DC outlet on the instrument panel. Neither the mobile phone nor the tablet was connected to the cable when the wreckage was examined on site, although it is possible that either device could have become detached during the ground impact.

In order to test the outlet itself, a 12 volt DC power supply was connected to the aircraft wiring in place of the battery. After switching the Battery Master to ON, it was found that, after inserting the charger into the outlet, a light on the charger illuminated and a mobile phone attached to the cable was charged normally. However, it was noted that the outlet socket displayed extensive surface corrosion and that the charger needed to be firmly inserted in order to obtain a satisfactory connection.

It was also found, after applying power to the instruments, that a loud grinding noise resulted. This was traced to the electrically-powered gyroscope in the turn and slip indicator. It was considered that this may have been the result of the gyroscope rotor bearings being damaged in the impact.

Engine and accessories

The engine was removed from the airframe and subjected to a partial teardown. As noted earlier, the carburettor was badly damaged and its associated air-box was severely crushed. Cutting open the box exposed part of the cable-operated flap; the position of the flap relative to a fold in the side panel of the box suggested that it may have been in the COLD position at the time the box was crushed.

The magnetos were removed from the engine and taken to a component overhaul facility where they were subjected to a bench test. The harnesses were removed from the magnetos and tested separately for electrical continuity and correct resistance. The magnetos were found to produce satisfactory sparks throughout the rpm range. The electrically operated fuel boost pump, which was located in the engine compartment downstream of the fuel selector, was removed at the same time as the engine. It was connected to an electrical supply and was found to operate normally. The fuel selector valve, as noted earlier, was found selected midway between OFF and LEFT tank. The valve, which comprised a suitably ported plastic cylinder, operated by the selector handle and located within the valve body, was dismantled and was found to reflect the selected position. This meant that only half the port area of the valve was exposed to the fuel outlet, which would restrict the flow at high engine power settings.

The cylinders were removed, with the pistons and combustion chambers being found in good condition. The big-end bearings were smooth in operation and there was no evidence of lubrication failure anywhere within the engine. Cutting open the oil filter revealed no metallic particles.

Analysis

Introduction

It was apparent, from the witness accounts and the on site evidence, that the aircraft had entered a spin from which it did not recover. The AAIB investigation focussed on whether factors such as weather, mechanical defect or training might have been causal or contributory in this spin.

Aircraft examination

The possibility of an engine failure was considered. Examination of the engine revealed no evidence of a mechanical failure beyond that the propeller showed little evidence of power at impact.

The fuel selector is designed against accidental operation. Although it is possible that the position of the fuel selector, as found, had been due to the rescue services, it is more likely to have been due to an attempt by the pilot to turn off the fuel.

The aircraft battery had reportedly become discharged whilst at White Waltham, perhaps due to the pilot leaving the Battery Master switch in the ON position. The emergency services reported a 'sputtering' noise coming from the aircraft on their arrival; this is likely to have been generated by one or both of the turn-and-slip indicator gyroscope and the electric fuel boost pump, and indicated that the battery at the time held a reasonable charge.

The stall warning horn could not be heard during the MAYDAY call transmitted by the pilot, when he advised that the aircraft was in a spin. The NASA flight test videos indicated that the warning horn operated intermittently, but with short gaps, while the aircraft was spinning in these tests. However, there is a possibility that this can be accounted for by differences in the stall warning vane rigging between airframes.

The flaps were found to be at the intermediate position and it was not possible to determine the reason. The radar data suggests that, for a period before the spin started, the aircraft was flying at less than normal cruise speed, but above the stall speed.

In summary, there was no indication that any mechanical defect was a factor in this accident.

Weather, training and aircraft characteristics

The weather conditions were benign and not likely to have been a contributory factor to the spin.

The pilot was experienced, in current flying practice and had undertaken aerobatic training previously, which would have included spin awareness and recovery. It is therefore likely that he would have recognised, and been able to recover from, a spin.

The time elapsed during the pilot's final radio transmissions, together with the rate of descent deduced from the NASA videos, suggested that the spin was likely to have started from a minimum height of 2,500 ft amsl, and probably higher.

The stall-spin behaviour of Tomahawk aircraft has been examined in the past and the data show it has been involved in a greater proportion of stall-spin accidents than other training aircraft. The data also shows that these are more probably related to stall entry at low level, rather than a failure to recover from a developed spin where sufficient height is available.

Actions of the pilot

There were a number of events which took place in the course of the afternoon which represented unusual actions on the part of the pilot.

It appears the pilot made a change of intended destination prior to leaving White Waltham. Having booked out for Elstree he subsequently called them to advise he would not be returning there; he did not book out to any other destination. After departing White Waltham and flying north for about half an hour, he flew in a large circular pattern for almost an hour. Although somewhat unusual, this may be explained by the need to re-charge the aircraft battery.

From the data available, it appeared that the pilot had not previously used either of the two mobile phones found on board for calls in flight and had sent only one previous SMS when in flight, earlier the same day. A number of calls were attempted during the final flight but most did not connect, probably because of limitations of the reception when in the air. However, the final SMS message did get sent.

The tablet computer track log ended at 1823 hrs, some 11 minutes before the final radar point was recorded. It could not be ascertained why it had ended; options included the pilot closing the navigation application or the application closing due to a system error. However, he had not selected it off during any of the previous 34 recorded flights.

A most unusual feature was the text message sent to the pilot's relative. If it was composed after the attempted telephone call to the same relative, then 148 characters were input within 25 seconds. To achieve this would require considerable dexterity, especially in an aircraft that may have been out of control.

At the time the SMS message was sent (1831:28 hrs) the aircraft was visible on radar and not lower than 1,450 ft amsl. The radar track indicates the aircraft then continued to turn to the left before the radar record stopped for 64 seconds. At 1833:21 hrs it showed the aircraft 0.9 nm to the south-west, maintaining a relatively constant track for the next 25 seconds, suggesting at least control of lateral flight at this time. Shortly after, the aircraft altered track, coincident with the pilot transmitting the MAYDAY in which he stated that the aircraft was in a spin.

The pilot had accumulated considerable experience in a variety of aircraft in the years that he had been flying. He was familiar with the Piper Tomahawk aircraft and was in recent flying practice. It was suggested in his final text message that he had lost control of the aircraft, to such an extent that he did not expect to survive. However, after this message was sent, the aircraft continued in flight for more than two minutes, before entering a spin from which it did not recover.

BULLETIN CORRECTION

Date & Time (UTC):	20 August 2014 at 1834 hrs
Location:	Near Padbury, Buckinghamshire
Information Source:	AAIB Field Investigation

AAIB Bulletin No 4/2015, Page 63 refers

This report stated that the pilot's headset enabled the pilot to accept incoming calls hands-free, but did not support either voice-activated dialling or dictated SMS text messaging.

Further inquiries have demonstrated that this model of headset **is** capable of supporting voice-activated dialling and dictated SMS text messaging hands-free when used in conjunction with the mobile phone the pilot was using.

This dictated SMS messaging function requires a data connection with a mobile phone network or Wi-Fi[1] network to operate. If the data connection is lost prior to completion and sending of a dictated SMS, the message is cancelled. It is not possible to interrupt a dictated message such that it can be completed later, or to use the function whilst a phone call is being made. Previously composed text cannot be copied to an SMS message using the hands-free function. Messages can also be dictated using the phone's microphone when a wireless headset is not connected.

The pilot had tried to make an outgoing call to a relative at 1831:03 hrs, but the call had failed to connect with the mobile network. This was followed at 1831:28 hrs by a 148-character SMS text message being sent from the pilot's phone to the same relative. A series of tests was carried out using the same model of headset and phone to determine if it was possible to send a dictated SMS within the available 25[2] seconds. When using the headset, a minimum of 46 seconds was required and without the headset, a minimum of 30[3] seconds was required. There was, therefore, insufficient time for the pilot to have dictated the message. This confirms that the message would have been composed and sent by physically accessing the phone.

This work corrects a detail in AAIB's factual reporting and does not change the analysis within the report.

Footnote

1 The message during the accident flight was sent over the mobile phone network.
2 The maximum amount of time between the failed call and the SMS being sent and is dependent on the phone having connected to the mobile network immediately after the failed call.
3 The time to send a dictated message is shorter when no headset is used as the dictation function does not read back the message before it can be sent.