ACCIDENT

Aircraft Type and Registration:	Jodel D117A, G-ASXY
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1958
Date & Time (UTC):	13 March 2011 at 1331 hrs
Location:	Grovesend, near Swansea
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Fatal) 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	1,138 hours (of which 687 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

Following a partial engine failure the commander carried out a forced landing. The aircraft subsequently overshot the selected field, clipped the top of some trees and its left wing struck a power cable suspended on a line of telegraph poles. On striking the cable the aircraft rotated about its left wing and struck the ground, inverted. The commander was fatally injured and the co-pilot suffered serious injuries. The cable was obscured by the trees.

History of the flight

The commander and co-pilot were members of a syndicate of seven people who jointly owned and flew G-ASXY. They had planned to fly from Cardiff International Airport to Haverfordwest Airfield, Pembrokeshire, for a coffee and possibly fuel. It was agreed that the co-pilot would assist the commander by making all radio transmissions and helping with the navigation.

The aircraft was kept in a hangar on the south side of Cardiff Airport. Prior to pushing the aircraft out of the hangar the commander put one litre of oil in the engine, while the co-pilot dipped the fuel tanks to ensure there was sufficient for the flight; he could not recall the exact fuel level. After pushing the aircraft out of the hangar, the commander and co-pilot completed a pre-flight inspection and the commander then strapped himself into the aircraft. The co-pilot remained outside so that he could swing the propeller and remove the chocks after the engine checks had been completed. The engine started on the first attempt and the commander then carried out the engine run-up and magneto checks. The co-pilot noted that the engine took a long time, about 10 minutes, to warm up. After the full power checks, the co-pilot removed the chocks, put them in the rear of the aircraft and climbed aboard.

After noting the airfield information, ATC clearance was received to taxi to Holding Point Hotel, for Runway 30. As the aircraft approached the hold it was given takeoff clearance. The front tank was selected for takeoff and the aircraft took off at 1304 hrs.

After takeoff, the aircraft climbed to 2,500 ft amsl and tracked towards Neath, north-west of Swansea, to avoid the coastal danger areas near Kidwelly. In the cruise, the commander set 2,200 rpm and accepted the IAS attained; this was about 100 kt. As the aircraft approached Port Talbot, the co-pilot changed frequency to Swansea Radio and made initial contact when they were overhead Neath.

At about 1327 hrs, 23 mins after take off, when the aircraft was west of the Morriston area of northern Swansea, the engine rpm suddenly dropped to 1,000 rpm. The commander said, "I think we've got an engine failure," and immediately leant over and changed the fuel selector from the front to the rear tank and selected FULL power. He then held the aircraft level before establishing a 50 kt glide. The co-pilot transmitted a MAYDAY to Swansea Radio. The commander pointed out the field he had selected and the co-pilot suggested that an adjacent one, to the left/south-west, may be better; the commander did not reply. The commander then flew one left hand orbit before establishing the aircraft on final approach to the field he had selected. An eyewitness, who initially saw the aircraft above him, stated that his attention was initially drawn to the aircraft when he heard its engine "missing". At this point, he estimated it was approximately 200-300 ft above him, just before it flew onto its final approach. He then watched it make its approach but lost sight of it.

The aircraft flew across the selected field at a height of about 15 ft agl. When it was about a third of the way across, the commander said, "we're not going to make it." When the aircraft reached the end of the field it banked left, clipped the top of some trees and struck a power cable suspended on telegraph poles. It rotated about its left wing and struck the ground, inverted.

Two eyewitnesses were quickly on the scene, followed a few minutes later by another two, including a police officer. The co-pilot was helped out of the aircraft first, followed by the commander. An air ambulance arrived soon thereafter. Despite the efforts of a paramedic and the police officer, the commander was declared dead at the scene. The co-pilot, who was seriously injured, though conscious, was taken to hospital by the air ambulance.

Co-pilot's comments

The co-pilot stated that he did not remember seeing the commander select carburettor heat in the cruise or after the engine failure. He added that the engine noise after the power loss was as if it was at idle; it did not splutter or cough. They did not consider the surface wind for the forced landing and the commander did not sideslip the aircraft, as he had done regularly when they had practised forced landings on the previous occasions they had flown together. He did not use the airbrake.

He commented that, from his experience of practising forced landings in G-ASXY, the aircraft's engine idles at about 750-800 rpm in flight.

The co-pilot asked the other syndicate members if they had experienced carburettor icing in G-ASXY. Most of them believed they had not.

Commander's experience

The commander had owned a share of G-ASXY since 1985 and, as well as some flying on a range of other aircraft types, he had nearly 700 hours experience on the accident aircraft. He had held a UK Private Pilot's Licence since 1979 and his Single Engine Piston rating was valid until 16 September 2011.

The commander's logbook showed that he had flown three other forced landings, the last one being in the accident aircraft in October 1997. Anecdotally, others, including the co-pilot, have said he had flown several more, though there was no evidence to substantiate this.

Medical information

The post-mortem was carried out by a consultant aviation pathologist. There was evidence that the commander had had severe coronary artery disease. However, this was regarded as coincidental, given the circumstances of the accident. The pathologist concluded that the commander died as a result of the injuries sustained in the impact. Toxicology revealed no signs of drugs or alcohol.

Weather information

An aftercast for the flight was obtained from the Met Office. In summary, it stated that the situation at the time of the accident in the Swansea and Cardiff area would have been dominated by a generally clear, cool north-westerly flow on the rearward side of a slow moving area of low pressure, centred near Belfast. Shallow cumulus cloud was present in South Wales, with a base around 2,000 ft amsl, but satellite imagery suggested that there was no significant cloud in the immediate accident area at the time.
Surface visibility ranged from 25 to 40 km and surface temperatures ranged from +8°C to +10°C. Between the surface and 3,000 ft the temperature fell from around +8°C to 0°C. The surface wind in the area of the accident was estimated to be from 280° at 11 kt.

The temperature and dew point at Cardiff at the time of takeoff were +8°C and +2°C, respectively. The temperature at the cruising altitude of 2,500 ft was +1°C and the dew point was -7°C. The Cardiff temperature and dew point were such that moderate carburettor icing may have occurred at cruise power or serious icing could have developed at descent (idle) power. The cruising altitude temperature and dew point were such that there was a likelihood of light carburettor icing at cruise or descent power. Figure 1 is the Carburettor Icing chart published in the CAA's General Aviation Safety Sense Leaflet 14 – *Piston Engine Icing*.

Field selection

The fields selected by both pilots were of level pasture with short grass. They appear to have been the largest in the locality. The field chosen by the commander was approximately 320 m in length, with its long axis orientated 350°/170°M. The adjacent field suggested by the co-pilot was approximately 720 m in length and orientated 340°/160°M. These axes were 60-70° off the estimated surface wind. Figure 2 shows an aerial view of the selected fields.

Engineering

Accident site

The aircraft was found lying inverted in meadowland, slightly north of a row of trees forming the field boundary and bordering a minor road. The ground impact site was adjacent to an overhead power

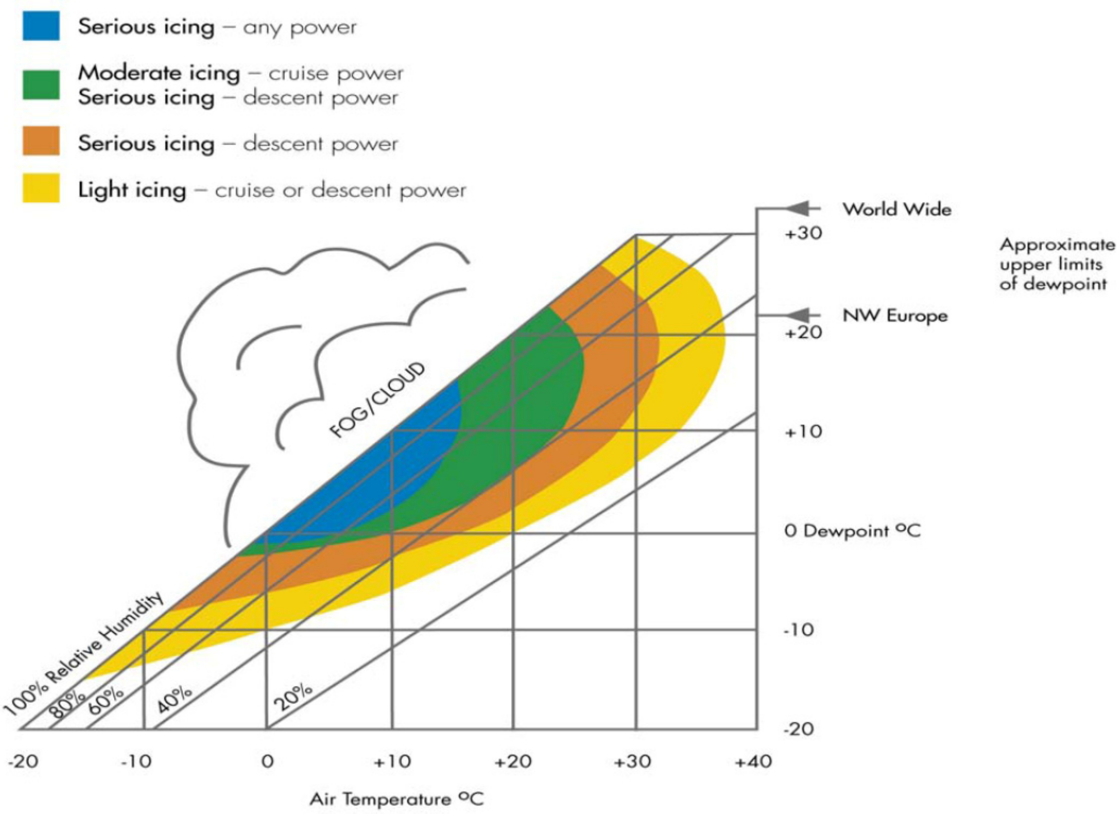

Figure 1

Carburettor icing chart

Figure 2

Fields adjacent to the accident site

cable running approximately parallel with the field boundary. The cable was observed to have separated from the insulator attaching it to the nearest support pole. Examination of the cable strands (now at head level, following separation of one mounting/insulator) indicated that it had been struck by a soft object which had slid a short distance parallel to the cable axis whilst remaining in contact with the strands.

The leading edge of the left outboard wing of the aircraft was separated and lying close to the cable. Examination of the remaining left wing structure and the leading edge indicated that the latter had been separated as a consequence of the cable having penetrated the leading edge skin as far as the front spar before sliding outboard relative to the structure, approximately along the face of the spar, severing the skin and ribs. Fragments of tree branch lying in the field, in the vicinity of the main wreckage, indicated that the aircraft had struck the row of trees before striking the cable. No defined region of damage could be identified in the upper boughs of the tree row to determine the roll attitude at the initial contact with branches. The absence of any horizontal swathe, however, suggested that the aircraft was steeply banked, making a narrow passage through the tree tops not identifiable from the ground.

Examination of the aircraft confirmed that it had fallen to the ground inverted and with translational motion to the north, the fuselage axis being orientated to the east. An overall assessment of the accident site indicated that the aircraft penetrated the upper branches of the row of trees whilst banked steeply to the left, striking the cable with its left wing after exiting the tree row. The contact with the cable restrained the left wing, rotating the aircraft, thereby accelerating the right wing. This resulted in differential lift, causing the aircraft to become inverted whilst continuing to rotate about its normal axis. After rotating through some 270°, with only residual lateral motion in a northerly direction, the aircraft fell to the ground. A blade of the wooden propeller separated during the impact sequence although the direction of failure was not clear.

The morning after the accident, limited quantities of fuel were successfully recovered from both fuel tanks on the aircraft.

Significant aircraft features

The aircraft was powered by a Continental C90 engine driving a two-bladed wooden propeller. The engine utilised a Stromberg carburettor and was supplied with fuel by two tanks, one mounted immediately behind the engine bulkhead and one in the fuselage aft of the passenger compartment. The fuel selector valve, mounted on the aft face of the engine bulkhead, was operated by means of a knob on the instrument panel driving a rotating shaft with a ratchet connection to the valve spindle. Both tanks were of approximately semi-circular lower cross section. A significant volume of unusable fuel normally remains in conventional wing-mounted or other approximately flat bottomed tanks. The curved lower profile of the design of the tanks on G-ASXY greatly reduced the amount of unusable fuel, if not eliminating it. Fuel passed via the selector valve, through a drain sump to the engine driven mechanical pump close to the lowest point on the engine. No electric pump was fitted.

A changeover flap was mounted in an air box forming the induction system. The box was attached to the bottom of the updraft carburettor barrel. In the normal position of the flap, the box supplied the carburettor with ambient air entering from the front via a filter. In the alternate position, it admitted air via a scat hose from a heat exchanger. This consisted of a small box surrounding one of the four individual exhaust pipes. Air was admitted to the box through narrow slots remaining on either side of the pipe where the box was not completely closed.

Detailed examination and testing

The aircraft was salvaged and the engine cylinders examined internally, with a boroscope, via the spark plug holes. No evidence of internal distress was noted. Dark colouration of cylinder heads and valves strongly suggested rich operation. Interior surfaces of the exhaust pipes were also black in colour, again consistent with rich operation. Throttle, carburettor heat and mixture controls were all correctly connected.

The engine was removed from the aircraft and installed on a dynamometer test rig. It was subjected to an extended test run, during which it was found to produce slightly less than rated power at maximum permitted rpm. It was then throttled back to 1,000 rpm whilst leaving the simulated propeller characteristics unaltered. The measure power output was then approximately 5 bhp.

The aircraft fuel and venting systems were then examined. Flow tests indicated that the system had been selected to the rear tank at the time of impact. Unobstructed flow was available from that tank to the flexible pipe supplying the engine driven pump. With the tank selector re-positioned to the front tank, correct flow was present from that tank to the supply line to the pump. No evidence was found to suggest that either the front or rear tank vent systems were obstructed.

Although the engine produced less than rated power when tested, it was confirmed that this was the normal result when the rig was used and that this engine performed as well if not better than the average of similar units.

Since the magneto earthing arrangements did not feature in the test, the four-position magneto switch was removed from the instrument panel and tested electrically. It was then dismantled. It was found to operate correctly on test and no evidence of internal defect capable of producing intermittent operation was found.

Occasions have occurred when magneto coils and/or harnesses on piston engines have suffered age-related deterioration. This has sometimes manifested itself in the form of ignition failure during flight when the temperature of the magneto and harness has stabilised at a high figure. Breakdown of insulation then occurs leading to ignition failure. On subsequent tests, at room temperature, the ignition performance returns to normal. The difference in cooling arrangements between those on the dynamometer rig and those experienced on the unit installed in the aircraft raise the possibility that the magnetos may have been running hotter in flight than under test. Accordingly arrangements were made to test the magnetos on a rig with heating applied to the bodies. An extended test run under these conditions failed to produce any loss of magneto performance.

The possibility of a restriction of the air supply was reviewed and the presence of the rich mixture symptoms noted. The possibility of some mis-setting of mixture in the carburettor, leading to excessively rich operation when flying with some carburettor icing present was considered. A strip examination of that unit, when undertaken, revealed no evidence of such mis-setting. The fine mesh fuel filter was found to be clean.

Analysis of the fuel samples recovered from the two tanks indicated that neither deviated significantly from the specification for 100LL grade aviation gasoline.

In view of the absence of any direct indication of the cause of the power loss, the significance of the features of the dynamometer test rig and the method of test were reviewed. It was determined that the head of fuel available to the fuel pump, when installed in the dynamometer test rig, was approximately six feet. The corresponding head with either aircraft tank close to minimum contents and the aircraft axis horizontal was only approximately two feet. Thus, the fuel supply under the test conditions did not fully represent conditions in the aircraft. Therefore, the mechanical fuel pump was removed and tested. It was found to perform correctly.

In all, no physical evidence was found to account for the loss of engine power.

Recorded information

Radar data was recorded for the accident flight. This data was from the radar head at Cardiff Airport which provided low level radar coverage for the Cardiff area. All the radar returns were primary so no height information was available for the flight.

Figure 3 shows the accident track from 1320:49 hrs, north of Cardiff Airport, to 1329:50 hrs, approximately 1 nm south of the accident site. Between 1323:43 hrs and 1324:19 hrs radar contact was lost. This loss of contact was probably due to the aircraft's altitude reducing briefly to a level that placed it out of line of sight of the radar head.

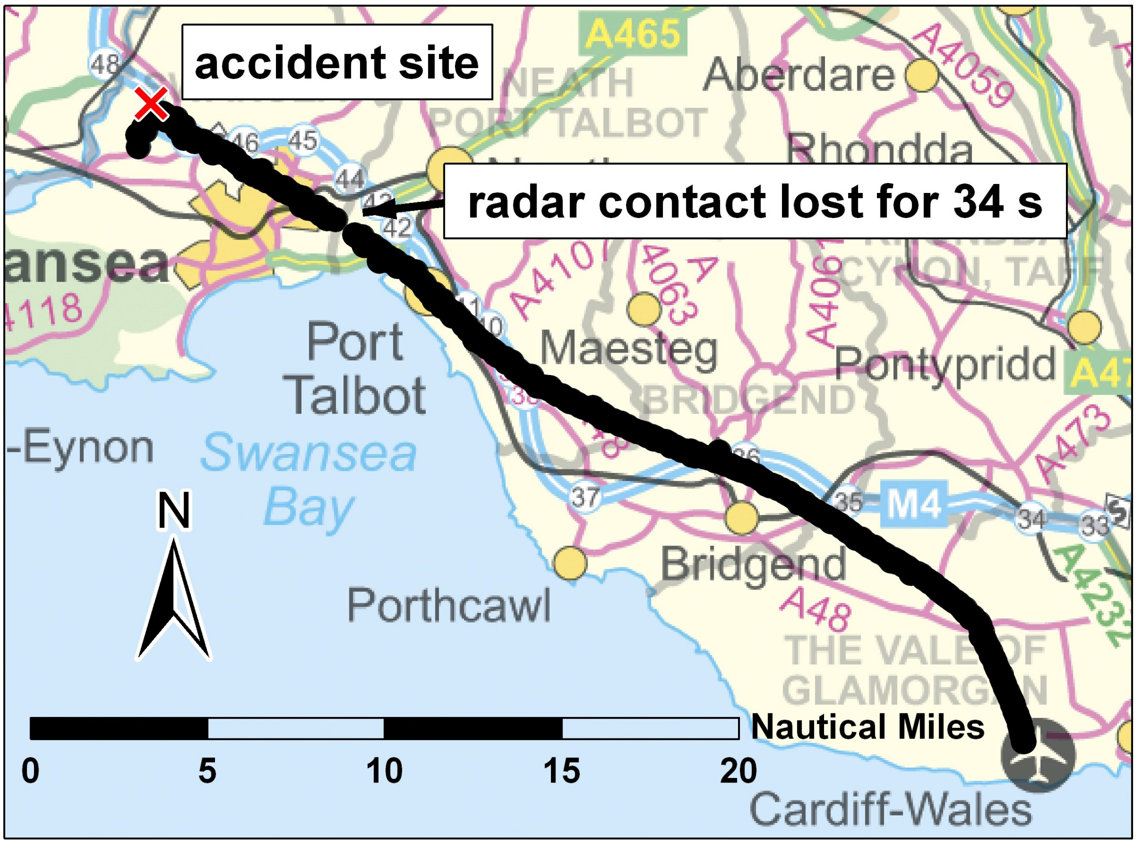

Figure 3

Radar track of G-ASXY and position of accident site

Shortly before the radar contact was briefly lost the track becomes jittery in nature, suggesting that the radar tracker software was having difficulty in tracking the aircraft at this range and altitude. Also, due to the jittering and other software issues, the software's calculation of the aircraft's groundspeed was unreliable.

Radar data issues

Cardiff radar is only recorded by the Air Traffic Service (ATS) Unit at Cardiff Airport, and is not part of the UK's national coverage that is recorded by the National Air Traffic Service (NATS). The provision of these 'local' recordings, in support of an accident investigation, is detailed in Civil Aviation Publication (CAP) 670 - *ATS Safety Requirements*. This document sets out the safety regulatory framework and requirements associated with the provision of an air traffic service. The requirements for an ATS Unit to record all surveillance data, provided to it or obtained by it, for the purposes of providing an air traffic service, are set out in CAP 670, SUR 10, Part 3. These requirements include the automatic recording and retention of surveillance data obtained 'through the wall' (TTW) from local and/or remote sources, including third party providers. Requirements relating to '*Replay Functions and Facilities*' include the capability to create, upon request, an extract of the data recorded TTW, from which an aircraft track can be generated[1]. SUR 10 also requires ATS Units and third party providers to provide, when required by either the AAIB or the CAA for use in an investigation, a copy of the aircraft tracks.

For this investigation, the ATS Unit at Cardiff were able to provide, on request, the track data in compliance with the extant version of CAP 670 (ie Amendment 11), which was current at the time of the accident. This version, however, did not specify the format in which the data was to be provided.

The format of the recording made at Cardiff Airport enabled it be replayed in a form that replicated a radar controller's screen. Multiple replays were made, during each of which the position and groundspeed of the aircraft were manually noted from a display box on the screen. This process was time-consuming and caused a delay in provision of the data, in a more useable format, to the investigation. Also, the groundspeeds displayed, calculated using the aircraft's latitude and longitude, appeared to be inconsistent with the indicated unit of knots, even taking into account the jittery nature of the aircraft's position.

Amendment 12 is the latest version of CAP 670 (issued 28 April 2011) and includes a revision to SUR 10 that notes:

> *'in most cases this data is provided as a spreadsheet formatted as .xml files or similar.'*

Compliance by ATS Units with this amendment is required by 1 January 2012.

A further planned amendment to CAP 670, SUR 10 will also include a time limit within which ATS Units and third party providers should make data available for investigative purposes. The date of the amendment and time limit are, however, yet to be agreed.

Partial loss of power

The guidance on forced landings given to student pilots, by instructors, is understandably not very prescriptive. After the initial exercises are complete there are many variations that can be taught, often well beyond the

Footnote

[1] ATS Units that use analogue radar systems, from which the recording of the through-the-wall data is not possible, will be permitted to record surveillance data captured at the display using screen shots recorded 'at the glass' (ATG).

text given in JAR-FCL 1 - *Flight Crew Licensing (Aeroplane)*. The general theme is the same whether the engine failure is total or partial; the principles of finding a suitable landing area, assessing the wind, completing a forced landing pattern or intercepting that pattern at a suitable point all hold firm.

In conducting the forced landing pattern, students are taught a series of checks to be completed at the appropriate stages of the emergency. The extent of checks required is determined by the nature of the failure. A benign engine failure eg carburettor icing, fuel starvation, ignition failure, would generate the need for an attempted restart drill whereas a fire or seizure would immediately require the engine to be secured. Most, if not all, PPL(A) training textbooks, checklists and Pilots' Operating Handbooks advise engine shutdown checks, sometimes referred to as a 'crash drill' or 'security drill', in the event of a complete engine failure. These engine shutdown checks would normally be completed downwind during the standard forced landing pattern. For a partial loss of power, an engine would normally be left running until the point at which arrival at the proposed landing area could be assured; the shutdown checks would then be completed. The shutdown checks ensure that a forced landing is executed with the engine in a safe condition and that power will not suddenly be restored at a critical moment. It also isolates the aircraft's fuel and electrical systems, reducing the risk of a post-accident fire.

Analysis

General

The accident was the result of the aircraft overshooting the field selected for a forced landing, following a partial loss of power, and striking a power cable.

The engine was running at 1,000 rpm during the forced landing. As a result, it was producing thrust in excess of that normally generated with the engine at its in-flight idle speed of approximately 750 rpm. This would have reduced the aircraft's rate of descent and changed the commander's sight line angle. Had the commander secured the engine, once he was assured of making his selected field, he would have removed the excess thrust and would have been less likely to overshoot the field. Additionally, if he had sideslipped the aircraft and/or used the airbrake, the aircraft's touchdown point would have moved closer to the start of the intended field.

The long axis of the selected field was about 70° off the wind. This is likely to have reduced the headwind component from 11 kt to about 4 kt. As practice forced landings are generally flown into wind, being off the wind would have reduced the aircraft's angle of descent.

Engineering

Following the accident, the engine performed correctly on the dynamometer test. Fuel was recovered from both tanks and the design geometry of each tank is such that virtually all fuel within remains useable, until the tank is empty. Thus the presence of any fuel in both tanks indicates that engine fuel starvation could only occur if the fuel cock was selected to the OFF position or a defect or blockage in the fuel system (including the venting) existed. No such defect or blockage was found.

Despite the absence of severe icing conditions in the aftercast for the area in which the aircraft was flying, the possibility that 'pure' carburettor icing occurred cannot then be ruled out. It is thought that the icing phenomenon both reduces inlet airflow and increases the depression in the throat, thus sucking a greater volume of fuel into the reduced airflow. The combination generally results in an increasingly rich mixture occurring until the engine suffers a 'rich cut' and a major drop in rpm.

The meteorological aftercast data did not indicate that the conditions in the cruise were those known to be excessively prone to causing carburettor icing and other syndicate members who had flown significant hours on G-ASXY did not report any tendency for the engine to suffer from this phenomenon. It is fair to say, however, that the aftercast is based on remote measurement and some variation in the humidity within an air mass can be expected. The absence of any evidence to account for engine failure, the correct operation of the engine on test and the black appearance of the exhausts and cylinder interiors when first examined, all combine to make the build-up of carburettor icing the most likely cause of the power loss.

The possibility of ice build-up initiating during extended operation with low throttle opening on the ground, while the commander waited for the engine to warm up, and not being cleared before takeoff exists. This would enable a slow rate of build-up in flight to cause eventual power loss earlier than would occur during flight in similar conditions with the carburettor beginning the flight free from any ice. Other variables include the possibility of operation with lower than normal throttle opening. Although it is far from clear why an icing-related power loss occurred on this flight, the absence of any other evidence-based explanation leaves this as the only realistic possibility.

Conclusions

In cruise flight the aircraft suffered a partial loss of power. The investigation could not determine, with certainty, what caused this but considered that it could have been due to carburettor icing. During the subsequent forced landing, the aircraft overshot the field selected for the landing, clipped the top of some trees and its left wing struck a power cable, which was suspended on a line of telegraph poles and obscured by the trees. On striking the cable the aircraft rotated about its left wing and struck the ground, inverted. The commander was fatally injured and the co-pilot suffered serious injuries.