ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140 Cherokee, G-ATRR
No & Type of Engines:	1 Lycoming O-320-E3D piston engine
Year of Manufacture:	1966 (Serial no: 28-21892)
Date & Time (UTC):	19 May 2013 at 1018 hrs
Location:	Caernarfon Airport, Gwynedd
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - 1 (Serious) Passengers - 1 (Fatal) 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	90 hours (of which 72 were on type) Last 90 days - 9 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was making an approach to Runway 26 at Caernarfon Airport when it struck a tree. The pilot reported that he had suffered a loss of power at a late stage of the approach and had been unable to reach the airfield. The investigation did not find any evidence of a failure within the engine but the atmospheric conditions were conducive to carburettor icing.

History of the flight

The pilot pre-booked the aircraft through an online booking system several weeks before the flight. He planned to make a cross-country flight from Blackpool to Caernarfon and then possibly on to Welshpool before returning to Blackpool. On the morning of the accident he arrived at the airfield with his passengers and found the aircraft he had booked was parked on the ramp. He checked the fuel contents, which were less than he required, so he decided to put in some additional fuel. He taxied to the pumps, filled each tank to the tab and then taxied back to the parking area and shut down the engine before boarding his passengers.

The passengers boarded the aircraft; the front right seat was occupied by the pilot's adult son and the pilot's five-year-old grandson was seated in the rear left seat. The pilot later recalled checking that the passenger seat belts were fastened before he commenced taxiing. The pre-departure power checks were carried out at the holding area prior to takeoff; the aircraft took off from Runway 28 and turned left on to a southerly course. The pilot followed a coastal route, maintaining an altitude of between 1,000 ft and 2,500 feet amsl. A GPS-derived track plot of the route is shown as Figure 1.

Figure 1
GPS track - Blackpool to Caernarfon

The pilot made several radio calls to RAF Valley as he approached the Caernarfon area but did not establish contact. He then contacted the Caernarfon Airport Air-Ground radio operator in the tower and was advised that Runway 26 was in use and that the circuit was clear of other traffic. The pilot requested, and positioned for, a straight-in approach. The radio operator saw the aircraft on a wide right base-leg position and estimated that it had joined the final approach course at about 4 nm. The approach path appeared normal to him and the pilot made a 'finals' radio call at what the radio operator estimated to be about 1.5 nm from the airfield. The radio operator acknowledged the call and gave the pilot the surface wind from 270º at 5 kt.

The aircraft was seen by several witnesses to get very low on the final approach and to be flying slowly. The aircraft struck a tree and dropped to the ground in a steep nose-down attitude, just inside the airfield boundary. The radio operator sounded the crash alarm and made an emergency call on the radio to advise all parties of an aircraft accident.

The airport fire service attended the scene and the local fire service were notified and attended subsequently. An air ambulance helicopter was already airborne in the local area and its pilot was listening out on the Caernarfon Airport radio frequency. He offered assistance and diverted to the airport; thus medical help arrived quickly at the scene. The adult passenger was fatally injured in the accident. The pilot and the child were freed from the aircraft and transferred to local hospitals, where they were treated for serious injuries.

Meteorological information

On the day of the accident there was a weak pressure pattern across the United Kingdom with a very light north to north-easterly airflow. The visible satellite image at 1000 hrs shows some stratocumulus-type cloud lying along the coast of north Wales; there was no precipitation indicated. Surface observations in the area showed a large amount of low-level stratocumulus-type cloud in the area, with bases between 2,500 ft and 3,500 ft in general. The 0950 hrs METAR from RAF Valley, 16 nm to the north-west of Caernarfon, showed a surface wind from 330º at 4 kt, visibility 10 km or greater, few cloud at 1,900 ft, scattered cloud at 2,400 ft, overcast cloud at 3,200 ft, temperature 13ºC and dewpoint 8ºC. The 0950 hrs METAR from Hawarden, 20 nm south east of the en-route track of the aircraft, showed a surface wind from 360ºat 2 kt, visibility 10 km or greater, broken cloud at 2,500 ft, temperature 13ºC and dewpoint 7ºC.

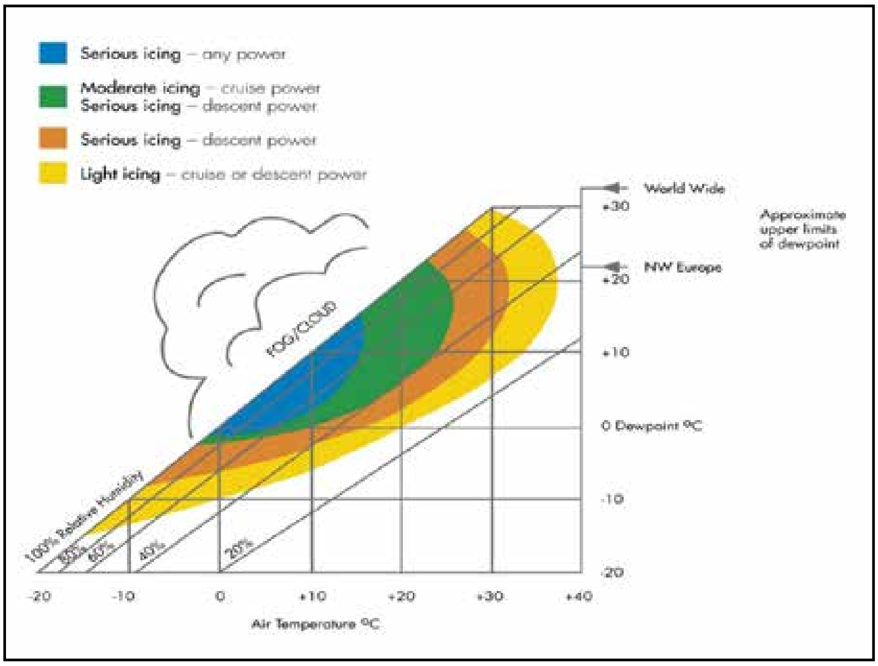

Figure 2

Carburettor icing probability chart

Figure 2 illustrates the probability of carburettor icing for values of air temperature and dewpoint. Assuming a reducing temperature and similar dewpoint above the surface, this would indicate that the latter part of the flight was operating in the blue sector: 'serious icing at any power'.

CAA Safety Sense Leaflet 14, '*Piston Engine Icing*', contains useful information and guidance concerning induction system icing. It includes the following information:

> *'Engines at reduced power settings are more prone to icing because engine induction temperatures are lower. Also, the partially closed butterfly can more easily be restricted by the ice build-up.'*

Pages 6 and 7 of this Safety Sense Leaflet give recommended procedures for the use of carburettor heating ('hot air') in different phases of flight, including Descent and Approach, Downwind and Base Leg and Final Approach:

> *'j) Descent and Approach*
>
> *Carb icing is much more likely at reduced power, so select carb heat **before, rather than after**, power is reduced for the descent, and especially for a practice forced landing or a helicopter autorotation, i.e. before the exhaust starts to cool. (A full carb heat check just before selecting hot air for the descent is advisable.) Maintain FULL heat during long periods of flight with reduced power settings. At intervals of about 500 ft (or more frequently if conditions require), increase power to cruise setting to warm the engine and to provide sufficient heat to melt any ice.*
>
> *k) Downwind*
>
> *Ensure that the downwind check includes the cruise carburettor heat check at paragraph 6(i) above. If you select and leave the heat on, however, speed or altitude will reduce on the downwind leg unless you have added some power beforehand.*
>
> *l) Base Leg and Final Approach*
>
> *Unless otherwise stated in the Pilot's Operating Handbook or Flight Manual, the HOT position should be selected well before power is reduced and retained to touchdown. On some engine installations, to ensure better engine response and to permit a go-around to be initiated without delay, it may be recommended that the carb hot air be returned to COLD at about 200/300 ft on finals.'*

Recorded information

Recorded information was available from a portable device[1] recovered from the aircraft. The device contained a track log of the accident flight, with aircraft GPS-derived position, track, altitude and groundspeed recorded. The record commenced at 0930 hrs as the aircraft departed Blackpool Airport and ended at 1018 hrs, shortly after the aircraft struck the ground. Information from the device is shown in Figures 3, 4 and 5; Figure 3 shows the approach commencing from overhead the town of Caernarfon, Figure 4 the time-history plot and Figure 5 the flight track of the final seconds of the approach. Times are UTC and altitudes are referenced to aal.

Having followed the coastline to the town of Llandudno, the aircraft altered track towards the town of Bangor, en-route to Caernarfon Airport. As it flew over the Menai Bridge, the aircraft climbed from 1,100 ft and at Caernarfon, about 3 nm from the airport, it was at 1,570 ft (Point A) and its groundspeed was 80 kt. The time was 1015 hrs. It then descended

Footnote

[1] Apple-manufactured iPad mini (version 1), operating a SkyDemon-manufactured flight navigation software application.

towards the final approach track for Runway 26, initially at about 300 ft/min, then at about 960 ft/min (Point B, groundspeed 103 kt, 2.2 nm from the runway threshold).

Figure 3
GPS track of approach to Caernarfon

At 1.25 nm from the runway threshold and 710 ft aal, the aircraft was on the final approach track, and the rate of descent increased to about 1,400 ft/min (Point C). As the aircraft approached 350 ft aal the rate of descent reduced; the aircraft was 0.87 nm from the threshold with its groundspeed 85 kt and reducing. As the approach continued, the groundspeed continued to reduce.

At about 500 m from the start of the paved surface of the runway, the aircraft was at 130 ft aal (Point D), its groundspeed was about 60 kt and the rate of descent 250 ft/min. Based on a wind from 270º at 5 kt, the airspeed would have been near 65 kt (75 mph). The descent rate then momentarily increased, whilst the groundspeed continued to reduce gradually. Shortly after, at about 80 m to the east of the paved surface of the runway, the aircraft struck the top of a tree at a groundspeed of about 49 kt (Point E - estimated airspeed 54 kt) before impacting the ground.

Airport information

Caernarfon Airport is located on the coast and has an elevation of 14 ft amsl. Inbound aircraft were advised to make a radio call to RAF Valley and to transit the Menai Strait at '*not above 1,500 ft amsl*'. At the time of the accident the airport had a licensed asphalt Runway 08/26, 935 m in length and 23 m wide. There was also an unlicensed Runway, 02/20, alongside of which there were two wind turbines at 140 ft aal.

To the east of Runway 26 (Figure 5), adjacent to the airfield boundary, there was a leisure park, with a number of mobile homes and caravans. At the time of the accident the park extended for 300 metres to the east of the airfield boundary.

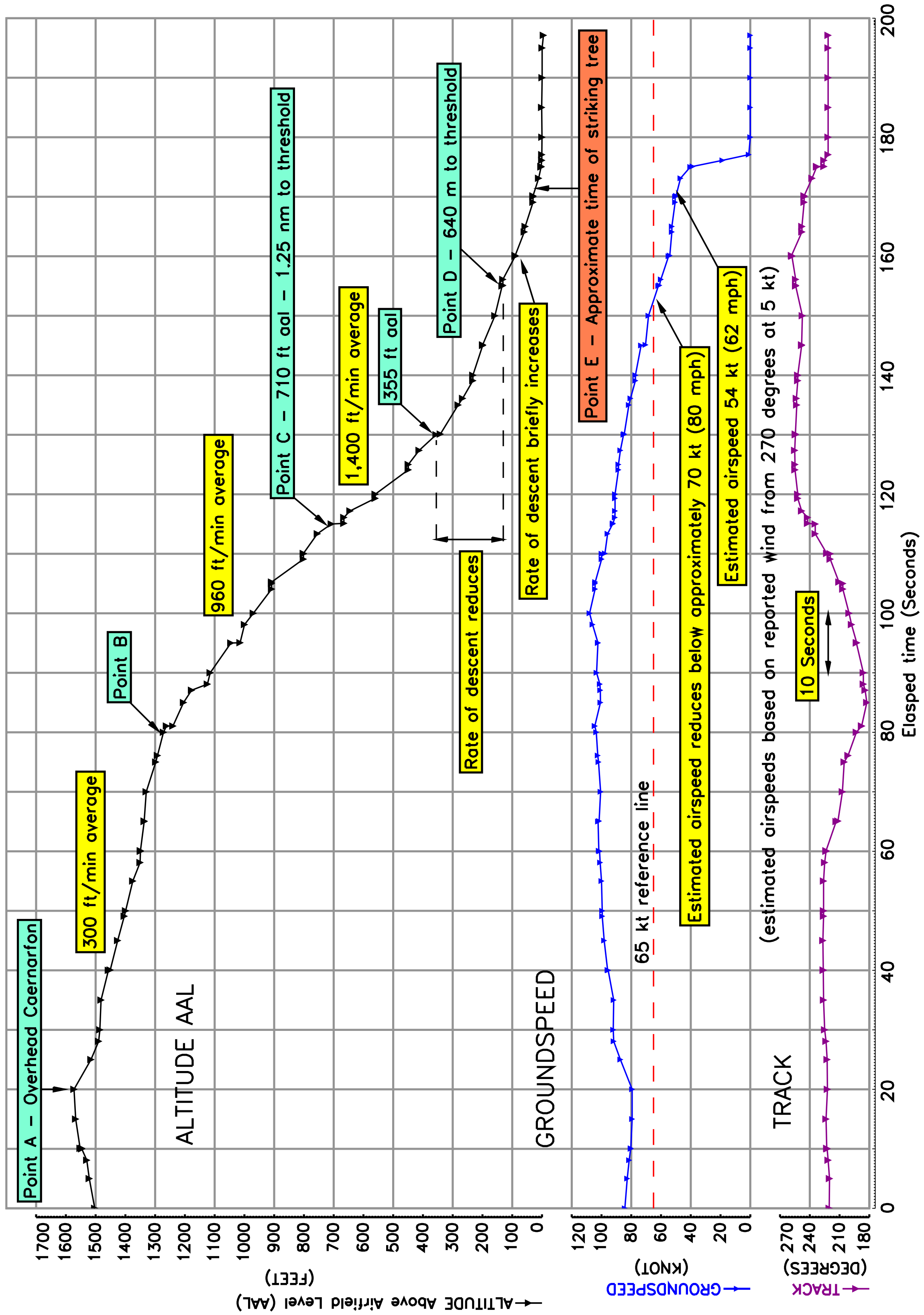

Figure 4

Time history plot of approach

Figure 5
GPS track of final approach

Witness information

There were a number of witnesses, both aural and visual, to the later stages of the approach of the aircraft. They all reported that the aircraft was lower than usual, some noted that the nose attitude was high and several commented that the flight path appeared flat and the aircraft very slow.

One witness's attention was drawn to the aircraft by an unusual noise. He reported that the engine was "trying to pick up and popping" and he had the impression that the pilot may have pumped the throttle three or four times. Another reported hearing the engine "spluttering and seemed to backfire", while others reported the engine was running, but at low power.

Pilot information

The pilot started training for his Private Pilot's Licence (PPL) at Blackpool Airport in January 2005. His training was completed successfully and his licence issued in October 2006. A proficiency check was carried out on 14 April 2010 to revalidate his SEP (land) rating, this remained valid until 14 April 2012. At the time of the accident the pilot's logbook and licence did not show evidence of a more recent revalidation or renewal.

The pilot had visited Caernarfon Airport several times before, most recently in October 2012. On some occasions when he flew he would ask an instructor to accompany him, particularly when visiting new airfields. The most recent flight with an instructor was on 5 April 2013, a cross-country flight with landings away, a total duration of 3 hrs 45 min. The AAIB later received from the pilot a photocopy of his logbook and licence indicating that the flight on 5 April 2013 had been conducted for the purposes of his rating renewal.

The pilot reported that his normal technique for an approach was to reduce power on base leg to around 1,900 rpm, select the first stage of flap and descend, maintaining a speed of "80" mph[2]. He would then turn onto final approach, deploy the next stage of flap and adjust power to maintain "80" into the landing.

The pilot was able to remember some of the events leading up to the accident and had a good recollection of the flight up to the point of joining the circuit at Caernarfon. He was not clear about the precise checks he had carried out while joining the circuit, but noted that it was his normal practice to use the checklist on his kneeboard.

A checklist was found attached to the pilot's kneeboard which contained the following checks relating to carburettor heat;

Downwind checks CARB HEAT ----- HOT/COLD

Base/Final checks CARB HEAT ----- HOT

The instructor who most regularly flew with the pilot reported that the method for carburettor heat he taught was to select it to HOT during the downwind checks, for up to 30 seconds, and then to return it to COLD for the approach. The pilot confirmed that this was the technique he used.

The pilot remembered that he had tried to increase power when on the approach but there was no response from the engine. He believes he tried unsuccessfully to pump the throttle in an attempt to gain power. Realising he was not going to reach the airfield he deployed first one stage, then a second stage, of flap in an attempt to clear the obstacles before the boundary.

Aircraft description

The Piper PA-28-140 is a four-seat light aircraft of conventional aluminium construction powered by a Lycoming O-320 piston engine and a fixed-pitch propeller. It has a maximum takeoff weight of 977 kg. The fuel tanks have a usable fuel capacity of 48 USG when full and 34 USG when filled to the tabs. The aircraft has mechanically-operated flaps, deployed by a control handle between the two front seats. To extend the flaps the handle is pulled up to one of three positions, corresponding to 10º, 25º and 40º of flap.

The stall speed of the aircraft at the maximum takeoff weight in clean configuration is 61 mph (53 kt) IAS and with Flap 40º is 55 mph (48 kt) IAS. The Flight Manual does not provide a recommended final approach speed but a typical final approach speed for the type would be 80 mph.

The carburetted engine has a carburettor heat control system which, when selected, feeds hot air from a shroud around the exhaust into the carburettor to prevent ice formation. Carburettor heat is controlled by pushing or pulling a knob marked *'CARB HEAT PULL HOT'* on the instrument panel to the left of the throttle.

Footnote

2 On this aircraft the main ASI numbers were marked mph. There was an inner ring with lower numbers, indicating kt.

Accident site and initial wreckage examination

The aircraft had struck the ground 40 m short of the start of the paved surface of Runway 26 and displaced 15 m left of the extended runway centreline (Figure 6). The ground impact attitude was about 50º nose-down with a slight left bank. Following initial impact the aircraft flipped onto its back and came to rest 2 m further forward (Figure 7). Prior to ground impact the aircraft had struck a tree located slightly south of the extended runway centreline, 80 m from the start of the paved surface of Runway 26. Only the crown of the tree had been damaged with a level cut, indicating that the aircraft had struck the tree in a near-level attitude. The tree was later surveyed to have a height above runway threshold of 9.21 m – this was after the airport had arranged for about 0.4 m to be trimmed from the top. Therefore, immediately following the accident the tree height was about 9.6 m above the runway threshold.

Figure 6
Accident site overview

The aircraft suffered significant structural damage to its forward fuselage and wing leading edges and the right wing spar had failed. The propeller blades were slightly bent rearward but did not have any leading edge or tip damage. There were two clear propeller strike marks in the ground at the initial impact point, spaced about 70 cm apart. Based on an estimated impact groundspeed of 40 kt the propeller would have been rotating at about 900 rpm. If the groundspeed had been 50 kt the propeller rpm would have been about 1,100 rpm.

The left flap was measured at 38º deflection while the flap selector handle was found in the detent for ‘Flaps 25’. The fuel selector was set to the right tank and although the right tank was punctured there was sufficient fuel remaining to recover a 2.5 litre sample. This fuel sample was tested and was free from contamination apart from a few small globules of water. The left fuel tank had ruptured and was empty. The throttle was at a near-idle position, the mixture was set to full rich and the carburettor heat selector was set to cold, although these could have moved in the impact due to the disruption to the engine and instrument panel. The magneto key was found in the OFF position but it was bent so may have moved in the impact. The electric fuel pump switch was found ON and the master switch OFF. The master switch and magneto switches may have been turned off by emergency services. The altimeter was set to 1013 hPa.

The rear spar bolts from both wings were found to be missing and there was no damage to the attachment fittings.

Figure 7
Accident site

Powerplant examination

The throttle, mixture and carburettor heat control runs were examined and there were no disconnections apart from overload failures caused by impact. The carburettor heat valve was found crushed and it was not possible to determine its pre-impact position. The engine was removed for a complete strip examination. It had not suffered any mechanical failures and all four cylinders, pistons, and piston rings were in good condition. There was some light corrosion inside the casing but no excessive wear. There was some corrosion pitting on the cam lobes and on the fuel pump lobe and gear, but this would not have affected operation. The magnetos were both tested and passed specification. The eight spark plugs were tested and operated satisfactorily except for the No 4 lower plug and the No 1 upper plug which both failed to produce a spark at high pressure (simulating high power conditions) even after cleaning, and only produced weak sparks at low pressure. The spark plug gaps were within specification except for the No 1 upper plug, at 0.024 inches (maximum allowable 0.022 inches).

The carburettor was destroyed in the impact so could not be tested, but an examination of its parts did not reveal any defects and its fuel filter was clear. The floats were of the 'old brass' type, which the engine manufacturer had recommended be changed to foam floats (Lycoming Mandatory Service Bulletin 582A and EASA Safety Information Bulletin 2009-04), but they were not defective. The engine-driven fuel pump was stripped and all parts were in good working condition.

The fuel selector was removed and tested, which confirmed that the right tank was selected. The right fuel tank was free of debris and its fuel tank filter was clear. There were no disconnections in the fuel lines apart from overload failures at the engine-driven pump connector and either side of the electric fuel pump.

Airframe examination

The right wing had failed in overload at the main spar attachment and its rear spar attachment bolt was missing (Figure 8). The bolt could not be found at the accident site and there was no damage to the holes of the attachment fittings, indicating that the bolt had probably not been present at impact. The left wing had remained attached to the fuselage but its rear spar bolt was also missing. There was no damage to the attachment fitting holes and, if the bolt had failed at impact, the forward section of bolt would probably have been trapped in the area between the wing and the lower gap strip, but it was not found there.

In the PA-28 design the primary loads on the wing are in bending and these are primarily reacted by the main spar. The forward and aft spars primarily react the torsional loads on the wing and the front and rear spar bolts work together, both carrying a shear load, to react this torsion. With the rear spar bolt missing, the shear loads would still be taken up by the main spar attachment bolts and the front spar bolt, preventing the wing from significant twisting, nose-up or nose-down. The possibility remained that, with the rear spar bolts missing, the wing structure aft of the main spar could still twist up or down to a minor degree. The aircraft manufacturer stated that they could not quantify that effect from analysis and had not tested that configuration. However, the pilot did not report any handling issues during the flight.

Figure 8

Missing rear spar bolts from left wing (left image) and right wing (right image)

Airport survey information

At the time of the accident Runway 26 had a threshold that was displaced 139 m from the edge of the paved surface. This was to accommodate obstructions along the approach and takeoff surfaces. CAP 168 '*Licensing of Aerodromes*' defines the approach and takeoff surfaces which should be free of obstructions. For a Code 1 airport, like Caernarfon, the approach surface is projected at an angle of 2.86º from a point 30 m before the start of the Landing Distance Available (LDA) which for Runway 26 is 30 m before the displaced threshold. The takeoff surface is projected at an angle of 2.86º from a point 30 m beyond the Takeoff Run Available (TORA) which, for the case of Runway 08, is 48 m before the end of the paved surface. Based on a height above the threshold of 9.6 m the tree that was hit by the aircraft infringed the approach surface to Runway 26 by 0.27 m and infringed the takeoff surface from Runway 08 by 3.2 m.

Following the accident the airport operator had about 0.4 m trimmed from the top of the tree and later moved the Runway 26 threshold in by 34 m and reduced the TORA of Runway 08 from 799 m to 727 m[3]. These changes resulted in the approach and takeoff surfaces being free of obstructions. The airport operator had not been aware that the tree had infringed the obstacle surfaces and had relied on hand-held laser distance measuring equipment to monitor the height of the trees, which resulted in lower-than-actual height readings. Following the accident the operator decided to commission a survey company to perform an annual survey of obstacle heights in the vicinity of the airport.

Aircraft maintenance history

The airframe had accumulated 17,124 flying hours and the engine had accumulated 828 engine hours. The aircraft had not been flown for over 3 years between 15 March 2009 and 18 July 2012 when it was sold to its owner at the time of the accident. The aircraft's last annual check was completed on 27 July 2012 (at 16,894.6 hours) and its last 50-hour check on 10 May 2013 (at 17,121.5 hours).

The maintenance of the aircraft was the responsibility of the aircraft's owner, who also owned and ran the flying training organisation. He employed unlicensed engineers to carry out the maintenance work on his aircraft, under the supervision of a self-employed licensed aircraft engineer. The licensed engineer certified for the 50-hour, 150-hour and annual checks. A separate Part-M maintenance organisation had carried out the aircraft's airworthiness review following its last annual check and recommended that the aircraft be granted an Airworthiness Review Certificate. This Part-M organisation did not have any ongoing maintenance responsibilities for the aircraft.

The engine was last overhauled on 4 November 1998 (14.5 years before the accident) and was first used on 20 August 1999 (13.7 years before the accident). The manufacturer-recommended overhaul period for the engine was 2,000 hours or 12 years, whichever came first. The Civil Aviation Authority (CAA) required that this time period was complied with on aircraft used for 'Aerial Work', such as flying training, but a 20% operating time or calendar time extension was permitted if the requirements of GR No 24 '*Light Aircraft Piston Engine Overhaul Periods*' in CAP 747 '*Mandatory Requirements for Airworthiness*' were met. A 20% extension would have allowed the engine to be operated up to 14.4 years after overhaul. The CAA stated that the calendar time period could be based on the time since the engine's first use (13.7 years), providing the engine had been stored since overhaul in accordance with the manufacturer's instructions, therefore the 14.4 year limit was not exceeded. The engine logbook for G-ATRR contained an entry which stated that GR No 24 had been complied with, but there were no records detailing what work had been carried out

Footnote

3 The new survey also resulted in the runway designations changing from 26 to 25 and 08 to 07.

beyond normal 50-hour and 150-hour checks to comply with GR No 24. GR No 24 requires that the engine be inspected at 100-hour or yearly intervals, whichever occurs first, and it details a list of additional checks that may be necessary to assess the condition of the engine. These include oil consumption monitoring and cylinder compression checks. The licensed engineer overseeing the maintenance of G-ATRR could not provide any documentation to show that oil consumption was being monitored or that a cylinder compression check had been carried out in the 229 hours since the last annual inspection.

On 11 December 20012 the aircraft was due a 150-hour check which would have included a cylinder compression check, but the maintenance work sheet for this check was of the type used for a 50-hour check and a number '1' had been written by hand in front of the printed '50-hour' title at the top of the worksheet (Figure 9), but all the additional check items that were part of a 150-hour check were missing. The aircraft and engine logbooks had been signed to indicate that a 150-hour check had been completed.

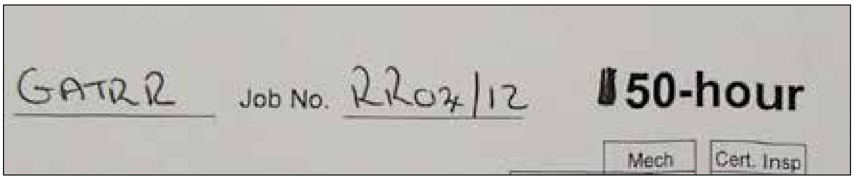

Figure 9

Header of the 50-hour maintenance worksheet used when the 150-hour check was due

The maintenance worksheets from the last annual check onwards did not detail work that would have required removal of the rear spar bolts and the licensed engineer overseeing the maintenance of G-ATRR stated that he was not aware of the rear spar bolts having been removed for any reason. He also stated that he could not envisage circumstances in which the rear spar bolts could be overlooked. The unlicensed engineer who carried out the last 50-hour check before the accident was also not aware of the rear spar bolts having been removed and stated that he would have noticed if they had been missing during the 50-hour check. The previous owner was contacted to find out if the wings had been removed while it had been in storage for three years, and he reported that the wings had not been removed and that he had always intended to fly the aircraft – the long storage period had not been planned. The maintenance records from the company that previously maintained the aircraft were examined for the period March 2007 to September 2008 and there were no entries related to removal of the rear spar bolts.

Audit of the operator's aircraft by the Civil Aviation Authority

The owner of G-ATRR operated a Registered Training Facility (RTF) for PPL training[4] which was not subject to CAA audit and, as the aircraft's maintenance was being certified by a licensed engineer and not by a Part-M organisation, the maintenance of the training

Footnote

[4] The owner of G-ATRR also operated an Approved Training Organisation (ATO) under the same name which was subject to CAA audit. This audit covered the training for helicopter type ratings, multi-engine piston ratings and flight instructor ratings.

organisation's aircraft was also not subject to audit. However, individual aircraft could be subject to audit by the CAA under the Aircraft Continuing Airworthiness Monitoring (ACAM) programme. Following the accident to G-ATRR the CAA carried out ACAM audits of two Piper PA-28 aircraft belonging to the owner of G-ATRR. The audits revealed a number of discrepancies and non-conformances with both aircraft, both from the physical survey and from an examination of the paperwork. This included findings of 150-hour checks being carried out as 50-hour checks. The owner of the aircraft was advised to rectify all the discrepancies found and then the aircraft would be re-audited a month later. During the subsequent audits of the two aircraft the CAA was not satisfied that all concerns had been addressed and therefore they could not be satisfied that the owner was adequately complying with his airworthiness obligations. As a consequence the CAA provisionally suspended the Certificates of Airworthiness of eight aircraft that were registered to the owner.

Changes to the approvals of flying training organisations

As a result of changes to the regulations each Registered Training Facility (RTF) that wishes to continue providing flight training must become an Approved Training Organisation (ATO) no later than 8 April 2015 (CAA Information Notice IN-2013-131). Following conversion each ATO will be subject to an audit programme by the CAA.

Survivability

Lap and shoulder straps were available in the front seat, the rear seats were equipped with lap straps only. The pilot could not recollect having used his shoulder strap and reported that in the past he had found it inconvenient to do so. However, evidence of post-impact bruising on his left shoulder area after the accident suggests that it was being worn. The rear seat child passenger was restrained by a lap strap.

A post-mortem examination was carried out on the deceased passenger. There was evidence to suggest that the passenger had not been restrained by either a lap or shoulder harness at the time of the accident.

Analysis

Engineering

The examination of the accident site revealed that the aircraft had struck the tree in a near wings-level attitude and then pitched nose-down and hit the ground in a nose-down attitude of about -50°. The limited damage to the propeller and the spacing of the propeller ground marks indicated that the engine was producing low or no power at impact. The examination of the engine did not reveal any faults that would have caused a loss of power; the remaining fuel was tested and found to be satisfactory, with no faults in the fuel system. The position of the carburettor heat valve could not be determined due to impact damage, but the carburettor heat selector was found in the cold position indicating that the selector may have been in the cold position at impact.

The rear spar bolts were found to be missing and the lack of damage to the holes indicated that they had probably not fractured at impact and, at some point, had probably been removed and not replaced. However, according to the pilot, the flight had proceeded uneventfully and he had not had any concerns about the aircraft's handling. The aircraft struck the tree following a loss of power and there was no evidence that missing rear spar bolts would have been a factor in this.

A review of the aircraft's maintenance revealed that the engine had exceeded its overhaul period by 1.7 years and there was no evidence to indicate that the actions required to extend this period by 20% had been carried out. There was also no evidence that a cylinder compression check had been carried out in the 229 hours since the last annual. The worksheets indicated that only a 50-hour check had been carried out when a 150-hour check was due, and investigations by the CAA revealed that this had occurred on two other aircraft owned by the operator. Further concerns about the maintenance of the operator's aircraft resulted in the CAA suspending the Certificates of Airworthiness of eight of the operator's aircraft.

The tree that was struck by the aircraft infringed the approach surface by about 0.27 m after the accident, and would have infringed it by slightly more prior to being hit. It is possible that, due to the aircraft's downwards trajectory, it would have still struck the tree if the tree's height had been at the upper limit of the approach surface. The same tree infringed the takeoff surface for the opposite runway by 3.2 m after the accident. The airport operator had been unaware of this due to the insufficiently accurate measuring equipment that had been used. As a result of these findings the airport operator plans to use a surveying company to carry out annual checks of obstacle heights.

The impact forces within the aircraft when it struck the ground were severe but two of the three occupants survived. The accident highlights the survival advantage which a correctly-worn harness can provide.

Flying technique

The pilot was familiar with the route and the weather conditions were suitable for the flight. The flight proceeded without incident until the latter stages of the approach when he attempted to add power, but the engine did not respond.

There were differences in the techniques for use of carburettor heat between the actions contained on the pilot's kneeboard checklist, and the method taught by the instructor. Following the accident the pilot could not remember exactly when or for how long he had applied the carburettor heat, but the selector was found in the COLD position after the accident. It was not possible to determine for how long the aircraft had been flying since carburettor heat had been applied. It is a possibility that, in carrying out a straight-in approach, the 'downwind' checks were overlooked or were conducted, with other 'downwind' checks, before the long straight-in final approach. The use of carburettor heat for 20 to 30 seconds at this stage would be unlikely to provide adequate protection against possible carburettor ice over the remainder of the approach.

The surface temperature/dewpoint split indicated by the meteorological reports in the area suggested that carburettor icing could be expected at any power setting. The time it would take for a significant amount of ice to form within the carburettor is unknown but in suitable conditions it can happen rapidly. Typical symptoms of carburettor icing include a gradual reduction of power followed, if not corrected by use of carburettor heat, by a complete loss of power. Although the pilot reported experiencing a sudden loss of power, a gradual loss of available power could have been masked by a reduced power setting during the descent and approach.