ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-CCWR	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2004 (Serial no: 8053)	
Date & Time (UTC):	18 April 2014 at 0843 hrs	
Location:	Farway Common Airfield, near Honiton, Devon	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Fatal)	Passengers - 1 (Serious)
Nature of Damage:	Destroyed	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	50 years	
Commander's Flying Experience:	162 hours (of which 100 were on type) Last 90 days - 2 hours Last 28 days - 2 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft was on final approach to land on a grass runway when it veered right and struck the tops of trees a short distance before the runway threshold. It then descended steeply and hit the ground on its left side. The pilot was fatally injured and the passenger suffered serious injuries. No pre-impact faults with the aircraft or engine were identified; it was probable that turbulence and downdraughts contributed to the aircraft's descent into trees.

History of the flight

The pilot planned to fly, with his nine year old son as a passenger, from Westonzoyland Airfield, near Bridgewater, Somerset to Farway Common Airfield, near Honiton, Devon, before continuing to Salcombe, Devon. The pilot carried with him notes about the landing procedures at Farway Common for in-flight reference. There was no record of the pilot having visited this airfield previously.

According to the passenger, the trike of G-CCWR had a full tank of fuel and was loaded with sleeping bags and inflatable beds. A tent, packed in a large circular bag, was stowed inside the wing. The passenger, who had, during the preceding five years, flown several times in this flex-wing aircraft, occupied the rear seat.

After departing Westonzoyland, G-CCWR routed in a southerly direction. Weather conditions were good and the route was flown with the aid of a tablet computer, using SkyDemon navigation software, that was attached to the instrument panel. The pilot had a radio and this was used while departing Westonzoyland and during the approach to Farway Common. He tried unsuccessfully to establish two-way contact with Farway Common and then transmitted messages to advise his position to any other aircraft listening on the frequency.

A windsock near the eastern airfield boundary should have been visible to the pilot as he overflew at 550 ft aal. There was a choice of an easterly or northerly runway (10/28 or 18/36) and the pilot positioned on the downwind leg for a right-hand circuit to Runway 36. It is estimated that the wind was from 040º at around 10 kt (11.5 mph) with possible gusts to 14 kt (16 mph).

The passenger had the impression that the aircraft lost altitude in the turn onto final approach but no problems were mentioned by the pilot at this stage. Recorded data recovered from the tablet computer indicated that the aircraft established on final approach approximately 0.5 nm from the runway and 400 ft above it. A witness working in a field slightly to the west of the approach path saw an aircraft fitting the description of G-CCWR at about this time. He thought that the aircraft was very low and the engine sounded normal as it began the turn. However, the engine started to sound as if it was running roughly while he was watching it. He lost sight of the aircraft as it descended towards Farway Common.

The passenger said that he believed that the engine ran normally throughout the flight and that it responded to the pilot's inputs during the approach. The pilot told the passenger that he was flying at a speed of 60 mph as he turned towards the airfield. As they neared the runway, the passenger said that the aircraft "dipped down" and he likened this to his experience of being affected by turbulence earlier in the flight. He recalled that the pilot increased power and appeared to push the control bar as far forward as he could, but this did not prevent the aircraft from hitting trees. The aircraft fell to the ground and the next thing the passenger remembered was sitting in the wrecked aircraft, which was lying on its left side. He could see the pilot on the ground a few feet in front of the aircraft. Despite a pain in his left arm, the passenger was able to undo his four-point harness but the left arm of his flying suit was trapped and he could not get out.

A witness, who was driving his car in a southerly direction along the road adjacent to the runway, observed the aircraft approaching the airfield at low level and saw it crash into some trees. He then spotted the wreckage in a field, about 10 m from the road, and he got out of his car and phoned the emergency services. A number of other people also stopped nearby and two men made their way into the field. Neither of them had witnessed the crash but they could see the pilot lying close to the wreckage and, as they approached, one of these men reported seeing the pilot attempt to lift his head. This witness went first to the passenger and helped him get out of the aircraft before joining the other man who was attempting to administer first aid to the pilot. They continued until the first paramedic arrived about 20 minutes after the aircraft crashed.

A doctor later pronounced the pilot to be dead at the scene. It appeared that the pilot had managed to undo his lap strap, remove his helmet and vacate the aircraft before collapsing. He had not used the third strap of his harness which would have been worn diagonally over his right shoulder.

Meteorological information

On the morning of 18 April 2014 a large ridge of high pressure dominated the region, bringing a stable, light to moderate north-easterly flow to the area. Satellite images and surface observations show that conditions were good with little cloud (the cloud base was generally 1,500 ft to 2,000 ft), and visibilities greater than 15 km. Winds at the surface were north-easterly around 10 kt, gradually increasing with height. The Met Office's computer model suggested that the 2,000 ft wind could have been from 040º at 14 kt and that the strength of this wind could provide a good estimate of what the maximum gust at the surface might have been.

The 0850 hrs METAR from Exeter Airport, 9 nm west of Farway Common, showed a surface wind from 060º at 9 kt, visibility 10 km or greater, FEW cloud at 2,000 ft, temperature 10ºC and dewpoint 5ºC. Exeter Airport is situated at 102 ft amsl, 669 ft lower than Farway Common and consequently a meteorological expert stated it was reasonable to assume that the wind at Farway Common would have been stronger than that at Exeter Airport.

Medical and pathological information

The pilot had made a Medical Declaration which was current and had been countersigned by his General Practioner on 11 March 2014.

A post-mortem examination found that the pilot had suffered internal abdominal injuries as well as severe chest injuries. However, the passenger's injuries were less severe and limited to cuts, bruises and a broken arm. Differences in the body weights and sizes, seating positions and use of harness restraints of the two occupants could provide some explanation for this variance but, if the injuries had been caused principally by the impact with the ground, as opposed to the impact with the trees, a higher degree of similarity could be expected.

The pilot's chest injuries may have occurred when the wing of the aircraft was arrested by the trees, causing the control bar to move rearwards, whilst the trike continued forwards, driving the control bar into the pilot's chest. The pathologist stated that while the pilot had no definitive external chest injuries to confirm that this had happened, their absence did not preclude such an occurrence. The investigation noted similarities between this pilot's injuries and those seen on pilots from two previous flex-wing microlight accidents[1]. In all three accidents the wing or A-frame had impacted a fixed structure during the accident sequence and this could have caused an interaction between the control bar and the pilot's chest. It was also noted that in all three cases the diagonal shoulder strap was not used by the pilot.

The pathologist's report indicated that the injuries sustained by the pilot of G-CCWR were consistent with evidence that he had freed himself from the wreckage before collapsing. The pilot's weight, plus that of the clothing worn for the flight, totalled 128 kg. The pathologist found no evidence of any medical condition that might have impaired the pilot's performance prior to the accident and toxicological tests for drugs and alcohol were negative.

Footnote

1 G-MWSH on 6 April 2007 (AAIB Bulletin 10/2007) and G-MVKM on 6 October 2013 (AAIB Bulletin 05/2014).

Pilot information

The pilot gained a UK National Private Pilot's Licence after completing a course of flying training on flex-wing microlight aircraft between April 2008 and May 2009. His flying logbook indicated that all his subsequent flying experience was on flex-wing microlights. He acquired G-CCWR in March 2011 and, according to his logbook, he had accumulated almost 65 flying hours in this aircraft up until late July 2013. On 16 February 2013 a Certificate of Revalidation on Microlight (land) aircraft had been signed by an examiner after a flight with the pilot in G-CCWR. This was valid until 6 March 2015.

The last recorded flight in the pilot's logbook was on 17 July 2013. However, the Westonzoyland Airfield movement log included an incomplete entry for 26 August 2013 which indicated he flew G-CCWR that day, on a local flight of unknown duration. There was no evidence to indicate that the aircraft flew again before being moved, during the winter, to the manufacturer's facility at Marlborough, Wiltshire, for repairs. On completion of the work, witness reports indicated that the pilot flew G-CCWR from Yatesbury Airfield, near Marlborough back to Westonzoyland (approx 43 nm) on 15 March 2014. The Westonzoyland movement log also indicated that the pilot had made a local flight lasting 1 hr 15 min on 12 April 2014, six days before the accident flight.

Farway Common Airfield

Farway Common Airfield is situated at 771 ft amsl, around 5 nm south of Honiton, Devon and has two grass runways. Airfield information was available in guides produced for pilots and on a dedicated website. The circuit height was given as 800 ft aal and the website asked pilots to make blind radio calls as they joined the circuit. A copy of the entry from Pooleys Flight Guide and a photograph of the runways, downloaded from the website[2], were carried by the pilot on the accident flight.

Runway 36 was identified in Pooleys as a grass strip 550 m long and 18 m wide, with the numerals 36 etched in the ground at the southern end. The white paint on the numbers had faded (Figure 1) and on either side of the strip there were cultivated areas which did not form part of the aircraft operating area. There were no runway edge markers and it appeared that grass cutting of the cultivated areas had encroached the runway, leaving a visual impression that the runway was narrower than it actually was. In Figure 1 the runway appears as a dark band, in contrast to the lighter coloured strips where the grass had been cut to either side.

Along the southern boundary of the field there was a hedge approximately 2.5 m (8 ft) high which was depicted in the Pooleys Flight Guide for pilots as a '*High Hedge Bank*'. This can be seen in Figure 1, along with a line of trees perpendicular to the approach path that were approximately 50 m further south. The trees on the extended centreline of the runway, were approximately 10 m (33 ft) high but the adjacent trees, immediately to the east of the approach path, measured around 15 m (50 ft) high. G-CCWR impacted two of these trees,

Footnote

2 The photographs on the website had been taken around five years previously but they were undated and there was no statement to suggest that the trees may have grown taller since the photographs were taken.

as indicated on Figure 1. Parallel to the approach track there were lines of taller trees along both sides of a road which ran south from the eastern airfield perimeter.

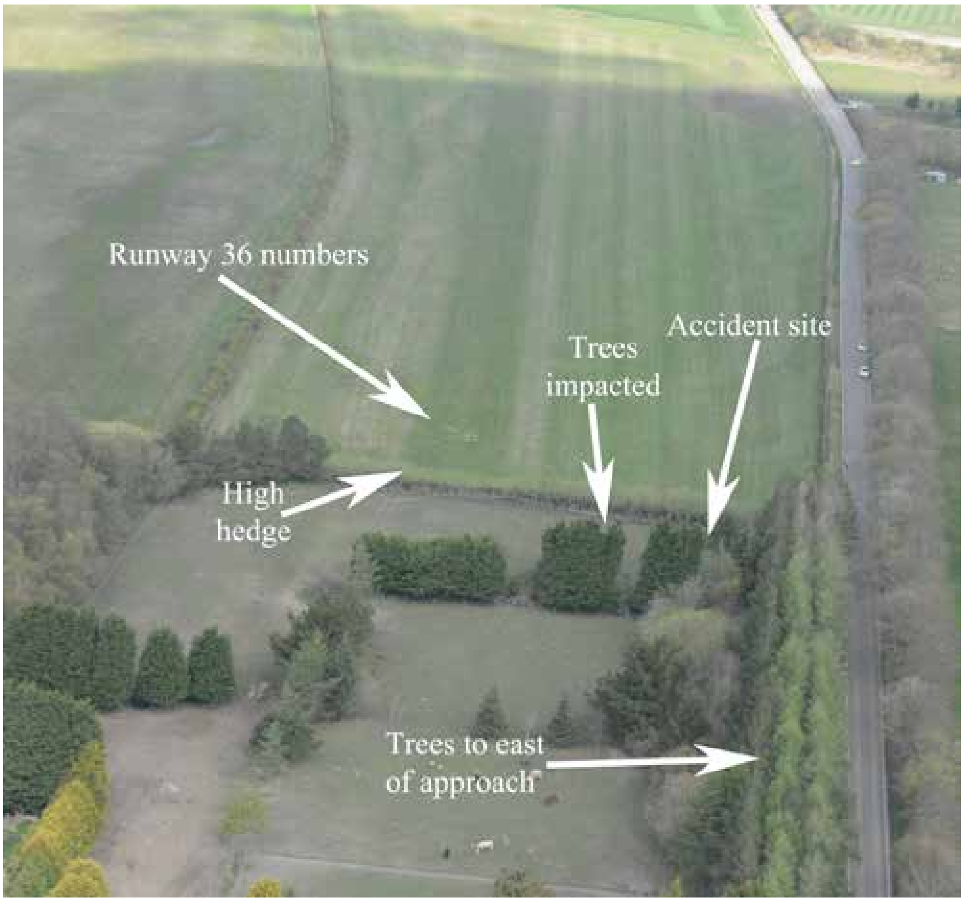

Figure 1

View of the approach to Runway 36
(photograph courtesy of the National Police Air Service, taken on 18 April 2014)

Recorded flight data

GPS derived data for the accident flight, recorded by the SkyDemon navigation software, was recovered from the pilot's tablet computer. The recording comprised GPS positional data (latitude, longitude and altitude amsl) together with groundspeed, track angle and a number of satellite signal quality metrics. There was no radar data for the accident flight.

The GPS data indicated that G-CCWR departed Westonzoyland at 0815 hrs. During the climb out, the average climb rate between 200 and 500 ft was about 1,050 ft/min. The highest altitude reached during the flight to Farway Common Airfield was 1,775 ft amsl.

The data indicated that G-CCWR approached Farway Common from the east and turned directly toward the airfield on a north westerly track with about 2 nm to go. The aircraft overflew the numbers of Runway 36 at about 550 ft aal, turned downwind at about 500 ft aal, and turned final at about 400 ft aal and 70 mph groundspeed. The ground track of the aircraft on final approach is illustrated at Figure 2 with the associated GPS data at Figure 3.

Figure 2

Ground track of G-CCWR on finals to Runway 36
(distance-to-go and height figures are relative to the airfield boundary for Runway 36)

The calculated distances to the airfield boundary for Runway 36 and descent rates are also shown. To compensate for the vertical errors present in the recorded GPS positions, in order that the recorded height of G-CCWR at the time it struck the tree matches the actual height of that tree, all references to the aircraft's altitude on final approach have been reduced by 36 ft.

Figure 3 shows that during the latter part of the approach the groundspeed reduced steadily over a 10-second period until it reached a minimum of 43 mph about 3 seconds before the aircraft struck the trees. The wind speed was about 11 mph from 040° with gusts up to 16 mph suggesting that the airspeed at this point could have been between 51 mph and 55 mph. However, in the shadow of the trees the wind speed could have been lower and consequently the airspeed could have been lower than 51 mph. The groundspeed then increased briefly to 54 mph as the aircraft turned and descended into the trees.

The flight ended at 0841:30 hrs; however, the software remained active and recording for a number of hours later until the battery of the tablet computer ran out of power.

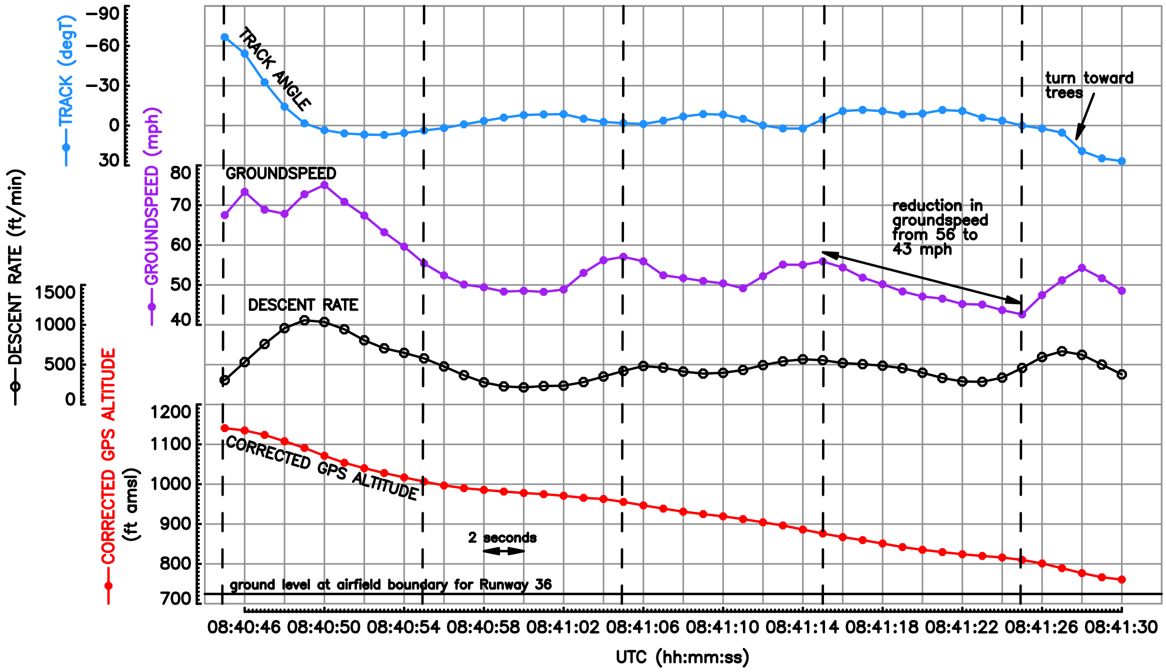

Figure 3

GPS derived data of G-CCWR on final approach to Runway 36
(with points highlighted in Figure 2 identified by dashed lines)

Approach to Runway 36

The altitude data of G-CCWR on final approach to Runway 36 is also presented in Figure 4 against distance to go to the airfield boundary to Runway 36. This indicates that G-CCWR was being flown with an approach angle of close to 6° after turning onto final approach (note that a 5.7° approach angle equates to a 10:1 slope ratio). It was calculated that an

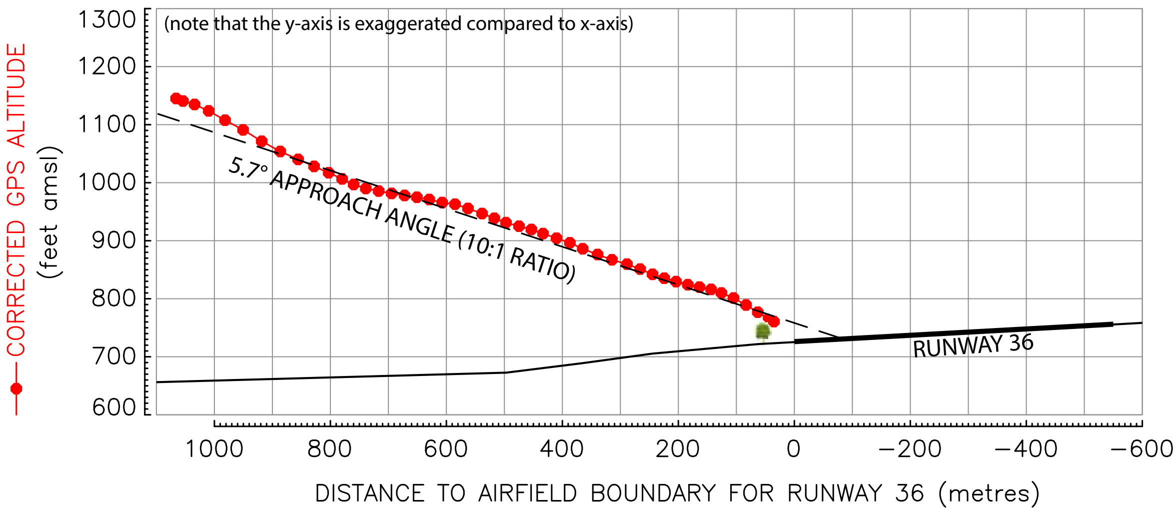

Figure 4

Vertical profile of G-CCWR on final approach to Runway 36 and a dashed line for reference depicting a 5.7° approach angle (10:1 ratio) to clear the 33 ft high trees (50 m before the airfield boundary) by 10 ft aircraft on such an approach angle for Runway 36 would have to aim at a point around 80 m beyond the airfield boundary if it was to achieve 10 ft clearance above the 33 ft trees positioned 50 m before the boundary. For comparison, an aircraft on a steeper approach angle of 9.5º (6:1 ratio) would need to aim at a point about 30 m beyond the airfield boundary to achieve a similar clearance, while an aircraft on a shallower 3º (19:1 ratio) approach angle would have to aim at a point about 200 m beyond the boundary. The recorded data indicated that G-CCWR was being aimed at a point far enough along the runway to clear the 33 ft trees.

Aircraft information

Figure 5

Pegasus Quik (*photograph courtesy Bill Brooks*)

The Pegasus Quik is a two-seat, flex-wing (weight-shift control) microlight aircraft, comprising a trike unit and wing connected by an upright monopole (Figure 5). The trike incorporates a tricycle undercarriage and G-CCWR was powered by a 100 hp Rotax 912ULS engine fitted with a 3-bladed Warp Drive propeller. Maximum engine speed is 5,800 rpm; however, with a Warp Drive propeller set to the recommended 16° pitch at the tip the maximum static engine speed is 4,800 rpm and the maximum in-flight engine speed, straight-and-level, is about 5,250 rpm.

The wing is controlled via a control A-frame, which consists of a horizontal control bar braced by fore and aft flying wires and two uprights attached to the wing keel tube. The Quik has a tandem seating configuration for a pilot in the front and a passenger in the rear. The rear passenger seat is equipped with a four-point harness, consisting of a lap strap and two shoulder straps. The front seat is equipped with a three-point harness, consisting of a lap strap and a separate single diagonal shoulder strap. The harnesses do not incorporate an inertia reel.

The aircraft was fitted with the optional, larger 65 litre fuel tank.

G-CCWR was manufactured in 2004 and had accumulated 531 flying hours. The engine had logged 539 hours. Its last maintenance was an annual inspection which was completed on 3 March 2014. This work included replacing the wing sail as part of the 500-hour wing service. Following this work a flight test was carried out by one of the factory pilots and no anomalies were noted. The maximum engine rpm was recorded as 5,100 rpm.

Accident site and initial wreckage examination

Examination of the accident site revealed that the aircraft had struck the tops of two trees 15 m high (Figure 6), and then descended steeply. It hit the ground in a steep left bank and then bounced about 7 m before coming to rest. Figure 7 shows the trike on its left side and the wing upside down. The left main landing gear leg had failed in compression and the left wing structure had crumpled in the impact. Two of the propeller blades had separated at the root and the remaining attached blade had suffered tip damage. One of the detached blades was found next to the main wreckage; the other blade was not found. Two pieces of propeller blade tip, identified as being from the two detached blades, were recovered from the opposite (southern) side of the trees. A piece of plastic cable end shroud was found midway between the trees and the main wreckage.

There was a distinct smell of fuel at the accident site and police reported having seen fuel leaking from the engine. Approximately 23 litres of fuel remained in the tank.

Figure 6

Accident site – the white Xs highlight some of the tree strike marks

Figure 7

Main wreckage (wing upside down)

Detailed wreckage examination

The aircraft wreckage was recovered to the AAIB's facility in Farnborough for detailed examination. The two flying wires from the right side of the A-frame to the right wing had failed in overload. The aft flying wire from the right side of the A-frame had also failed in overload at a location close to the propeller arc. There was also a leading edge nick in one of the propeller blades consistent with a wire strike. The failures within the wing structure were all consistent with ground impact loads and there were no anomalies with the rigging of the wing. A circular pop-up tent weighing 3.5 kg, of diameter 78 cm and thickness 14 cm, was found tucked inside the right wing resting against the leading edge tube and the keel tube. The control bar had a slight upwards bend. The reflex trimmer wheel was found set to FAST (about 80 mph), but this could have changed in the impact sequence. The mixture control was found set to full LEAN, the forward ignition switch was ON and the aft ignition switch was OFF. The hand-operated throttle lever was set to idle.

The rear seat four-point harness and the front seat lap strap were found undone and undamaged. The upper portion of the front seat shoulder strap was found tied in a knot – this appeared to have been done deliberately to prevent it from dangling when not in use. The lower portion of the front seat shoulder strap was found to be secured in the wrong location on the base tube beneath the seat; it was in front of the vertical rod which supports the fuel tank, instead of behind it. In this location only friction between the harness and keel would have prevented it from sliding forwards. This harness was also found to be the 'short' version – later versions are 3 inches longer. Due to the pilot's size it was unlikely that the shoulder harness was long enough for it be secured around him with the lower strap secured correctly.

Examination of GoPro video

A GoPro Hero video camera, that had been mounted on the pilot's helmet, was recovered from the accident site. It contained a video recording which started 5 min before the aircraft lifted off from Westonzoyland and ended 3.5 min later. The video showed that the fuel gauge indicated full after engine start and that the takeoff had proceeded normally. Audio spectral analysis revealed that the takeoff engine speed was 5,044 ±20 rpm. The mixture selector can be seen set to the 6 o'clock position, which is a mid-mixture position, during and after the takeoff. The normal position for takeoff is full RICH – about the 8 o'clock position (full LEAN is at about the 4 o'clock position).

Powerplant examination

The engine had not suffered any impact damage apart from damage to the propeller, a small split in the lower left radiator hose and a small leak from the left side of the radiator. The aircraft was equipped with a FLYDAT engine instrument which records peak engine parameters on start-up, at 6 minute intervals and at shutdown. The maximum engine speed during the accident flight was 5,100 rpm which was recorded during the takeoff. The maximum engine speed recorded during the final period to engine shutdown was 4,970 rpm. The exhaust gas temperatures, oil temperature, oil pressure, and cylinder head temperature were all within normal ranges for the entire flight. This indicated that the leak from the radiator hose and radiator was probably a result of impact damage.

The engine was tested in situ with a different test propeller[3] and using some of the fuel remaining in the tank. The engine started normally, ran smoothly and achieved a maximum speed of 5,620 rpm with both ignition switches on and the mixture set to full RICH. With the mixture set to the 6 o'clock position, engine speed reduced to 5,580 rpm, and with it set full LEAN it reduced to 5,360 rpm. The engine ran smoothly under all three mixture conditions. This test was repeated with the aft ignition switch OFF. The maximum engine speed with full rich mixture was 5,420 rpm, mixture at 6 o'clock 5,320 rpm and full lean mixture 5,050 rpm. The engine ran smoothly on one ignition in all three mixture conditions.

The test propeller was installed on another Rotax 912ULS engine which achieved a maximum speed of 5,730 rpm with the mixture full RICH and both ignition switches ON.

Operator's manual

The Pegasus Quik Operator's Manual (OM) provides the following advice:

> *'If you have not flown within the previous 3 months, take a refresher lesson with a Qualified Instructor before flying as Pilot in Command, and do not operate the aircraft until the Instructor is satisfied with your ability.'*

The maximum authorised takeoff weight (also referred to as the *'maximum weight'*) is listed in the OM as 409 kg and the limiting weight for either seat is 110 kg. This is considered to be a structural limit for the seat. The manual provides information about aircraft weights and centre of gravity and there is a requirement to place a placard[4] in the cockpit to show how the fuel load may have to be reduced in order to avoid exceeding the maximum weight before takeoff. Pilots are instructed to calculate the combined weight of the aircraft, fuel, pilot and passenger to ensure that this never exceeds 409 kg. There is a warning that exceedance of this limit could cause structural failure or loss of control.

In a section relating to centre of gravity, there are statements that: '*The CG of the wing* ***is*** *critical*' and '*Items should not be attached to the wing which significantly change the CG*'. The OM contains no information or advice about the placement of any items inside the wing.

The OM describes the harnesses fitted to the Pegasus Quik and states that the three-point harness for the front seat pilot and the four-point harness for the rear seat passenger should be worn at all times.

Guidance is given in the OM about the criteria for selecting appropriate airstrips. It recommends that both the approach and climb out zones should be free of high obstructions such as trees, pylons and buildings. The OM then states:

Footnote

[3] The test propeller was a two-bladed 52-inch diameter GSC Tech 3. This propeller produces less drag than the 3-bladed Warp Drive propeller, and therefore allows the engine to run at a higher rpm at full throttle.
[4] Such a placard was fitted to G-CCWR.

> *'Airstrips surrounded by trees or other obstacles should be avoided, particularly in windy conditions, since low-level turbulence and rotor are likely to be present. Exercise great care when visiting other airstrips for the first time, since it is possible that they are not suitable for safe Microlight operation.'*

The OM describes roll control with the following statements:

> *'The roll response is aided by the intentional flexing of the airframe and sail designed into the Quik wing. The Quik wing also incorporates a floating keel and hang-point roll linkage to reduce the effort required to produce and stop the roll, especially in response to small pilot inputs. This makes the aircraft much easier to fly if the pilot inadvertently flies into turbulence. Because the wing is only deflected a certain amount by the pilot's roll input, the roll rate achieved will be faster at high speeds than low speeds.'*

It also states:

> *'Roll control becomes slower at low airspeeds, so the bar should be pulled in slightly to increase airspeed before commencing the turn.'*

The recommended approach speed for a Pegasus Quik is 60 mph but '*a slightly higher speed than normal*' is recommended when a crosswind approach is unavoidable. The maximum crosswind limits which pilots must observe is dependant on experience and the OM states that the following apply:

- For beginners with less than 10 hours time as pilot in command, the maximum permitted windspeed is 5 mph (4.5 kt) and no crosswind is allowed.
- With between 10 and 100 hrs time as pilot in command, the maximum permitted windspeed is 15 mph (13 kt) and the crosswind limit is 5 mph (4.5 kt).
- For those with greater than 100 hrs time as pilot in command[5], the maximum permitted windspeed is 23 mph (20 kt) and the crosswind limit is 12 mph (10.5 kt).

Permit to Fly

G-CCWR was being flown under the conditions of a Permit to Fly from the CAA. This exempted the requirement for the aircraft to be issued with a Certificate of Airworthiness. The conditions of the Permit to Fly stated:

> *'The aircraft shall be operated in accordance with the current procedures and limitations contained in the applicable technical publications and with the manufacturer's instructions for the type and model of aircraft.'*

Footnote

[5] The pilot of G-CCWR had logged 132 hours pilot in command time in the five years since he started pilot training.

Aircraft weight

G-CCWR had an empty weight of 212 kg. The pilot weighed 128 kg (see *Medical and pathological information),* while the passenger weighed 50 kg. The structural weight limit for the pilot's seat was exceeded by 18 kg. The baggage, including camping equipment, carried on the accident flight was weighed after the accident and found to total 16 kg. A full 65 litres of fuel in the tank would have a weight of 46.8 kg, assuming a specific gravity of 0.72 kg/litre. This indicates that the aircraft weighed a total of 452.8 kg at the start of its flight.

Based on fuel consumption figures from the OM, about 8 litres (5.8 kg) would have been burnt during the flight and the aircraft would therefore have weighed around 447 kg at the time of the accident. This would have placed the aircraft around 38 kg or 9.3% above the *'maximum weight'* at the time of the accident.

Aircraft designer's comments

The designer observed that flex-wing microlight aircraft have a light wing loading and low inertia. Roll control may be quite heavy when close to the stall speed but response will improve as airspeed increases. Wind or thermal activity can create strong turbulence and windshear close to the ground when trees or other obstacles are present. Such turbulence is often strongest around treetop height and if the airspeed is too low at this stage during a landing approach or on climb out, there may not be enough roll control to prevent involuntary turns. Wind shadow may also cause airspeed to decay rapidly, inviting a wing drop. If this occurs close to the ground there may be insufficient height to recover.

He stated that the normal approach path for a Pegasus Quik is about a 10:1 ratio (5.7º angle). However, he observed that when a pilot is committed to landing in low-level turbulence, a better technique is to make a steeper-than-normal approach at about a 6:1 ratio (9.5º angle) through the turbulent zone whilst maintaining an extra margin of airspeed and that "70 mph is enough for the Pegasus Quik". The round-out should take place a few feet above the ground, allowing speed to decay in the ground effect until the final flare. This technique minimises the time spent in the turbulent zone and maximises control authority.

An overweight aircraft will require more power to fly straight and level and therefore it will have less excess power available to help it climb than one which is lighter. The best rate of climb quoted in the OM for G-CCWR at 409 kg was 1,200 ft/min. Calculations by the designer indicated that this would be reduced by around 19% to 957 ft/min if the aircraft weighed 450 kg.

The front seat in this type of microlight is forward of the hang point[6], so the heavier the occupant of that seat is, the more the trike will hang nose down. The pilot will balance this increased nose-down attitude by positioning the control bar further forward. This will place the control bar closer to the front strut, limiting the bar's forward range of movement which will reduce the aircraft's pitch-up capability. The designer estimated that exceedance of the

Footnote

6 The hang point is the position on the wing from which the trike unit is suspended.

seat limit by 18 kg would have meant that the control bar was about 20 mm closer to the front strut than it would have been if the pilot had weighed 110 kg. He suggested that this would have had a minimal effect on the aircraft's ability to pitch up.

When the weight of a flex-wing aircraft is increased, the shape of the wing is altered and this tends to increase the machine's longitudinal and lateral stability. This means that more force has to be exerted to manoeuvre the aircraft. The designer indicated that with the aircraft 9.3% overweight, the pilot would need to exert about 7.5% more force to push the control bar forward, but he considered that an increase by this amount would probably not be discernible unless a pilot was very experienced and frequently flew aircraft that were loaded differently.

The designer stated that the carriage of items within the wing envelope was not approved, but it was his opinion that the presence of the pop-up tent would not have significantly affected the profile of the wing. The tent was found resting against the leading edge tube and the keel tube but, as it was not restrained, calculations were done to check how it could have affected control of the aircraft had it moved. As a result of these calculations, the designer concluded that if the tent had shifted the maximum possible distance in either the fore and aft or the lateral axis, any changes to the control forces or to the aircraft's speed would have been small and masked by the effects of moderate turbulence. It was noted that there were no control cables within the wing which could have been fouled by the tent.

The designer considered the possibility that the control bar may have caused the pilot's chest injuries. He was unable to propose an alternative design for the control bar on the Pegasus Quik but said that this information could help influence the design of future aircraft. He noted that inertia belts are offered for later models of microlight and that it might be possible to modify the Pegasus Quik with an inertia belt.

Analysis

Aircraft examination

The damage to the wing and trike was consistent with the aircraft having hit the ground on its left side. The location of the plastic cable end shroud midway between the trees and main wreckage indicated that the right wing flying wires most likely failed as a result of impact with the trees. When these wires hit the trees, the A-frame would have been pushed aft against the pilot's chest, and the aircraft would have yawed right while the left wing dropped. The propeller was damaged and was turning at high speed when it hit the trees, as evidenced by the two propeller tip pieces that were found south of the tree line. It was probable that the right aft flying wire was cut by one of the propeller blades during the tree impact sequence. There was no evidence to suggest a defect in the wing or airframe prior to tree impact.

A test of the engine after the accident revealed that it was capable of producing 5,620 rpm using a test propeller, which was within 2% of the maximum engine rpm measured using the same propeller on another Rotax 912ULS engine. This evidence combined with the propeller damage indicated that the engine had not suffered a loss of power prior to impact with the trees. The evidence from the GoPro recording revealed that the maximum engine speed during takeoff was about 5,044 rpm[7] with the mixture in a mid-position, which was close to the 5,100 rpm measured during the post-maintenance flight test. And, since the FLYDAT recorded a peak engine rpm of 4,970 rpm during the last 6 minutes before the accident, this indicated that the engine was probably producing near to full power when it hit the trees. It was not possible to explain why the mixture was found in the full LEAN position and one ignition switch was OFF; however, had these been the pre-impact positions, the engine would have still run smoothly, albeit at a lower rpm and producing less power.

Aircraft weight

The maximum authorised weight for the aircraft was estimated to have been exceeded throughout the flight. Guidance in the OM on how to limit the fuel load should have been followed, to prevent the maximum authorised weight from being exceeded. The extra weight would have reduced the aircraft's climb performance. The designer indicated that the force needed to push the control bar forward would have been increased by 7.5% due to the extra weight. However, this was unlikely to have been discernible to the pilot given his limited experience.

Also, the 110 kg structural limit for the pilot's seat was exceeded by 18 kg. This would have slightly reduced the ability of the aircraft to pitch up.

The exceedance of the maximum weight quoted in the OM, meant that the conditions of the Permit to Fly were not met.

Operation of the aircraft

The pilot of G-CCWR had little recent flying experience. Records indicated that he had not flown between August 2013 and March 2014, and although there is evidence that he had flown twice since then, he had not had a refresher lesson with an instructor, as advised by the OM.

As part of his pre-flight planning, the pilot made enquiries about Farway Common but it was not an airfield he was familiar with and there were no warnings promulgated about the trees in the vicinity of the approach to Runway 36. The airfield photograph that the pilot carried with him did show trees near the runway, but he would not have known that the photograph was five years old and that the trees were likely to have grown taller since the photograph was taken.

When he joined overhead, about 250 ft below the height advised, the pilot might have seen from the windsock that the wind was about 10 kt (11.5 mph) or more. The direction of the wind may have indicated that Runway 36 was more favourable with regard to the crosswind but there were fewer obstacles on or adjacent to the approach to Runway 10. The OM advises pilots to exercise great care when visiting airstrips for the first time and that, particularly in windy conditions, they should avoid airstrips surrounded by trees because of the likelihood of turbulence.

Footnote

7 Lower than in the test due to the different Warp Drive propeller.

It was apparent from the recorded data that the final approach was flown at an angle of around 6º. The aircraft designer has indicated that, when low-level turbulence is anticipated, a better technique is to fly a steeper approach, at about 9.5º, and to penetrate the turbulence at the higher-than-normal speed of around 70 mph. If the approach had been flown in this way, G-CCWR would have spent less time descending through the turbulence that was probably present in the lee of the trees. A higher speed would also have afforded more roll control.

Recent grass cutting adjacent to the runway could have made the strip appear narrower than it actually was. When making a visual approach, a pilot uses the visual aspect ratio of the runway to help judge if he is flying along the desired approach angle or not. On a steep approach a runway will appear to be long and thin. Conversely, on a shallow approach it will appear relatively short and wide. When a runway is narrower than expected it will look thinner and may give a pilot the impression that the approach is steeper than it actually is. This may have influenced the pilot to adopt a shallower approach path than intended.

The passenger's evidence suggests that G-CCWR was being flown at a target airspeed of 60 mph for the approach, which is slower than recommended for turbulent conditions. Recorded data showed that at the start of the approach the groundspeed was close to 70 mph but that it then reduced, with indications that the airspeed may have fallen below 51 mph before the accident.

It is likely that, during the latter part of the approach, G-CCWR descended into turbulent air in the lee of the trees to the right. This is borne out by the steepening of the descent angle and the increased rate of descent in the last 100 ft. The right turn recorded before the crash suggests that the turbulence or loss of airspeed in the wind shadow caused the right wing to drop and that the pilot was unable to prevent the aircraft from turning right towards a group of trees that were taller than those below the final approach track. The pilot appeared to be applying full power and attempting to push the bar as far forward as he could to climb the aircraft. In the overloaded condition, the aircraft's climb rate would have been adversely affected. As the airspeed had probably reduced below 60 mph, it would have made it more difficult for the pilot to turn the aircraft away from the trees.

The reduction in groundspeed that occurred during the latter part of the approach was reversed in the final few seconds before the aircraft struck the trees. This may have been because the aircraft was now below tree level and in shadow of the wind or it may have been because the aircraft was accelerating in response to a power increase. However, the pilot was unable to climb the aircraft to clear the taller trees that were now in its path and it collided with two of these trees.

Survivability

The pilot wore a lap strap around his waist but he had not attached the third strap that could have fitted over his right shoulder to provide upper torso restraint. It was estimated that the shoulder strap installed was of insufficient length to correctly fit this pilot. A slightly longer belt was available and the manufacturer intends studying the possibility of offering an inertia reel seat belt modification for Pegasus Quik aircraft.

It was evident that the pilot had freed himself from the aircraft before succumbing to his injuries. It is possible that the pilot's chest injuries had been caused by impact with the control bar when the wing collided with the trees; similar injuries have been noted in two previous microlight accidents. While it may not be practical to modify the control bars of existing microlights to prevent this type of injury, this observation may help in the design of future aircraft.

CAA advice

The CAA publishes two leaflets that are pertinent to this accident. Safety Sense Leaflet 09 is titled '*Weight and Balance*' and it cautions pilots that the effects of overloading an aircraft include impaired manoeuvrability and controllability. It provides examples of pre-flight calculations that must be done and emphasises that accurate weights must be used for all persons and items that will fly in the aircraft. The leaflet's summary includes the following instruction:

> *'Check that the aircraft maximum take-off weight is not exceeded. If it is, you MUST reduce the weight by off-loading passengers, baggage or fuel.'*

Safety Sense Leaflet 12 is about '*Strip Flying*' and it contains extensive guidance for pilots who intend to fly to an unfamiliar airstrip. It refers to *CAP 793 - Safe Operating Practices at Unlicensed Aerodromes* and advocates careful planning of the approach and go-around area, paying particular attention to woods or buildings that could create windshear or turbulence. There is also a suggestion that a first visit to an unfamiliar airstrip should be done in the company of a pilot who has experience in operating from there. On the last page of the leaflet there is a summary of things to do and not to do, including the following:

> *'**DO** be ready for unexpected effects from trees, barns, windshear, downdraught etc.'*

Both leaflets can be downloaded from the CAA's Publications website.

Safety action

After this accident, the owner of Farway Common Airfield changed the airfield's website to add a cautionary note about turbulence and windshear from the trees close to the Runway 36 approach. He said he would request that the hazards be mentioned in commercially produced airfield guides. The Pooleys Flight Guide was subsequently amended in July 2014.

In addition, he allowed grass to grow over the numerals near the runway thresholds so that they were no longer visible. He realised that pilots approaching Runway 36 might have been inclined to have used the numbers as an aiming point, even though they might have needed to aim further along the runway to ensure clearance from the trees under the approach path.

The owner acknowledged that the website photograph which showed Runway 36 and its approach was old and that the trees had grown taller. He has annotated the website photograph with a note about the height of the trees on the approach to Runway 36 and added a cautionary note about turbulence. He has also stated that he will brief pilots about the hazards associated with Runway 36 when they phone him to request prior permission to visit Farway Common.

The CAA intends to revise its '*Strip Flying'* leaflet and add illustrations to show how obstructions can create low level turbulence and how obstacles below the approach path can affect an aircraft's approach angle and point of touchdown.