ACCIDENT

Aircraft Type and Registration:	Europa, G-HOFC
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	1996
Date & Time (UTC):	1 June 2007 at 1445 hrs
Location:	Near Magor, Gwent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	1,631 hours (of which 1,054 hours were on type) Last 90 days - 17 hours Last 28 days - 8 hours
Information Source:	AAIB Field Investigation

Synopsis

The pilot and a friend were returning from Bodmin Airfield in Cornwall to Uckfield Farm strip near Newport, Gwent. The aircraft was seen by witnesses flying at approximately 500 ft in a wings-level attitude, possibly in a gentle descent. The engine sounded normal, running at a medium to high speed. Witnesses on the ground saw the tail move up and down rapidly, and debris was seen to fall from the aircraft before the wings and horizontal tailplanes detached. The fuselage came down in a grass field, fatally injuring both occupants. The investigation has found that a structural failure of the right wing trailing edge retaining pin mechanism had initiated the in-flight break-up of the aircraft.

At an early stage of the investigation the AAIB issued a Special Bulletin to publicise the factual information available at that time. As a result of those initial findings, immediate and repetitive inspections of other aircraft of the type were mandated.

History of the flight

On the day of the accident the pilot and a friend were to fly to Bodmin Airfield in Cornwall for the aircraft to have an annual permit inspection. Following the inspection they were then to return to the Newport area. During the return flight it is believed that the pilot intended to carry out the required annual Permit-to-Fly air test.

The aircraft was based at Kemeys Commander, which is a grass farm strip close to the pilot's home. It was kept

in a secure, weather proof trailer similar in design to a glider trailer, which required the wings and stabilizers to be fitted prior to flight and removed for storage.

In the late morning, the pilot was seen at the strip assembling his aircraft. His normal procedure was to withdraw the fuselage from the trailer and support it in an upright position before attaching the wings and stabilizers. Two trestles were used to take the weight of the wings whilst he manoeuvred them into position before inserting locating pins. Having assembled the aircraft the pilot was seen to depart Kemeys Commander at about 1100 hrs to fly to Uckfield Farm to collect his passenger. Uckfield Farm is located to the east of Newport and has a single concrete runway orientated 05/23, 650 metres long by 10 metres wide, which the pilot preferred to use for collecting his passenger. The passenger also held a Private Pilot's Licence and had flown with the pilot on previous occasions.

The aircraft departed from Uckfield Farm at about 1130 hrs and flew to Bodmin Airfield in Cornwall arriving at 1215 hrs. It was taxied to the maintenance hangar where the pilots met with the Popular Flying Association (PFA, now renamed the Light Aircraft Association or LAA) inspector and the annual inspection was carried out. Following the inspection the pilots had lunch before departing at 1330 hrs. At 1410 hrs the pilot contacted the Cardiff Radar controller when 5 nm south-west of Linton and stated his intention to route from Minehead to Newport. His altitude was given as 2,200 ft on a mean sea-level pressure setting (QNH) of 1024 hPa and Cardiff issued a clearance to orbit initially before the aircraft was cleared to transit the zone at 2,500 ft on the QNH of 1019 hPa. With 5 nm to run to Uckfield Farm, the pilot was cleared to change to the Uckfield Farm radio frequency of 130.4 mHz. No further radio calls were heard from the aircraft.

Radar data obtained from the Cardiff radar site recorded the aircraft track and ground speed. No Mode C (altitude) information was received and therefore no height information was available. The aircraft track is shown at Figure 1. From this information the aircraft flew north-east, away from Uckfield Farm and then made a sharp left turn onto a south-westerly heading. No reason for this turn was identified.

Witnesses in the vicinity of the accident site saw the aircraft heading to the northeast at a height of approximately 1,000 to 2,000 ft before turning left and heading south-west. The aircraft had by then descended to approximately 500 ft. The engine sounded normal at a medium to high rpm setting but with a constant and regular sound. It was observed flying in a wings-level attitude, possibly in a slight descent. The tail section was then observed to move up and down rapidly and at the same time papers and other loose articles fell from the aircraft and streamed back in the airflow. The aircraft then broke up in what some witnesses described as being like an explosion but without fire and smoke. Other witnesses described the horizontal tailplanes detaching and the wings folding up before breaking away. Some witnesses thought the wings broke off first before the tail structure separated. All the witnesses heard the engine stop co-incident with the break-up.

The fuselage, wings, stabilizers and other aircraft components were scattered over a wide area with both occupants suffering fatal injuries on impact.

Initial impact and wreckage distribution

The wreckage trail continued for 430 metres on an approximate heading of 170° immediately to the south of a railway line, see Figure 2. The first items recovered were flight documentation and some personal effects. Approximately 35 metres south of the railway

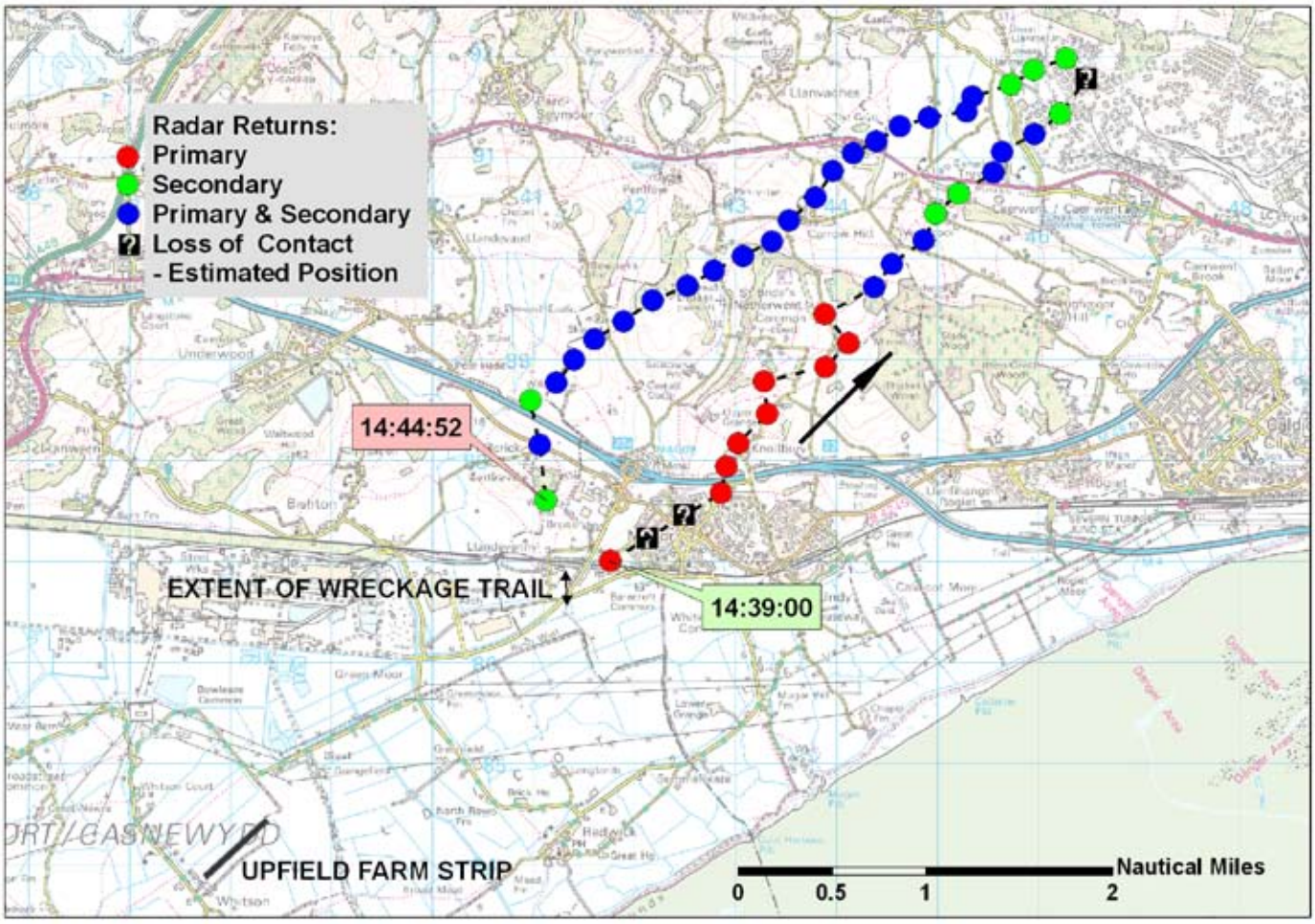

Figure 1

embankment small fragments of blue foam were found, which were later identified as being part of the internal structure of the right wing. As the trail of foam fragments continued southwards, the size and frequency of these fragments increased. A significant amount of the cockpit glazing was also found in the field. A fragment of the right inboard upper wing skin about 1.5 metres square was found close to an electricity pylon within the field. The remains of the right wing were found on the verge as the wreckage trail passed over a road. The left tailplane and sections of the cockpit doors and rear right wing root lay on the road, together with the left wing. The remains of the cockpit roof and the right tailplane lay 25 metres beyond the left wing at the road junction.

The fuselage had struck the ground in a steep nose-down attitude in a field immediately to the south of the junction. The engine and cockpit sections had both come to rest close to the point of impact. The rear fuselage and fin structure had broken away from the cockpit section and come to rest 15 metres from the initial impact point. The fin and rudder were found in a water-filled ditch 15 metres beyond the rear fuselage. The aircraft's fuel tank had been thrown from the aircraft and was also found in the ditch. Examination of the overhead power lines by the local electricity company confirmed that the aircraft had not struck the overhead cables.

Figure 2

The distribution of the wreckage confirmed that the aircraft had suffered from a catastrophic in-flight structural failure which had resulted from the separation of the mainplanes and tailplanes prior to the fuselage impacting the ground. Initial examination of the wreckage confirmed that it was probable that the propeller had not been rotating at the time of ground impact. The tailplane torque tube, together with the tailplane bushes, pip pins and balance weight remained attached to the fin structure. The left wing was found to be intact but the right wing was found to be severely disrupted, with peeling of the aft sections of the inboard wing skins and the loss of a substantial amount of foam infill. The right wing spar had failed and a section of spar which extended from the wing root into the fuselage had separated. Despite a search of the surrounding ditches by police divers, it was not recovered. A section of the right wing root which contained the rear drag pin mount was recovered from the roadway. The pin, together with a section of the mounting structure, was found attached to the remains of the fuselage. The remains of the aircraft were recovered and transported to the AAIB for detailed examination.

As a result of these initial findings, the AAIB published Special Bulletin S3/2007, and the PFA issued two Airworthiness Bulletins which required both immediate and repeated inspections. These inspections were made mandatory in the UK by the issue of Mandatory Permit Directives 2007-005 and 2007-006.

Aircraft description

The aircraft was a Europa 'Classic' powered by a Rotax 912S engine, and it had been built from a kit in 1996. It had been operated for approximately 50 hours prior to being sold to the pilot in February 2000. At the time of the accident it had operated for approximately 1,125 flight hours. The aircraft had a valid Permit-to-Fly and had successfully completed an annual permit renewal inspection at Bodmin immediately prior to the accident flight. The aircraft kit was of a type which required the builder to construct the complete aircraft, including the wings; later kits providing the builder with a set of partially completed wings.

The fuselage of the Europa is made up of a series of Glass Reinforced Plastic (GRP) mouldings fitted out and bonded together by the builder. Each wing of the 'Classic' consists of a single GRP spar, to which is attached a series of ribs. The profile of the wing is produced through the use of shaped medium density foam 'infill' and bonded GRP skins. The wings are secured to the fuselage at three points; the spar, a 'lift' pin and also by a rear 'lift/drag' pin, see Figure 3. The wing spars, which carry the majority of the flight loads, pass through a slot in the fuselage where they are connected to each other and to the fuselage by stainless steel 'rigging' pins. The lift pin is located towards the leading edge of the wing and the drag pin just forward of the trailing edge flap. The lift and drag pins are secured to the wing by a mount bonded to the face of the inboard wing rib. The mount consists of a laminated structure made up of three aluminium alloy plates, 25 mm wide and 3 mm thick, and layers of GRP cloth. (Later versions of the Europa, with factory assembled wings, made use of plates which were 50 mm wide.) The drag pins are designed to stabilise the wings in a fore and aft direction. The lift pin transmits some of the wing's lift load to the fuselage and maintains its torsional stiffness. At high angles of attack the lift distribution on the wing is such that the drag pin and its mounting are in tension. The aircraft is fitted with flaps which are connected to an actuation beam within the fuselage. The 'Classic' makes use of a mono-wheel main landing gear, with two 'outrigger' wheels mounted on the outboard end of the flaps. The flaps and landing gear cannot be lowered independently and are operated by a single lever in the cockpit.

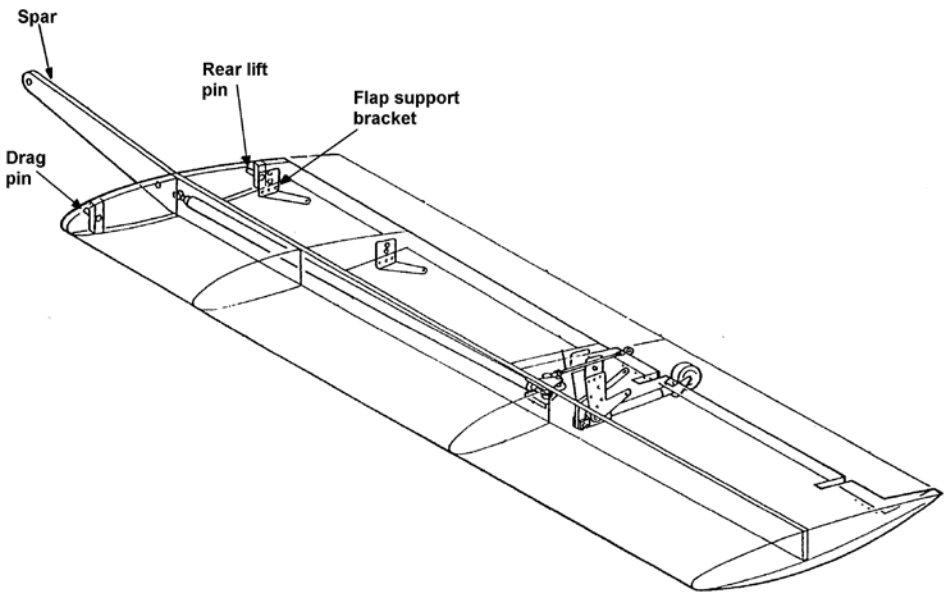

Figure 3

The Europa is fitted with an 'all flying' tailplane with an anti-balance/trim tab fitted to both the left and right surfaces. As with the wings, the tailplanes can be removed for transportation, being held in place on the tailplane torque tube by steel pip pins which pass through holes in metallic sleeves bonded in the tailplanes, (see Figure 4). Control inputs are transmitted by four pins, two on each side of the fin, which locate in bushes set into the inboard rib of each tailplane. The tailplane incorporates a mass balance weight which is connected to the tailplane torque tube by an arm within the fuselage. The mass balance is located between two vertical members bonded within the fuselage; these members restrict lateral and vertical movement. Tailplane deflection in pitch is restricted by lateral stops secured between the two members.

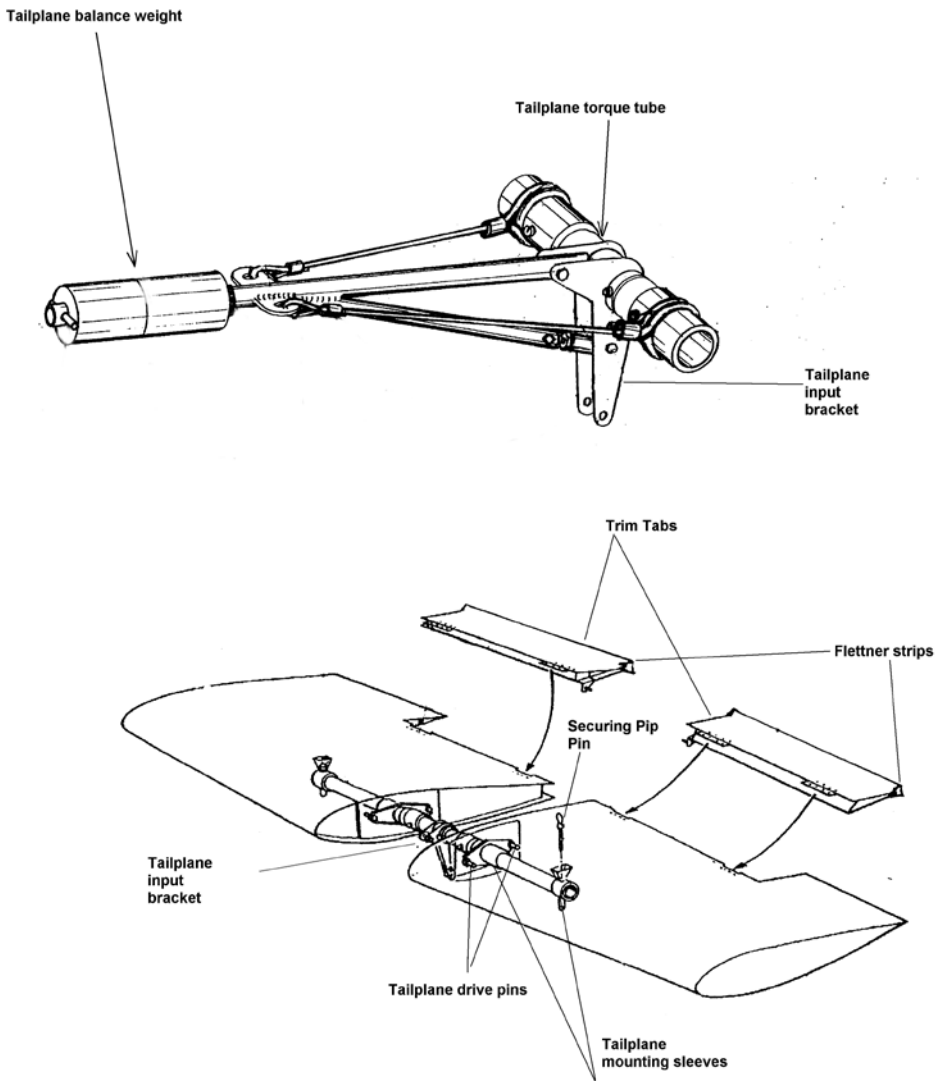

Figure 4

Meteorology

The Met Office provided an aftercast covering the route flown for the duration of the flights.

At 1450 hrs the Cardiff weather was recorded as surface wind 180° at 5 kt, variable between 120° and 230° with visibility in excess of 10 km. Cloud was FEW at 3,500 ft with temperature 19°C, dew point 12°C and QNH 1019 hPa. This also reflected the conditions in the immediate vicinity of the accident as described by the witnesses.

Weight and balance

The exact weight and balance of the aircraft could not be determined as it was not known what the total fuel was at the time of the accident. By using a simple calculation of the time flown of 2 hrs and 40 minutes multiplied by the minimum cruise consumption stated in the Europa Owners Manual of 18 litres per hour at 1.59 lbs per litre, approximately 48 litres or 76 lbs of fuel was used during the flight. Had the aircraft departed Kemeys Commander with a full fuel load of 70 litres, approximately 22 litres of fuel weighing some

35 lbs would have been onboard the aircraft at the time of the accident.

The maximum permitted gross weight was 1,370 lbs.

The centre of Gravity (CG) datum is located at the front face of the engine cowl and CG limits are defined as distances in inches aft of that datum. The limits remain constant for all weights with the forward limit at 58 inches and the aft limit at 62.5 inches aft of the CG datum point.

The following calculation is based on the known weights of the pilot, passenger, baggage and estimated fuel on board the aircraft at the time of the accident.

	Weight (lbs)	Arm (inches)	Moment
Aircraft Prepared for Service (APS)	789	59.4	46866
Pilot	222	56	12432
Passenger	246	56	13776
Baggage	20	88	1760
Zero Fuel Weight	1277	58.6	74834
Fuel	35	76	2660
Actual weight	1312	59	77494

At the time of the accident the aircraft estimated total gross weight was 1,312 lbs with the CG at 59 inches aft of the datum. The aircraft was, therefore, being operated within the permitted weight and balance limits.

Aircraft flight limitations

The following limitations are of relevance to the accident:

Condition	Limitation
Never Exceed speed (Vne)	165 kt
Stall speed (1,300 lbs) clean (Vs1)	49 kt
Max. flap/gear extension speed (Vfe)	83 kt
Structural Limit Loads (at 1,370 lbs)	+3.8g/-1.5g

Medical information

A post-mortem examination was carried out on the pilot. There was no evidence of any pre-existing disease or condition which could have had a bearing on the accident. The cause of death was a result of the injuries sustained in the accident.

Aircraft maintenance and records

The aircraft had been constructed in 1996 and flown for approximately 50 hours prior to its sale to the pilot in February 2000. Since that date the aircraft had been maintained by both the pilot and a PFA approved inspector based at Bodmin. The records kept by the pilot were found to be extremely thorough and appeared to detail all of the work carried out on the aircraft since its purchase, together with correspondence with both Europa and the PFA regarding potential modifications to the aircraft. The records held by the inspector were also found to be complete and thorough. Examination of the engine and airframe log books showed that the aircraft appeared to have been in compliance with all of the mandatory requirements in force at the time of the accident.

In November 2006 a log book entry stated that the pilot had re-built the Flettner strips which were fitted to the trailing edge of the tailplane tabs, and that in May 2007 the drive bushes within the tailplanes and been re-bonded. Records held at Bodmin confirmed that the aircraft had completed the 'technical' part of its permit renewal inspection without any defects being identified. The inspector stated that both tailplanes had been partially de-rigged to allow the tailplane drive bushes to be inspected as a result of the November 2006 log book entry; no defects were observed.

Detailed examination

Examination of the engine confirmed that it had not been operating at the point of impact but there was no evidence of any pre-impact failure or malfunction. The damage sustained to the fuel system prevented any samples of fuel being taken but there was a strong smell of fuel close to the fuselage together with discolouration of the surrounding grass, characteristic of a fuel spillage. The extent of damage to the cockpit instrumentation prevented any analysis of the flight or engine instrumentation. Based on the evidence of witness statements, further investigation then focused on the aircraft's tailplane system and wing structure.

Tailplane system

No evidence of an in-flight disconnection or restriction was found within the tailplane control system. All of the failures within the system were characteristic of 'overload' events and consistent with impact with the ground. The lower turnbuckle of the mass balance arm was found to have failed, which had allowed the mass balance weight to rotate and deform the tailplane input arm. Metallurgical examination of the fracture surfaces of the lower turnbuckle confirmed that it had fractured due to bending overload in the lateral plane. Approximately 2 mm of play was found between the tailplane input arm and the tailplane torque tube.

Both the left and right tailplane drive pins were found to be distorted, indicating the application of significant loads either through the control system or by the tailplanes. The bushes set into the inboard spar of each tailplane, which locate on these pins, had been distorted and become partially disbonded. Distortion of the drive pins and bushes would have led to the transmission of torque loads to the outboard sleeve and securing pip pin.

All four of the tailplane locating sleeves (see Figure 4) which had been bonded within the tailplanes, remained on the torque tube; the outer sleeve on each side was secured by its pip pin. Examination of the holes drilled into the outboard sleeves and the tailplane torque tube showed distortion and folding of the fore and aft edges of the holes which confirmed the application of a torque load between the sleeve and the torque tube. Discussions with both the Light Aircraft Association (previously the PFA) and Europa confirmed that the purpose of the outer sleeve and pip pin was to prevent the outboard movement of the tailplane and had not been designed to carry tailplane torque loads. Damage to the tailplanes confirmed that a failure had occurred in the bonding of the outboard sleeves. This had allowed both tailplanes to migrate outboard, disengaging both the tailplane drive pins and the trim tab drive pin and pulling the pip pins through the foam infill. Examination of the pip pin recesses in both tailplanes showed that they did not appear to have been constructed in accordance with the Europa Aircraft Build Manual, see Figure 5. The recesses in G-HOFC's tailplanes were significantly smaller than those shown in the manual; they consisted of a hole, and possibly an insert, of only slightly greater diameter than the pip pin whereas the build manual showed a significantly larger recess which made use of several layers of glass fibre cloth bonded to the sleeve. No abnormalities or inconsistencies which may have initiated the failure of the bond were found. Given that the bonded joint of the outboard sleeve had not been designed to carry torque loads even had it been constructed in the manner shown in the Build Manual, it is probable that it would also have failed due to the application of loads which it had not been designed to withstand.

Damage observed on the left side of the fin showed that the left tailplane trim tab had become disengaged from the 'T' bar mechanism which controlled it whilst

the tailplane remained in position. It is therefore considered that the right tailplane must have moved outboard, either pulling the 'T' bar or allowing it to move to the right. This would happen if the bond between the outboard tailplane sleeve and the outboard rib failed, and this would also allow the tailplane drive pins to disengage.

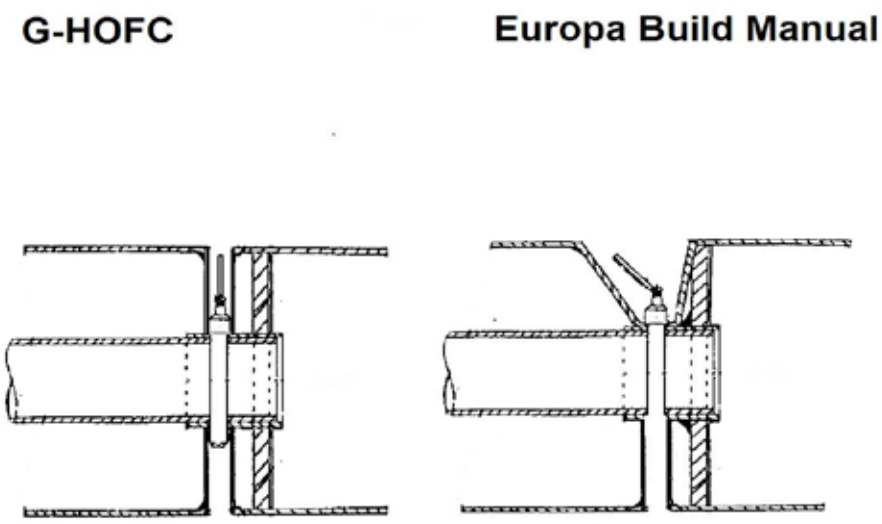

Figure 5

Disengagement of the drive pins would have caused the tailplanes to become free to rotate about their hinges, making the aircraft uncontrollable in pitch. This would have also subjected the airframe to significant loads beyond its design limitations. Scoring on the left side of the fin structure above and below the trim tab drive slot indicated that the left tailplane tab drive pin had become disconnected from the 'T' bar within the fin and had been moving beyond its normal range of movement prior to the tailplane becoming detached. Given that the tailplanes has been partially de-rigged at Bodmin, tests were carried out on another Europa to determine if it would have been possible to re-rig the tailplanes without engaging the trim tab drive, allowing the tab to be unrestrained. These test showed that the pin on the inboard edge of the tab could sit on top of the input drive 'T' bar and, when the tailplane was moved, the tab would move in a manner similar to that when properly engaged. The application of a very small load (a gentle push with a finger) caused the tab pin to slide off the 'T' bar, allowing the tab to drop. Discussions with pilots involved in the flight testing of the Europa confirmed that in cases where this has happened, pilots have become aware of a significant change in the control forces either during or shortly after takeoff but have also been able to land the aircraft successfully. Significant damage was found on the tailplane tab hinges and the tab drive pins, which appeared to be characteristic of the presence of a vibratory load. The Flettner strips on the trailing edge of the tailplane tabs were measured and found to be at or just below minimum depth requirements of the Build Manual. In view of the rebuilding of the Flettner strips and the re-bonding of the tailplane drive bushes, together with the play found between the tailplane input arm and the torque tube, a microscopic examination of the tailplanes, tabs and torque tube was carried out to determine if aerodynamic flutter or another vibratory condition had been present in the tailplane system. This examination confirmed that all the damage identified on the tailplane input arm, the tab hinges and the tab drive pins was caused by the break-up of the aircraft and there was no evidence of aerodynamic flutter originating within the tailplane system.

Wing

The left wing, together with its flap, was found to be complete; however the right wing had suffered from significant 'peeling' of the inboard rear skins, together with the loss of approximately 35% of its foam infill. The right flap had failed 280 mm from its inboard edge

and had separated from the remains of the right wing. The damage observed to the aileron control circuits was consistent with the break-up of the aircraft and no evidence of restriction or pre-accident disconnection was found. The left wing spar was found to be intact but the right spar had failed at the point where it entered the fuselage, the failure being characteristic of torsional overload.

Both the left and right wing lift pins had failed together with the drag pin of the left wing. The mountings for these pins, together with the threaded portion of the pins, remained in place in their respective wing ribs. Examination of the fracture surfaces of the pins showed that they had all failed due to the application of large cyclic bending loads. A section of the right wing inboard rib which contained the right drag pin mounting was recovered from the accident site some distance from the remains of the right wing. The mounting structure of the pin, which consists of several aluminium plates laminated together (including the one which hinges the flap), appeared to have failed due to the application of a tensile load. The innermost (closest to the wing rib) plate and flap plate remained in situ, but the outer two plates (closest to the fuselage) had been deformed and pulled away from the structure, see Figure 6. The outermost plate together with the right drag pin remained attached to its mounting point on the fuselage. The corresponding mount was removed from the left wing for comparison. This showed that whilst the left wing mount had been constructed in accordance with the Europa Build Manual, the right mount had not. The laminated plates of the right drag pin mount had become staggered during the lay-up, so that the forward edge of the outermost plate (closest to the fuselage) had been placed 5.5 mm ahead of the edge of the plate immediately below it, and that plate was 3 mm further forward of the innermost (closest to the rib) plate. The forward edge of the innermost plate was aligned with the forward edge of the flap hinge plate. The hole had also been drilled 2.5 mm forward of the vertical centreline of the outermost plate. This had reduced the edge clearance of the hole in that plate from 7.5 mm to 5 mm.

Due to the staggered lay-up of the mount, the edges of all of the subsequent laminations had been breached. The edges of the innermost plate and flap hinge plate had been breached to the extent that the hole consisted of little more than a semi-circular cut-out of the forward edge. The description of how to assemble the lift and drag pin mounts, given in the Europa Build Manual issued at the time of the aircraft's construction, requires that all three plates are laid up at the same time and does not show any method of maintaining the alignment of the assembly while it cures. It does however provide the following advice:

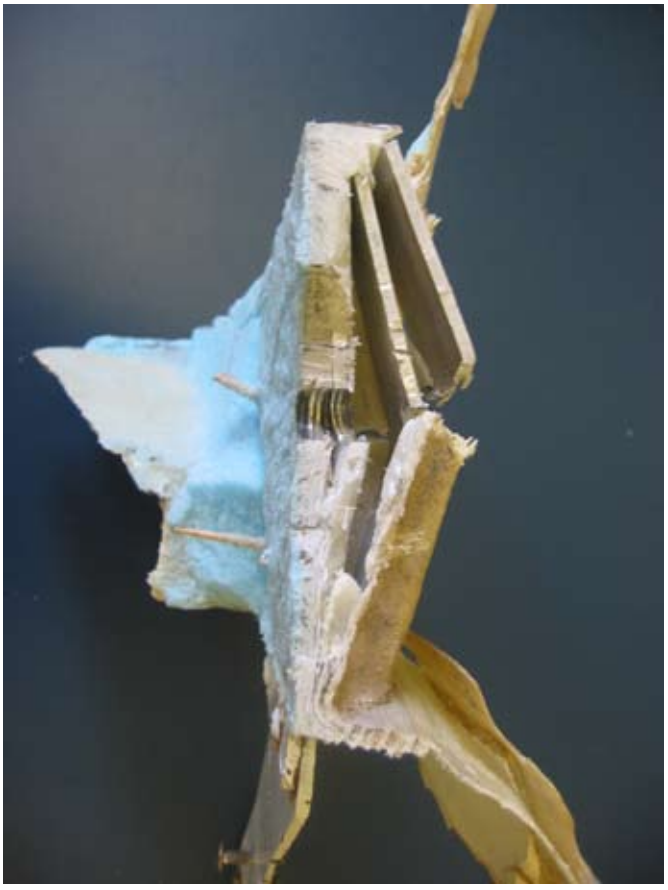

Figure 6

'Make sure that the plates don't move until the layup has cured. If there has been some displacement of the plates during layup, carefully reposition them through the laminate before it starts to harden'.

The method detailed in the Europa Build Manual chapter 29 for drilling and tapping the completed mount to accept the threaded lift pin, places reliance upon sighting the drill against visual markers on the wing spar and a straight edge taped to the upper surface of the wing to ensure that the hole is drilled correctly. The accuracy of such methods can vary depending on the degree of accuracy of the position of the eye line, drill and visual marker. Comparison of the left and right lift pin mounts confirmed that in their completed state both mounts would have looked identical, with no evidence of internal misalignment. The PFA confirmed that these mounts would only have been inspected on completion of the wing, when it would have been difficult to detect any misalignment of the plates.

In order to determine the load-carrying capability of the incorrectly built joint, a tensile load test was carried out using two test specimens, one replicating the construction of G-HOFC's right drag pin mount, and one constructed in accordance with the build manual. Due to the limitations of the test equipment the full range of loads experienced by the drag pin could not be reproduced and the tests were limited to the determination of the ultimate tensile strength of the specimens. The results from the test confirmed that both test specimens were capable of holding the unfactored tensile design limit load of 10.03 kN without failure. The test was then repeated and both specimens loaded until they failed. Examination of the specimen replicating G-HOFC's right rear pin mount showed that the innermost (closest to the rib) plate had pulled away from the GRP surface of the specimen, bending under the load, which had disrupted the bond with the next plate, see Figure 7. This showed that the inner plate of the test specimen had carried a significant load prior to disbonding. The damage observed to G-HOFC's right

Figure 7

rear lift pin mounting suggested that it had not been subject to a similar load. Therefore measurements were taken of G-HOFC's rear right lift pin and lift pin mount. These measurements showed that the lift pin was dimensionally correct (12 mm diameter) and that the thread had been cut to the required depth of 2 mm through all of the lamination plates. The diameter of the hole in the outer plate of the mount met the requirements of the Europa Build Manual. Measurement of the second plate confirmed that the partially complete hole within it had been 10 mm in diameter. However, there was some distortion and 'opening' of its circumference where the hole breached the edge of the plate. The partial holes through the innermost plate and the flap plate had become distorted and were found to have a diameter of 11.62 mm. The magnitude of this distortion would have significantly reduced their ability to carry loads from the drag pin and allowed a degree of movement of the pin within the mounting. This, together with the distortion to the second plate, would have meant that the majority of the tensile loads within G-HOFC's right drag pin mounting would have been carried by the outermost plate alone, whereas the undistorted holes in the test specimen allowed load to be carried by all the plates.

At the time of the accident, the pilot was properly licensed and qualified to conduct the flight and the aircraft was being operated within the permitted weight and balance limits. So far as could be determined, the aircraft was compliant with all of the applicable mandatory requirements and had been maintained in accordance with the requirements laid down by the PFA.

Up until the point when the aircraft made a sharp left turn some 3.5 nm north-east of Magor, the flight appears to have been uneventful. The pilot had not reported any abnormalities either at Bodmin or during radio communications with Cardiff. He had extended his flight beyond the point where he would normally have joined the circuit to land at Uckfield Farm. The reason for this is not known but it is possible that he simply wanted to extend the flight in the local area.

No apparent reason was established for the sharp left turn. No other aircraft were known to be in the area at that time or were observed on radar. A scatter of radar returns were seen simultaneously at a position 30 seconds before the turn and at the time the aircraft manoeuvred into the turn. It is possible, therefore, that the pilot may have been avoiding a flock of birds. It is also possible that the pilot, seated on the left, may have made a steep turn to the left in order to check the airspace below visually prior to his descent. The aircraft maximum positive load factor is restricted to +3.8g and the load experienced during the tight left turn should not have exceeded that limit. The V_{NE} limit of 165 kt was not exceeded and the speed did not reduce below the stalling speed.

The wreckage trail confirmed that the aircraft had suffered a catastrophic in-flight structural failure. The aircraft had not struck the nearby overhead electricity lines. There was no evidence of a pre-accident restriction or disconnection of the flight control circuits. The engine showed no evidence of mechanical failure and the staining of grass and the strong odour of fuel at the crash site confirmed that fuel had been present in the aircraft at the time of the accident.

The width of the plates used in G-HOFC to make up lift and drag pin mounts provided little margin for error in either the lay-up of the joint or the subsequent drilling and tapping. The method detailed in the build manual to ensure that the hole drilled in the mount was correctly aligned was reliant on alignment with visual cues and

therefore open to some inaccuracy. The forward stagger of the right wing drag pin mounting had resulted in the formation of incomplete holes in all but one of the plates. When the lay-up was completed there would have been no means of identifying the defects within the right wing drag pin mount prior to its failure. Whilst tests confirmed that it was probable that the mounting would have been able to carry its designed load when originally constructed, distortion of the mis-formed holes, due to normal loads experienced during the aircraft's operation, would have resulted in the progressive weakening of the internal structure of the mount.

Failure of the right wing drag pin mounting would have allowed the rear portion of the wing to become unrestrained. This would have allowed the rear portion of the wing to move both vertically and, to some degree, fore and aft. The lack of torsional stiffness would also have resulted in variations in the lift developed by the inboard section of the right wing, with resulting changes in the aircraft's pitch and roll. As the right wing flap was connected to its fuselage mounted actuation bar, any vertical movement of the wing trailing edge would result in a change in the relative angle of the flap and wing increasing the forces acting on the aircraft. These conditions would have introduced large static and dynamic forces in the wing which would have resulted in the aircraft oscillating violently in pitch, and would also have generated large forces within the tailplane system. The evidence suggests that these forces were of sufficient magnitude to distort the tailplane drive pins, causing the failure of the tailplane retention system which allowed first the right and then the left tailplane to become uncontrollable. The subsequent torsional load on the wing resulted in the failure of the right wing spar. Examination of the tailplanes, trim tabs and the torque tube confirmed that aerodynamic flutter did not appear to have originated in these components.

Whilst the sharp left turn would have increased forces on the wing, the catastrophic failure did not occur at that point in the flight. The position of the aircraft relative to Uckfield Farm was close to the point where the combined flap/landing gear would be lowered. The maximum flap extension speed is promulgated as 83 kt. It is possible that the flap/landing gear selector operating handle was moved to the DOWN position and, as a result of the change in aerodynamic forces the first stages of the break-up may have occurred at that point. If so, releasing the operating handle before it was in the DOWN position would cause the flaps and landing gear to retract and the handle to move to the UP position, where they were found.

Alternatively the pilot may have experienced the first indications of the break-up as an airframe vibration or some form of flutter and made the sharp left turn to return to Uckfield Farm. Whatever the indications or lack of them in the last few minutes of the flight, the break-up was sudden, catastrophic and rendered the aircraft uncontrollable. The accident was not survivable.

Safety action

Following the release of AAIB Special Bulletin S3/2007, and discussions between the AAIB and PFA, the PFA issued two Flight Safety Bulletins, PFA247/FSB006 '*Europa Classic And Europa Xs Tailplane Flutter Avoidance And Integrity Of Tailplane Attachment*', and PFA 247/FSB007 '*Europa Classic Integrity Of Wing Attachment*' , which were subsequently supported by the CAA Mandatory Permit Directives MPD 2007-005 and MPD 2007-006.

In addition to the above, in August 2007, Europa Aircraft issued two mandatory modifications to address

the issues identified in the investigation, Modification No 73, 'Improved bonding of tailplane sleeves' and Modification No 74, 'Improved rear lift pin mounting'.

As a result of these actions, which adequately addressed the build problem and mandated inspections of aircraft already completed, no further safety recommendations are made.