ACCIDENT

Aircraft Type and Registration:	Dyn'Aero MCR01 Club, F-PYMD
No & Type of Engines:	1 ROTAX 912 ULS piston engine
Year of Manufacture:	1999 (serial no. 102)
Date & Time (UTC):	30 September 2007 at 1352 hrs
Location:	Near Fridd Farm Airstrip, Bethersden, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	UK Private Pilot's Licence
Commander's Age:	74 years
Commander's Flying Experience:	537 hours Last 90 days - 7 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

Summary

The aircraft, soon after takeoff, suffered a partial loss of engine power. The pilot returned to the farm strip from which he had taken off, and attempted to land. However, the approach was made with a tailwind and the aircraft was too fast to land before the end of the runway. The pilot attempted a go-around but there was not sufficient engine power available; the aircraft descended and landed in a field just beyond the end of the runway. The aircraft struck a large oak tree, the passenger-side harness mounting was disrupted and the passenger was fatally injured.

The investigation found that the main fuel jet of the right carburettor had become obstructed by a corrosion fragment liberated from the carburettor bowl. The failure of the passenger's restraint was found to be due to the failure of the bond between the shoulder harness attachment fitting and the inner surface of the fuselage, to which it was secured.

One Safety Recommendation is made, at the end of this report.

History of the flight

The pilot, together with his wife, was planning to fly on a trip from Fridd Farm strip to Pontoise, France, where the aircraft was usually based. This particular route was a fairly regular flight for him.

On the morning of the accident the pilot drove from London to Fridd Farm. He stopped on the way at a garage and filled a container with petrol; this was fuel for the aircraft. When he arrived at Fridd Farm he went to the hangar where the aircraft was kept, pushed it out, refuelled it and got it ready for the flight. The fuel container was made of clear plastic so that it could be inspected for contaminants. The fuel was strained as it was put into the tank, then the fuel drains were tested for water.

It was the pilot's normal practice to arrange with the Air/Ground (A/G) radio operator at nearby Headcorn (Lashenden) Aerodrome to activate a previously filed flight plan once he was airborne.

The owner of Fridd Farm strip was there when the aircraft left. He saw the aircraft start, taxi and noticed it spent a few minutes on run-up checks before takeoff. The aircraft took off from Runway 32 at 1348 hours and carried out a normal climbing turn to the right. A short time later the pilot contacted Lashenden Radio, there was a brief general conversation and then the radio operator asked if the pilot wanted the flight plan activated. The pilot replied, after a pause, that he did not because he had a rough-running engine and was instead going to return to Fridd Farm. The radio operator asked if he would like him to telephone anyone but the pilot replied that there was no need, he was fine. About a minute later the radio operator called the aircraft again and asked how he was getting on, the pilot replied "I am OK, on short finals, thanks."

The owner of the farm strip saw the aircraft returning and watched some of the approach to land. He noticed that the flaps were down and the propeller was turning. He thought that the aircraft was a little higher than usual on the approach. He saw it cross the threshold of Runway 32 at a height of a few feet and later commented that it appeared too fast to land and that there was a tailwind. He watched the aircraft fly at a low height down the runway and then, towards the end, saw it start to climb. The aircraft cleared the hedge at the end of the runway then, as he watched, it descended again and, shortly before it went out of sight, he saw the left wing drop. He realised the aircraft had crashed and went to ask his wife to call the emergency services. He then drove down to where the aircraft had come to rest, the air ambulance arrived on the scene a few minutes later. The pilot was taken to a local hospital, his wife had suffered fatal injuries in the impact.

The accident site

The aircraft had come to rest in a field immediately beyond the road which passed across the end of the runway at Fridd Farm. The aircraft had struck an oak tree in the field, which resulted in the right wing separating from the aircraft. The aircraft had then come to rest approximately 14 metres beyond the tree, having spun approximately 180° from its direction of approach. The first ground mark was found 14 metres before the aircraft struck the tree and consisted of a straight cut 3.7 metres long. This mark had been made by the base of the rudder and the aircraft had been on a heading of 288°. A second mark started some 7 metres from the tree, made by the aircraft's nosewheel, this mark continued to the tree. The right wing of the aircraft had struck the tree approximately 1.4 metres from the wing root; the impact caused the right wing spar to move aft, disrupting the mounting structure and cockpit floor on the right side. The spar had then failed, allowing the right wing to separate.

Damage to the propeller indicated that it had been turning at the impact with the tree. The mounting structure for the nose leg had distorted, allowing the leg to rupture the aircraft's fuel tank which resulted in a significant amount of fuel spilling into the cockpit. The cockpit was substantially intact, with the exception of the cockpit floor and the rear bulkhead, which had separated from the fuselage; the instrument panel had separated from its mountings and been distorted on the passenger side. Both control columns had failed where they protruded above the seats and the seats remained secured to their mountings. Whilst the seat harnesses were found to be intact, the attachment point for the passenger's shoulder harness had pulled away from the inside surface of the fuselage.

Meteorological information

The general weather conditions in the area were fine with easterly winds and scattered or broken cloud at 3,000 ft. The anenometer at Headcorn Aerodrome, 4.5 nm to the west, recorded the surface wind at the time of the accident as from 100° at 8 kt.

Aerodrome information

Fridd Farm has a single bi-directional grass runway of 500 metres length, and orientated 14/32. The surface was in good condition at the time of the accident, the grass had been recently mown and was short and dry. Runway 32 has a downslope along its length. There is a windsock located to the south of the runway about half-way along. At the end of the runway there is a hedge and a public road, then there is a grass field beyond with a small thicket and the large oak tree in line with the extended centreline of the runway.

Aircraft information

The Dyn'Aero MCR01 type was first produced in 1998 and was designed to meet JAR-VLA requirements: there is also a 'microlight' version, complying to FAI ULM conditions. The aircraft F-PYMD, manufacturers serial number 102, was registered in 1999 and had been bought by the owner/pilot in 2000. It was registered in France and was normally based at Pontoise airfield. It was originally fitted with a ROTAX 912 S (80hp) engine and a variable pitch propeller. In February 2001 a new ROTAX 912 ULS (100hp) engine was fitted.

The Basic Empty Mass of the aircraft was 278 kg and the Maximum Takeoff Mass (MTOM) was 490 kg. The two persons on board weighed 140 kg and the baggage on board, which was weighed after the accident, amounted to a total of 30 kg. The estimated fuel load was around 50 kg and it is calculated that the mass at takeoff was close to the maximum.

At the aircraft's MTOM of 490 kg, landing from an approach at 57 kt would have required a distance of 270 metres under standard conditions. Using the information published in CAA General Aviation Safety Sense Leaflet 7B, *Aeroplane Performance*, with a tailwind component of 8 kt (+20%), a downslope (+10%) and a grass surface (+20%), this would have increased to 430 metres. Any extra approach speed would also have increased the distance required.

Pilot information

The pilot had qualified for his UK Private Pilot's Licence in 1991 and had recorded a total of 537 hours flight time. Since the year 2000 he had almost exclusively flown this aircraft. He was in regular flying practice and it was his habit to practise emergencies. In May 2007, he had completed a biennial flight review for a US Federal Aviation Administration PPL revalidation.

Pathological information

A post-mortem examination of the passenger was carried out. Death was as a result of multiple injuries which included a severe head injury. The report noted that the crash was of relatively low energy and that the accident was potentially survivable. The pilot suffered less serious injuries. The report also remarked that if the passenger's harness had remained intact her injuries may not have been significantly worse than those sustained by the pilot.

Recorded information

The pilot was equipped with a hand-held GPS receiver which was powered throughout the flight, recording time, position and GPS altitude. This device suffered minor damage during the accident but was successfully downloaded at the AAIB. F-PYMD was also captured on the Fridd Farm CCTV system which was also downloaded.

The CCTV identified F-PYMD, starting to taxi from outside the Fridd Farm storage hangar at around 13:41:45. After travelling a short distance, the footage then showed the aircraft stopping for around three minutes. During this period, the GPS was powered and began recording.

The aircraft was then seen taxiing towards the threshold of Runway 32. After waiting about two further minutes on the runway, the takeoff commenced at around 13:48:21. The aircraft lifted off and performed a right-hand circuit, achieving a maximum GPS altitude of 981 ft, before returning to the runway from which it had departed (Figure 1).

Just before the Runway 32 threshold, the groundspeed derived from GPS position and time was 76 kt with a heading of 315° True. F-PYMD crossed the runway threshold at around 13:51:00, just over two and a half minutes after takeoff commenced. Four further positions were recorded by the GPS as the aircraft continued tracking along the runway. The last five track points represented a ground track distance of 0.4 nm.

The last two GPS positions were located in fields just beyond the end of the runway. The final position was

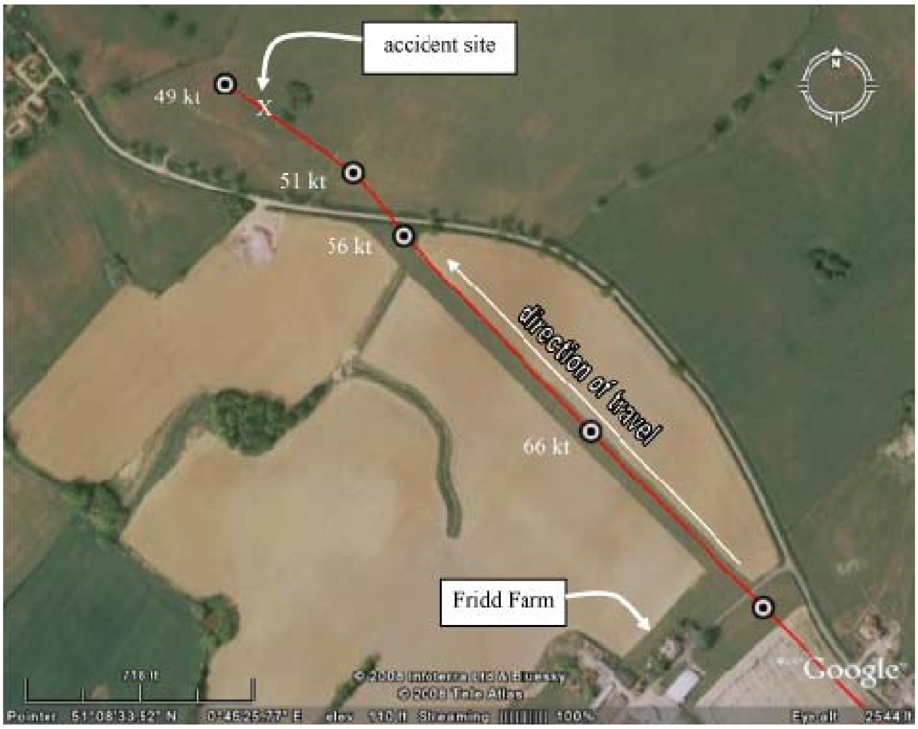

Figure 1

Fridd Farm airstrip with final 5 recorded GPS trackpoints

(Google Earth ™ mapping service/Infoterra Ltd & Bluesky /Tele Atlas) recorded at 13:51:20, located around 56 metres from the location of the accident site:

Figure 1 also shows the aircraft groundspeeds as derived from the GPS positions over time. Due to the limited number of points over the runway and the inaccuracy of the final track point, speed measurements for the end of the flight cannot be considered accurate.

The CCTV system also caught, briefly, the image of F-PYMD as it crossed the road at the threshold of Runway 32 and the image data was assessed by the National Imagery Exploitation Centre. The accuracy of the photogrammetry was affected by the poor image resolution and unverified CCTV 'frame rate' (nominally four frames/sec). However, the assessment that the wheels were about 0.5 metres above the ground and the speed was about 70 kt, accorded well with the witness report and the GPS data.

Engineering investigation

Measurement of the flap drive screwjacks confirmed that the flaps had been at, or close to, fully retracted when the aircraft collided with the tree. Ground marks confirmed that the aircraft had touched down 14 metres ahead of the tree and the aircraft's wing had been seen to 'drop' in flight; it is therefore likely that the speed of the impact was around the aircraft's stall speed of about 50 kt.

Based on the pilot's report of rough running, the engine was removed from the aircraft and tested under AAIB supervision, installed in a test stand and fitted with a fixed-pitch propeller. The engine was found to operate normally up to 3,500 rpm, beyond which it ran roughly and would not accelerate further.

Carburettors

Examination of the left carburettor showed that its barrel had been misaligned. The position of the barrel is determined by a diaphragm fixed to the top of the barrel; this has a locating tab on its outer edge which sits in a slot in the carburettor case to prevent rotation of the barrel after assembly. When disassembled, the diaphragm locating tab was found to have been incorrectly aligned, producing the misalignment of the barrel. However, after correctly reassembling the carburettor the engine again failed to accelerate beyond 3,500 rpm.

The right carburettor was removed and a well-defined area of exfoliating corrosion was found in the bottom of the carburettor bowl, a small piece of this material was also found in the main fuel jet, see Figures 2 and 3. There was no evidence of corrosion on the left carburettor bowl. The position and clearly defined nature of this material suggested the presence of water in the carburettor bowl. It was noted that the inclusion of a drip tray under the carburettor prevented removal of the carburettor bowl without first removing the carburettor from the intake manifold and there was no requirement to carry out an inspection of the bowls during routine maintenance. Burring found on screw heads around the carburettor did indicate that it had been disassembled at some point prior to the accident.

The right carburettor bowl was examined under a scanning electron microscope, which confirmed that the material in the bowl was a corrosion product of the zinc alloy bowl. Swabs taken for analysis confirmed the presence of chloride, bromide and acetate ions on the inner surface of the bowl. The concentration of these ions within the corroded area was found to be significantly higher than the surrounding material and sufficiently high to have initiated corrosion in the zinc

Figure 2
Corrosion in right carburettor bowl

Figure 3
Blocked fuel jet

alloy bowl in the presence of moisture. Whilst the origin of the chloride and bromide ions could not be positively determined, their level of concentration meant that they were probably introduced as a result of chemical contamination, possibly by a cleaning solution, rather than by natural residues.

In January 2001 the pilot had purchased a new engine, complete with carburettors, from the manufacturer's agent and this was installed in February 2001. The aircraft's log book confirmed that since its purchase the engine had been removed from the aircraft on three occasions. The first was in April 2004 to balance the carburettors and the second was in April 2005 to incorporate a starter clutch modification during which the carburettors had been cleaned. The final workshop visit was in July 2005 to carry out adjustments to the carburettors to cure engine misfiring in flight. The pilot confirmed that on these occasions the work had been completed by the same ROTAX agent, all other scheduled work being carried out by a subsidiary of the airframe manufacturer.

Information provided by the repair agency (ROTAX agent) confirmed that they had carried out work on the engine on the occasions detailed in the aircraft log. It was also stated that the engine components had been cleaned in an ultrasonic tank using water and detergent, and dried prior to reassembly.

Passenger restraint

The aircraft had been fitted with two three-point harnesses. The harnesses had remained intact, although the stitching at the point where the upper attachment strap was joined to the main harness had begun to stretch and 'open out'. Each harness was secured to three bonded carbon-fibre fittings, two on the cockpit floor beside the seat and a fitting secured to the inner surface of the upper fuselage, behind the rear cockpit bulkhead, see Figure 4. All the lower harness attachment points remained attached to the fuselage structure and, whilst the pilot's shoulder harness fitting remained attached to the fuselage, it had become disbonded from the fuselage at its forward edge. As noted earlier, on the right side of the fuselage the passenger's shoulder harness fitting had separated entirely.

A section of the fuselage, together with the rear cockpit bulkhead was removed to examine the bonds under laboratory conditions.

Fuselage inner surface

The inner face of the fuselage showed four areas of differing surface finish, see Figure 5. Area A was an area where no bonding had taken place and had been painted for aesthetic reasons, Areas B and D were shiny in appearance and had a smooth surface finish. Area C had a rough finish, normally associated with the

Figure 4

Shoulder harness installation

removal of a 'peel ply' from the composite structure[1]. The manufacturer's documentation confirmed that the harness fittings were to have been bonded in Area C and, in the event that the bond extended beyond the 'peel ply' area, the surface finish in those areas was to have been abraded to improve the bond strength. The remains of the bond for the passenger harness fitting extended 45 mm forward and 18 mm aft of the peel ply area, whereas the pilot's fitting had, with the exception of the rearmost 25 mm, been bonded to area C. The positioning of area C across the fuselage was not uniform: the area was narrower and its forward edge was displaced aft on the right (passenger) side of the fuselage. Adhesive paste had extruded from both harness fitting joints which indicated that there was adequate adhesive present during the bonding process. However, the depth of adhesive varied across the cross section of the fitting, possibly in an attempt to maintain the vertical alignment of the fitting when bonded to the curved cross section of the fuselage.

A detailed examination of the area where the passenger attachment had been bonded revealed that in area B the surface of the carbon fibre remained highly reflective and the bond failure appeared to be 'adhesive' (the bond having failed at the interface between the adhesive and the composite surface). This was clear evidence of a relatively poor bond. There was evidence of light abrasion to the surface in areas B and D but this had not improved adhesion in those areas. In area C, the prepared area, the bond line had a dull appearance and was characteristic of 'cohesive' failure of the bond, with the surface of the composite structure being pulled away together with some of the underlying fibres.

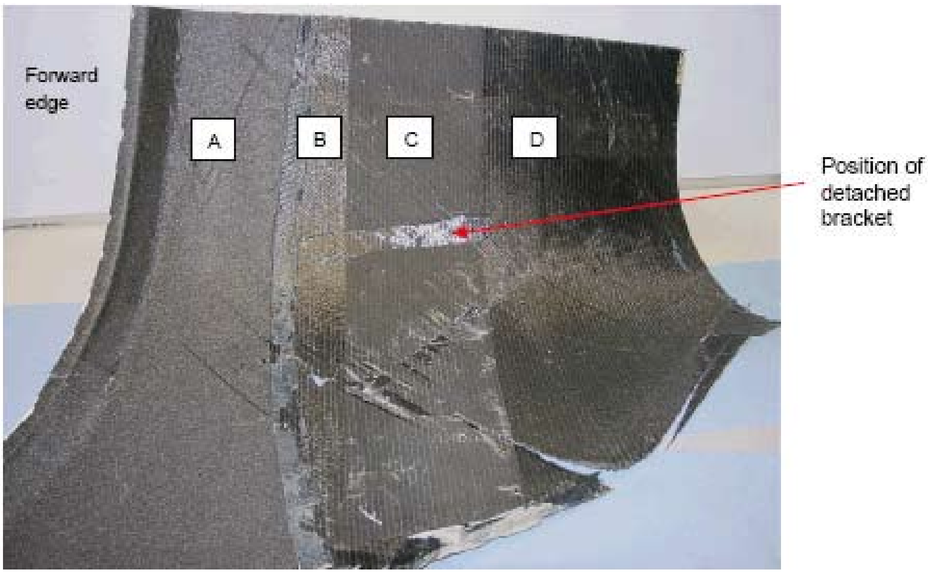

Figure 5

Interior fuselage surface finish

Footnote

[1] A peel ply is applied to the surface of a composite material during its manufacture. When removed after curing it leaves a rough surface finish suitable for bonding.

Seat harness attachment and modifications

Figure 6 shows the normal position of the shoulder harness. The location of the shoulder harness fittings allows the shoulder harness to remain roughly horizontal when worn; however, given the contour of the fuselage, any application of load on the harness will produce a perpendicular 'peel' load on the bond between the harness fitting and the fuselage. These 'peel' loads would be increased as the size of the occupant of the seat decreased. The bulkhead, constructed of a thin lamination of carbon fibre through which the harness attachment passes, was found to offer little additional resistance to the application of peel loads. The curvature of the fuselage cross section in this area means that it is also possible to introduce torque loads into the fitting if it is not accurately aligned.

The Dyn'Aero MCR01 was designed to meet the requirements of Joint Aviation Requirements (JAR-VLA). This required the design of the seat harnesses and attachments to be capable of withstanding a '9g' forward deceleration (JAR-VLA.561). Shortly after the introduction of the aircraft type to the UK, the Light Aircraft Association, LAA (formerly the Popular Flying Association) issued a mandatory modification, MOD/301/001 to reinforce the harness attachment fittings with additional carbon fibre 'straps' at the rear of each fitting to improve the resistance of the fitting to peel loads. In 1999 the manufacturer issued Service Bulletin BS 201 0005, which required the installation of two 5 mm bolts to provide additional retention of the fittings. This Service Bulletin is mandatory for aircraft serial number 130 and above, together with earlier serial numbered aircraft already on the UK register and was released to satisfy the requirements of LAA MOD/301/001, The accident aircraft, being on the French register, however, was not required to comply with LAA MOD/301/001 or Dyn'Aero Service Bulletin BS 201 0005.

Figure 6

Normal shoulder harness position

Climb performance

Performance data published by the engine manufacturer showed that at 3,800 rpm the engine would produce approximately 52 HP, in contrast to the maximum rated power of 100 HP at 5,800 rpm. This performance is reliant on both carburettors providing a 'balanced' and sufficient fuel flow, which appears not to have been the case during the attempted go-around. It is therefore probable that the engine would have been unable to produce 52 HP at 3,800 rpm. The aircraft's weight at the time of the accident, and the restricted engine performance, would have severely affected the aircraft's climb performance.

Analysis

The landing

The aircraft suffered a partial loss of power in flight soon after takeoff. The pilot attempted to return to land on the runway from which he had taken off but this was not the most suitable runway because of a tailwind and a downslope. The approach was unsuccessful and when a go-around was attempted there was not enough power available for the aircraft to climb. The aircraft made a forced landing in a field just off the end of the runway. The aircraft struck the tree at a moderate speed such that it is considered that the accident should have been survivable.

On departure from Fridd Farm the pilot chose to use Runway 32, accepting the tailwind and benefiting from the downslope. When the emergency arose he decided he would return to land. He continued with a right-hand circuit and chose to use Runway 32 again. However, he now had both a tailwind and the downslope for the approach and landing. Given the prevailing wind conditions, there would have been a significant tailwind on base leg, as well as on the final approach. Although it is possible that he was keeping extra height in case the engine stopped altogether, the result was that he ended up too high and in a position from which he could not land. When he tried to go around there was not enough power for the aircraft to climb so he landed in the field beyond the end of the runway. The aircraft touched down but, after only a short ground roll the right wing and fuselage hit a very substantial tree. This caused considerable disruption to the right side of the aircraft.

The pilot had practised forced landings on a number of occasions but on this occasion he misjudged the approach and landing and was forced to go around. Despite having practised, in the situation of a real emergency there is considerable added pressure. This can reduce the time available to think and, given that on this occasion the aircraft was only at 1,000 ft, time would already have been short, indeed, the whole flight lasted less than four minutes. The conditions for landing all favoured Runway 14, but the pilot instead used Runway 32. The reason for this is likely to be that, because he had taken off from Runway 32, without time for thinking he chose to use the same runway. If he had been able to consider the circumstances for longer it is probable that he would have chosen to use Runway 14, into wind and upslope.

Safety action

It is possible that were a pilot to give consideration to the most suitable runway for a return, before taking off, the problem of the reduced time available for deciding upon the best course of action in the event of an emergency could be mitigated. It is hoped that publicising the circumstances of this accident may help to remind pilots that a runway suitable for a departure may not always be the best runway for a return to land.

Loss of power

The loss of power was established to have been caused by the blockage of the right carburettor main fuel jet by corrosion products from the carburettor bowl. Analysis showed that the initiation of corrosion in the bowl was due to the presence of concentrations of chloride and bromide ions, normally associated with the residue of cleaning products. Whilst the origin of the chloride and bromide ions could not be positively determined, their level of concentration meant that they were probably introduced as a result of chemical contamination. The only work carried out on the engine which involved removal of the carburettor bowls was completed at the ROTAX agent's facility; it is possible that the contamination of the carburettor bowl occurred during one of the engine's visits. The installation of drip trays beneath each carburettor prevented the carburettor bowls being easily removed to check for the build-up of water or sediment/corrosion.

ROTAX confirm that the Maintenance Manual (Line maintenance) for the 912 series of engines strongly recommends removal of both carburettors for inspection every 200 hours. The following recommendation is therefore made with regard to the engine maintenance:

Safety Recommendation 2008-029

It is recommended that ROTAX introduce a requirement into the engine maintenance schedule for engine type 912 series, to remove and inspect the carburettor bowls periodically for the presence of moisture and other contaminants.

Restraints

Assuming that the aircraft was travelling at around the stall speed of about 50 kt when it hit the tree, calculations show that, in order to exceed the '9g' forward deceleration load, it would have had to come to a complete halt within about 5 metres. Given that the aircraft came to rest 14 metres beyond the tree, it is unlikely that the aircraft and its occupants were subjected to any sustained decelerations greater than 9g. The attachment fitting for the passenger's shoulder harness failed during the impact sequence, which allowed the passenger to be thrown forward striking the control column and the right side of the instrument panel. The area within the fuselage to which the fitting should have been bonded was narrower than the fitting which was to be bonded to it, and it appeared to have been misaligned, with the forward edge displaced aft on the right side of the fuselage. This resulted in the first 45 mm of the passenger's fitting being bonded to an area of structure not fully prepared for bonding. The poor bond in this area would have failed at lower loads than the bond in the 'peel ply' area and resulted in the remaining bond becoming overloaded and failing. It should also be noted that, despite the pilot's shoulder harness attachment point being correctly bonded to the fuselage, it had also begun to fail.

The installation of two fasteners in accordance with Dyn'Aero bulletin BS 201 0005 was intended to improve the harness attachment fittings' ability to withstand peel loads and meet the UK LAA requirements. However, it cannot be determined whether this modification would have prevented the separation of the shoulder harness fitting in this instance.

Safety action

The accident to F-PYMD clearly demonstrates the potentially life-saving properties of a correctly fitted harness with effective upper body restraint. From late 2006 the manufacturer has introduced an improved method of diffusing the restraint loads into the upper fuselage and this attachment is used where a ballistic recovery system is fitted to the aircraft.