ACCIDENT

Aircraft Type and Registration:	Team Himax 1700R, G-CCAJ
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	2003
Date & Time (UTC):	30 August 2005 at 1216 hrs
Location:	Rhigos, South Wales
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	846 hours (of which 80 were on type) Last 90 days - 14 hours Last 28 days - 9 hours
Information Source:	AAIB Field Investigation

Summary

The aircraft took off, carried out an abbreviated circuit and stalled at a low height on the base turn. The ground impact was in a steep nose-down attitude and the pilot suffered serious injuries. One safety recommendation was made.

History of flight

Two microlight aircraft, a Team Minimax and a Team Himax (G-CCAJ), departed from a private site in Gloucestershire and flew to Rhigos. One of the pilots had previously telephoned the airfield operator to confirm that weather conditions were suitable. Both pilots carried handheld radio transceivers and were in radio communication and occasional visual contact with each other during the flight. The weather conditions were good although there was some broken cloud en-route which they were able to avoid.

On arrival at Rhigos, at around 1050 hrs, both aircraft flew circuit patterns and landed in an easterly direction at the start of the grass landing strip. They then taxied along the landing area and parked close to the clubhouse. The surface wind conditions were reported as south-south-east at 8 kt.

The pilots spent about an hour on the ground before they prepared to depart. The intention was to fly on to Shobdon Aerodrome and then to return home to Gloucestershire. While on the ground they had some discussions with the Chief Flying Instructor (CFI) of the resident gliding

club about the local terrain, area flying conditions and possible departure routings. He advised that they should not fly too close to the high terrain to the south of the airfield following an easterly departure as there could be strong downdrafts and turbulence. He also pointed out that the options for a forced landing when taking off to the east were limited because of two lines of pylons directly ahead, and therefore favoured a right turn.

There was also present at the airfield another pilot who had been involved in building some parts of G-CCAJ. This was the first time that he had seen the aircraft since it had been completed. He discussed with the pilots some options for take-off direction in the prevailing conditions. He then stood and watched their departure from in front of the clubhouse.

The pilots decided to take off as much into wind as possible; it was still from the south-south-east but now at around 10 kt, across rather than along the east/west strip. The first aircraft departed and after gaining sufficient height, turned left on to the planned course to Shobdon. G-CCAJ departed in turn and was seen to climb to around 400 ft before starting a turn to the right. The aircraft flew on approximately a downwind course and started descending. The pilot watching from the ground became concerned that it was too low and might get caught in downdrafts created by the high terrain to the south. He saw it start a right turn onto a base leg and then saw the right wing drop and the aircraft go into a steep nose-down attitude before disappearing from his view.

Inside the clubhouse the CFI was on the telephone and saw G-CCAJ once it was airborne. His view was restricted but he saw the aircraft climbing out initially and then turning right and flying downwind. He was concerned about its course and watched it through the window. He saw it turn to the right and drop into a steep nose-down attitude. He realised it must have crashed and ran to his car to drive to it.

On reaching the accident site he saw the aircraft tipped on its nose with the tail up in the air. He heard sounds coming from the aircraft, rang '999' on his mobile telephone, reported the accident and then went to assist the pilot. He was able to push the fuselage off the pilot to help him sit upright and he stayed supporting him for about 15 minutes until the emergency services arrived. The pilot was taken by air ambulance to a nearby hospital.

Pilot information

The pilot started flying in gliders some 30 years ago. In 1990, he qualified for his Private Pilot's Licence (Microlight). Since then he had owned and regularly flown flex-wing type aircraft, accumulating some 700 hours of flight time. He then decided to build a Himax aircraft, which has conventional three-axis controls. This aircraft, which was part built when he bought it, took him some nine months to complete. Before flying it he undertook a conversion/refresher course in a three-axis microlight aircraft. The initial test flights for G-CCAJ were completed in March 2003 and over the next two years he had flown some 85 hours in it.

The pilot, who was interviewed one month after the accident, could recall taking off from Rhigos and turning to the right, but was unable to remember anything after that moment. He was unsure as to why he had turned to the right but thought it likely that he was planning to fly over the airfield to perform a 'flypast' before departing on course. He could not recollect having experienced any problems during either the flight inbound to Rhigos or on departure.

Wreckage and impact information

It was reported that following the crash the leading edges of both wings were resting on the ground and the tail was pointing upwards. During the rescue of the pilot the tail was lowered, the engine and cockpit items moved, the control column was broken and the fuel taps were selected to 'OFF'. The throttle lever was found close to the idle position; it is not known whether it was moved when the emergency services made the aircraft safe prior to treating the pilot.

From the wreckage and ground marks it was established that the aircraft crashed within the airfield boundary approximately 42 m south of Runway 07 on a of heading of 231º. Ground marks from the left wing tip, which broke off on impact, and broken fragments from the cockpit floor indicated that the aircraft struck the ground left wing first at a nose-down angle of between 60º and 80º. The left wing, the fuselage forward of the cockpit and the left side of the cockpit were totally destroyed. There was minor damage to the leading edge of the right wing; however the landing gear and structure aft of the cockpit were undamaged. The fuel tanks, which were $^{2}/_{3}$ full, were intact. One of the propeller blades had broken off close to the hub and fragments of the blade were discovered in a hole approximately 0.6 m wide and 0.12 m deep. The aircraft was equipped with a four-point harness of which the shoulder harness securing cable had failed at its anchor point. There were no ground marks beyond the immediate vicinity of the aircraft. See Figure 1.

Figure 1

Crash site

Recorded information

A Garmin GPS III Pilot was recovered from the wreckage and appeared undamaged by the accident. The stored data was downloaded to a computer and interpreted. The GPS was set up to record samples of latitude, longitude, magnetic track and ground speed whenever there was a significant change in these parameters. Altitude was not recorded by this model of GPS.

There were 11 track logs recorded on the GPS, the first recorded on 7 August 2005 and the last covered all the flying carried out on 30 August 2005. The flying on 30 August started at 0944 hrs near Gloucester. The aircraft landed at Rhigos at1053 hrs. The take-off roll of the accident flight started at 1216:08 hrs with the aircraft's track varying between 107°M and 122°M. The aircraft became airborne and the ground speed peaked at approximately 33 kt. It then started to decrease as the aircraft turned to the right, reducing to 28 kt on a track of 195°M. The ground speed then quickly increased to a maximum of 48 kt as the aircraft turned through west, reducing again to 41 kt as it then turned north. After this, no further track points were recorded. Figure 2 shows the GPS sample points of the final flight.

Meteorological information

The 'Airmet' area forecast contained the following information; visibility generally 15 km with broken cumulus and stratocumulus cloud between 2,000 and 5,000 ft. The forecast wind at 1,000 ft was from 140º at 15 to 20 kt and at 3,000 ft from 150º at 15 kt.

On the morning of 30 August the airfield was covered in fog but this had cleared by around 0930 hrs, leaving the grass damp. The wind observed at the airfield was from the south-south-east at 8 kt.

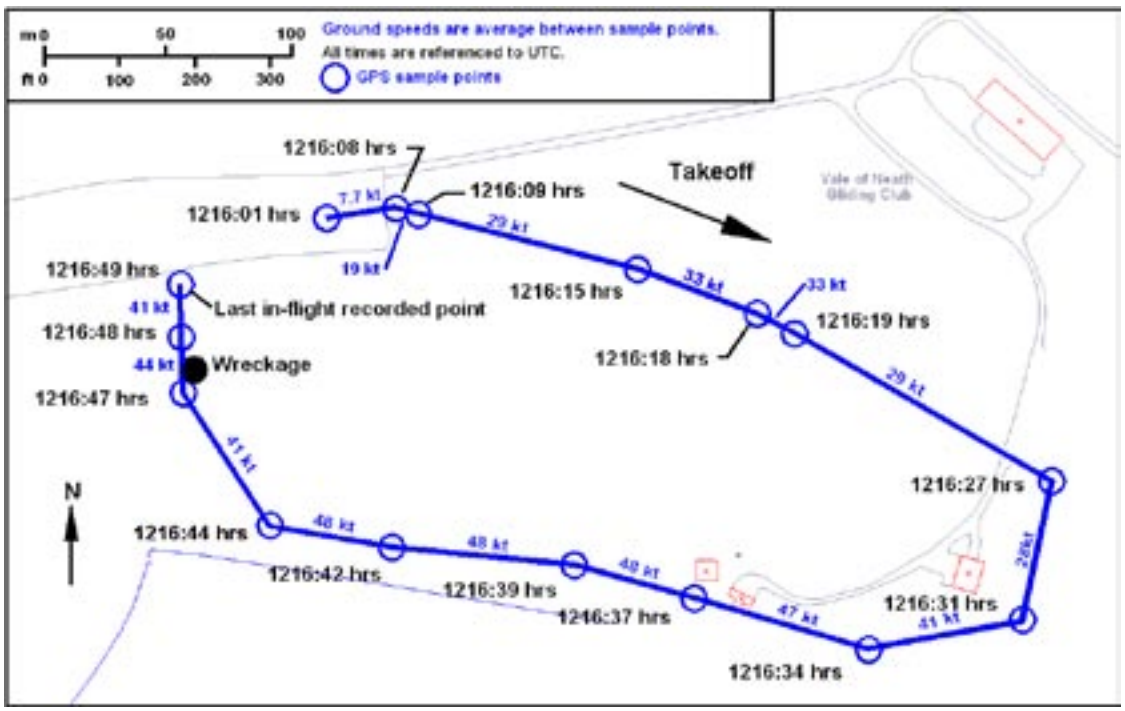

Figure 2

GPS plot

Airfield information

Rhigos Airfield is located on a small ridge of high ground at an elevation rising to 790 ft amsl (240 m). The surface of the runway is grass and the total length is some 2,950 ft (900 m); it is curved but the landing direction is generally aligned west/east and there is an upslope from west to east. To the south of the airfield there is a valley and then terrain rising sharply to 1,970 ft amsl (600 m). This terrain can give rise to significant local wind effects, particularly in southerly wind conditions. To the north and east there are lines of pylons close to the airfield. There was a description of the airfield on a website which included the following information;

> *"The airfield is in the hills, difficult to spot and can be particularly demanding particularly in Southerly winds. It is also curved, narrow, drops off steeply each side, has a pronounced slope down from East to West and is often too soft to operate off.*

Visiting pilots are encouraged to discuss the weather conditions and prior permission is required before landing there.

Aircraft information

a The aircraft

The Team Himax is a high wing version of the single seat mid-wing Team Minimax. It is constructed from wood and fabric and has conventional flying controls, elevator control movement being transmitted via a pair of Teleflex cables. It has no flaps, is not fitted with, nor required to have, a stall warning system and has a maximum take-off weight of 254 kg. G-CCAJ was constructed as a Popular Flying Association (PFA) Homebuilt Project and was originally intended to be built as a Team Minimax; however part way through its construction the owner obtained permission from the PFA to convert it into a Team Himax. G-CCAJ was equipped with a two-stroke Rotax 447 engine, which was operated on MOGAS. The aircraft undertook its first flight in February 2003 and the Permit to Fly was revalidated by the PFA on 22 April 2005. At the time of the accident the aircraft had flown approximately 94 hours.

b The airspeed indicating system

The aircraft is equipped with a conventional pitot static system, with the pitot probe mounted on the left wing strut and the static ports mounted either side of the fuselage forward of the tailplane. The Air Speed Indicator system is checked during the flight test by comparing the expected stall speed with the actual stall speed and by using GPS to check the indicated air speed against the ground speed. The flight test undertaken on 17 March 2003 showed that the stall occurred at an indicated 31 mph in straight and level flight with a loss of 50 to 75 ft during recovery. It was also observed that, when stalling, the aircraft occasionally suffered a wing drop to the left and that this could occur even when the aircraft was in a right turn. The stall speed was last checked during a flight test undertaken in April 2005, as part of the Permit to Fly revalidation, when it was again measured at 31 mph. This figure is consistent with the 30 mph stalling speed specified in the aircraft manual. The pilot who undertook both flight tests considered the airspeed recorded on the ASI to be accurate.

c The restraint harness system (See Figures 3 & 4)

The aircraft was equipped with a four-point harness consisting of a lap strap and two shoulder straps. The shoulder straps should have been connected to a galvanised steel cable which looped back through the elevator control support bracket fitted at the rear of the fuselage. The design drawings showed that one shoulder strap should have been attached to each end of the cable

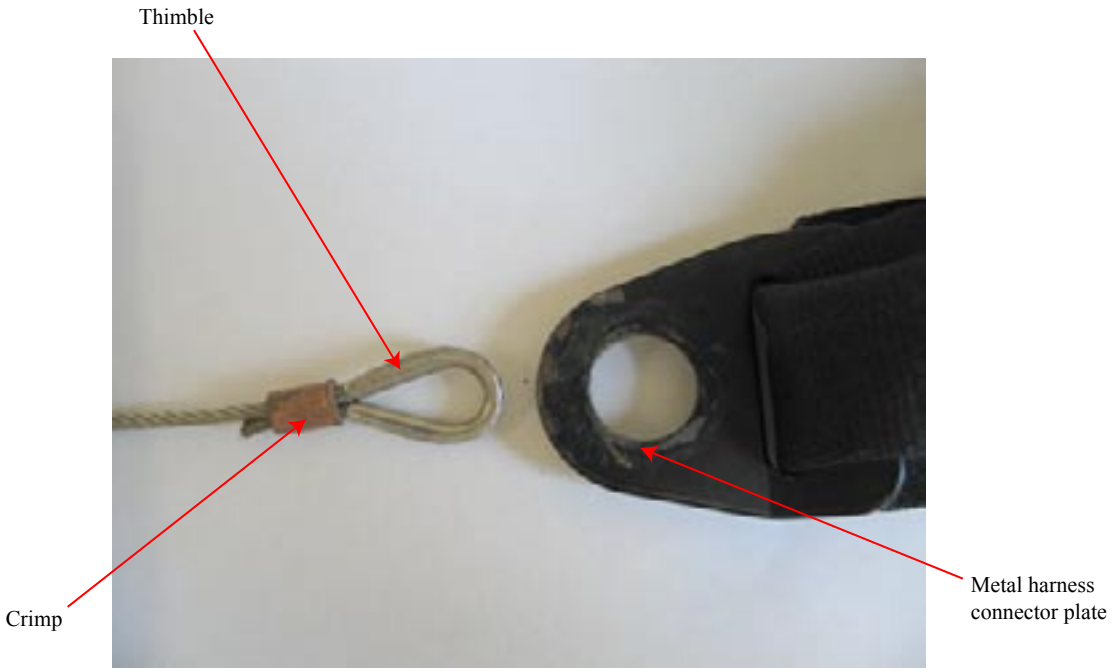

Figure 3

Connection of harness to cable (Note the thimble should be fitted over the lug of the harnesses connector, joining the cable directly to the connector plate)

by crimping the cable end around a thimble inserted through the lug of the harness connector plate. (Fig. 3) It did not indicate that the connector plates of the two shoulder straps should be constrained to stay together.

At the aft end of the fuselage, the cable passed downwards, with a tight 90º bend, through one hole in the horizontal flange of the bracket which supported the aft ends of the two elevator Teleflex cables. The harness cable then was looped underneath the Teleflex outer sheath end fittings before passing up through another hole in the horizontal flange and, with another tight 90º bend, forward again to the pilot's shoulder harness. (Fig. 4)

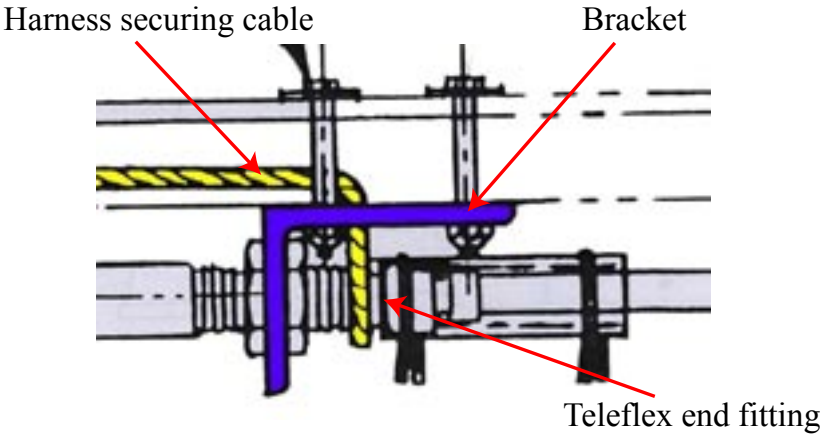

Figure 4

Routing of shoulder harness securing cable in rear fuselage

It was noted that whilst the design called for the harness cable to be made from galvanised carbon steel with a breaking strength of 1,000 lbs; the cable fitted to the aircraft was stainless steel and had a nominal breaking strength of 920 lbs. Subsequent testing of this cable and attachment, conducted for the PFA, showed that the strength of the arrangement, as fitted to G-CCAJ, exceeded the requirements of BCAR Section S, 561(b).

Detailed examination of wreckage

a General

The front of the aircraft had been badly disrupted in the accident making it difficult to establish the position of the engine controls and the condition of the instruments and pitot static system. Nevertheless, it was possible to establish control continuity on all the primary controls and to confirm the integrity of the fuel system between the tank and gascolator. It was noted that the rubber seal between the gascolator bowl and upper fitting had been damaged during assembly, thereby allowing small pieces of rubber to enter the fuel bowl. However, there was no sign of rubber debris downstream of the mesh filter in the gascolator in either the carburettor fuel bowl or jet.

b Engine and propeller

Whilst there was no damage to the leading edge of the broken part of the blade, which had shattered on impact, mud had been driven into the exposed part of the grain on the hub which was consistent with the hub rotating when the aircraft struck the ground. The position of the broken fragments of the blade found in the hole made by the propeller also suggested that the engine was turning prior to impact. Overall the damage to the propeller was consistent with the aircraft impacting the ground in a very steep nose-down attitude, whilst the engine was still turning.

The impact had damaged the engine controls, external pipe work and electrical components; consequently, it was not possible to test the components in the ignition system. Nevertheless, the engine control cables were still connected to the carburettor, which had been knocked off the engine. Whilst any fuel that might have been in the fuel bowl had drained away, the carburettor was relatively undamaged, the jets were clean and the valve and needle operated smoothly.

Both spark plugs were found to be finger tight; the rear plug could be hand tightened by a further 2 turns and the front plug by approximately $^{1}/_{2}$ turn. The rear plug was normal in colour and appearance whereas the front plug was light grey with a grey deposit bridging the gap between the electrodes. The front plug was subsequently tested and a strong spark between the electrodes was observed. It was also noted that very little torque was required to undo the cylinder head securing bolts. Both cylinder barrels and both pistons appeared to be in good condition and the engine turned over freely. There was no evidence of hot gasses leaking out of the cylinder heads or from round the spark plugs. Whilst the condition of the front plug suggested that this cylinder was running on the lean side, there was no evidence of mechanical damage that would have caused the engine to stop prior to the crash.

c Shoulder harness

The shoulder harness attachment cable was found to have failed at the two points where it passed through the holes in the elevator Teleflex cable mounting bracket. (See Figure 5.) The failed shoulder harness cable and attachment bracket were subjected to further analysis.

Energy dispersive x-ray analysis of the cable material determined that the cable was stainless steel rather than the galvanised carbon steel specified in the design.

Further examination by optical and scanning electron microscope techniques revealed that the cable was in good condition with no evidence that any of the strands in the cable had broken or been subject to fretting prior to the accident. Assessment of the failure of individual strands indicated that the cable had failed in shear. It was concluded that the damage to the cable was consistent with a tensile load having been applied to the cable and the cable failing in shear at the edges of the holes where the cable turned through a tight radius.

It was also observed that, at its forward end, the cable had not been connected to the shoulder straps in accordance with the design drawing. Instead both ends of the cable had been crimped around thimbles and both thimbles had then been connected to both shoulder straps using a single shackle passing through all four apetures. Whilst there was slight distortion to the pin in the shackle, the connection between the two straps remained intact. This deviation from the drawing had not been authorised by a concession issued by the PFA.

Discussion

The reason why the pilot turned to the right after take off in an apparent attempt to return to the airfield could not be definitely determined. There was no evidence to suggest that there was a mechanical problem although it is possible that the looseness of the spark plugs, or a lean running front cylinder, might have resulted in the engine producing less than normal power. However, not only does the pilot not recall having a problem with the engine, but the rate of climb of the aircraft prior to it turning downwind suggests that the engine was operating normally. The circuit he flew was short and the base turn started from a position that would have taken the aircraft over the centre of the airfield. If the pilot had encountered a minor problem or for some other reason wished to return to land on the airfield, it would be expected that he would fly a complete circuit, as he had done on his initial arrival. It therefore seems likely that either he had a major problem and was making a forced landing, or that he was attempting to perform a 'flypast' over the

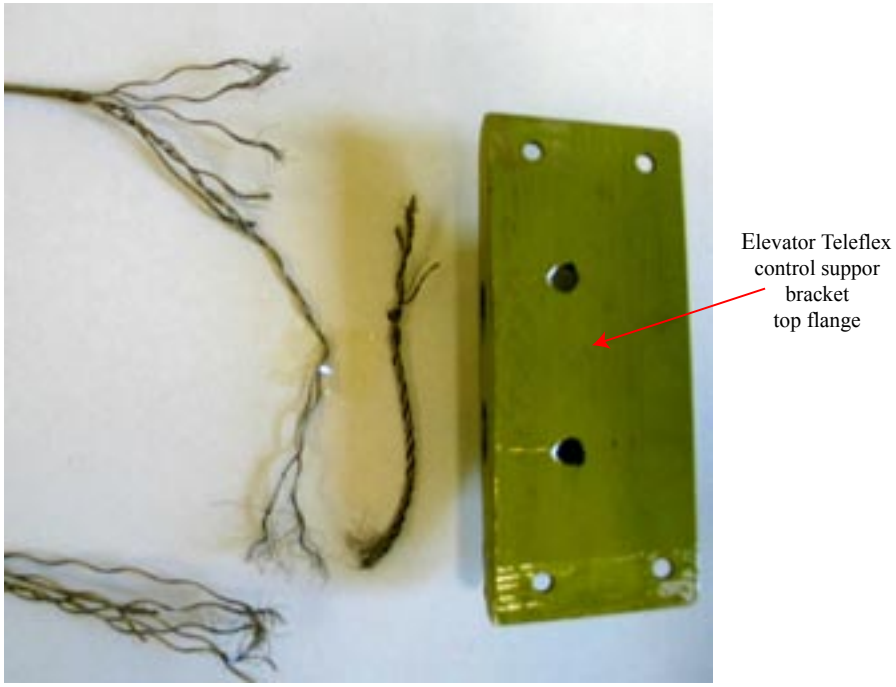

Figure 5

Shoulder harness cable and elevator Teleflex cable mounting bracket

centre of the airfield before departing en-route. The fact that someone who was involved in building the aircraft was out on the airfield watching, and the pilot's own view of his actions, makes an attempted flypast the most probable explanation. The pilot, in discussion, pointed out that because he was unfamiliar with the airfield most of his attention would have been on looking out, rather than looking in at his airspeed indicator.

The evidence suggests that the aircraft stalled during a right turn at the end of the downwind leg. It appears that the left wing dropped, away from the original turn direction, and the aircraft entered a steep nose-down attitude. With very little height available there would have been insufficient time to recover.

There is no reason why a 'flypast' such as this should not have been successful but it was probably carried out 'off the cuff' and thereby lacked a pre-consideration of the environment and any plan to avoid associated problems. The aircraft was flying at a low level with a significant tailwind which would have created an illusion of speed. There is always the risk in such conditions, of flying too slowly and stalling while turning. Without the benefit of a stall warning system, and with the low inertia of a microlight aircraft, an inadvertent stall can occur very quickly. It is possible that the presence of a stall warning system could have prevented this accident.

The PFA confirmed that the design called for a galvanised carbon steel cable rather than the stainless steel cable fitted to this aircraft. Notwithstanding this discrepancy, the damage to the cable indicates that it was a combination of the tensile load and the tight radius through which the cable turned around the holes in the mounting bracket that caused it to fail in shear. It was considered unlikely that the change of material of the harness cable had significantly affected its mode of failure or the load at which it failed. Whilst the method used on this aircraft of securing the shoulder harness to the forward ends of the cable, by a shackle, had a number of advantages over that required by the design, there was no evidence that the owner had either sought a concession, or undertaken any analytical work before selecting the particular shackle used. It is considered, however, that the intent of this deviation from design resulted in the shoulder restraint being more effective by reducing the likelihood of the straps slipping sideways off the pilot's shoulder. The following recommendation is made in order to improve the effectiveness of the safety harness on the Team Himax and Minimax aircraft:

Safety Recommendation 2006-006

It is recommended that the Popular Flying Association reviews the design of the attachments of the shoulder harness and its securing cable in the rear fuselage of Team Himax and Minimax aircraft, to reduce the possibility of the shoulder harnesses slipping off the pilot's shoulders and to ensure that all bends in the restraining cable are of greater than the minimum bend radius recommended by the cable manufacturer and not routed over sharp edges.

Safety action

Following circulation of this Report and Safety Recommendation, in draft form, the PFA has issued an approved modification (MOD/186/009) which introduces an improved fixing of the aft attachment of the harness cables.