AAIB Bulletin No: 12/95 **Ref: EW/C95/8/5** **Category: 1.4**

Aircraft Type and Registration:	Mainair Mercury, G-MYGG
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1992
Date & Time (UTC):	31 August 1995 at 0945 hrs
Location:	4 km north northwest of Sandtoft Airport, Doncaster
Type of Flight:	Private (Training)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - Fatal Passengers - N/A
Nature of Damage:	Severe damage to the trike and the wing
Commander's Licence:	Student Pilot
Commander's Age:	20 years
Commander's Flying Experience:	32 hours (all on type) Last 90 days - 32 hours Last 28 days - 27 hours
Information Source:	AAIB Field Investigation

History of the flight

The student pilot was undertaking a course of intensive flying instruction leading to the grant of a Private Pilot's Licence (PPL) for weightshift control microlight aircraft. The course had commenced on 18 July 1995 at Sandtoft Airport. All of the student's training had been carried out by one instructor, apart from four flights totalling 3.25 hours dual training with a different instructor. The student went on his first solo flight on 8 August 1995 after a total of 9 hours instruction. Four further solo flights totalling 3 hours duration, followed by four dual training flights of 4 hours duration were undertaken on 8 and 9 August. The student then flew on 10 consecutive solo flights totalling 10.5 hours duration between 9 and 11 August.

The aircraft that had been used for most of this training course was a similar type, registration G-MYPV. That aircraft suffered significant damage on landing after a solo training flight while being operated by another pilot sometime after 11 August. Fortunately on that occasion there were no injuries, but the accident was not reported to AAIB even though the aircraft had sustained severe damage. The aircraft was returned to the manufacturer for repairs.

The student pilot returned from holiday and resumed his flight training on 30 August using G-MYGG, which had been borrowed from its owner by the instructor as an interim replacement while G-MYPV was repaired. The student flew a 50 minute dual refresher flight on 30 August, followed by a 2.5 hour solo flight on the same day, practising circuit flying in preparation for taking the General Flying Test for the microlight PPL. The instructor commented that the student's handling of the aircraft was very good, and no significant handling problems were noted that day.

On the morning of 31 August, the student was briefed to undertake another solo flight, during which he was to practice the flight procedures for Forced Landings without Power, and general flying consolidation in the local area. The student took off on his final flight at around 0840 hrs. The area primary radar recording from Claxby was examined in order to determine the route of the aircraft, but only intermittent returns were obtained in the Sandtoft local flying area. The aircraft was equipped with a portable VHF radio, which was tuned to the Sandtoft Radio frequency 130.425 MHz, but no distress transmissions were heard on the frequency.

No eyewitnesses were found who had observed the aircraft's final manoeuvre, but the aircraft had been observed circling at various heights in the vicinity of the accident site a short time beforehand. Another witness observed the aircraft heading west towards the accident location and it was seen to pitch-down sharply to about 45° nose down, then to immediately recover to a nose up pitch attitude of about 10°. The aircraft continued flying westbound and the witness turned away. The witness could not recall any changes of engine sound, but described its sound as "normal". The aircraft's location at that time was some 1 km east of the accident site.

Several people were fishing in the vicinity at the time of the accident and each stated that their attention was drawn to the aircraft by a loud cracking noise. The trike section of the aircraft was seen to fall vertically away from the wing section, which subsequently spiralled and drifted down to the surface some distance away from the trike.

The weather at the time was good. An aftercast from the Meteorological Office indicated that a weak ridge of high pressure was established over the area, with a weak warm front over Cumbria and southern Scotland moving slowly southeastwards. There was no precipitation in the area, the visibility was 20 km and the surface wind was from 300° at 7 kt. The temperature was +16°C and the mean sea level pressure was 1,027 mb. There was scattered cloud with a base between 2,000 and 2,500 feet, with a further broken cloud layer above 3,500 feet. The wind at 2,000 feet was from 330° at 15 kt, with a temperature of +10°C.

The student was wearing a nylon fleece lined coverall flying suit with normal light underwear and with no gloves. Reference to a wind chill chart indicated that for normal flying speeds of the aircraft, with the ambient air temperatures, the wind chill factor would have been in the COLD/VERY COLD category with effective temperatures around -8 to -10°C. The post-mortem did not reveal any medical condition which may have caused incapacitation of the pilot.

Accident Site and Impact Parameters

The microlight had crashed onto a level field of sugar beet. There was no fire. Inspection of the accident site revealed that the wing had separated from the trike unit whilst in flight, allowing the trike to descend almost vertically to the ground from a height estimated as 500 feet. The wing had drifted downwind, coming to rest inverted on the ground some 350 feet distant on a bearing of 184°M from the trike. Also, a slightly deformed fuel 'jerry' can was found, together with a section of torn nylon webbing, on a bearing of 140°M from the trike at a distance of 135 feet. There were no signs that there had been any fuel in the can, but a relatively large area of crop had been damaged by fuel which had splashed from the trike's ruptured main fuel tanks. The extent of this splashed area suggested that the trike had been travelling at low speed in a westerly direction at the time of its impact with the ground. There was evidence from the tips of the three propeller blades and the rear of the wing keel that the engine had been running at about the time the wing detached, but that the engine had stopped by the time the trike reached the ground.

Aircraft Description

This Mercury Microlight was fitted with an Alpha wing. The trike unit had provision for two occupants in tandem, and was powered by a Rotax twin cylinder two stroke engine driving a three bladed pusher propeller mounted behind the crew. Control of the aircraft in flight was accomplished by the movement of the wing relative to the trike, about a longitudinal axis for roll, and a transverse axis for pitch, the wing being pivoted atop a monopole which formed part of the structure of the trike. This monopole was braced to the front of the trike by means of the front strut. The monopole contained a safety cable, but the front strut did not. The wing was a simple tubular aluminium wire braced structure supporting a fabric cover, which was stiffened and profiled by battens. The pilot effected control of the wing by movement of an 'A' frame, which was attached under the wing at its apex and braced by fore, aft and lateral rigging wires, the lower transverse bar of which was positioned ahead of the front seat position such that it could be readily grasped by both hands. To pitch the aircraft up, the bar was pushed forward, to pitch down it was pulled back. Roll control was achieved by lateral movement of the same bar. Forward motion of the bar was limited by contact with the front strut, and rearward motion by contact with the front pilot's chest. In normal flight these limits precluded any possibility of the propeller making contact with the wing.

Wreckage Examination

With the assistance of the manufacturer, the wreckage was examined in the field and later after it had been recovered to the AAIB at Farnborough. This examination revealed that all failures to the microlight's structure and rigging wires had been as a result of overstressing. Three areas of damage were significant, however, in the context of this accident. Firstly, both wingtips outboard of the outer rigging wires, had failed as a result of negative loading (downward bending). Secondly, the horizontal bar of the 'A' frame had made sufficiently hard contact, in a forward direction, with the front strut to cause both items to fail in bending. Thirdly, all three propeller blades had made contact with the rear section of the wing keel and had severed the two aft 'A' frame rigging wires close to their point of attachment with the keel. This evidence is consistent with control of the microlight being lost in pitch, which probably resulted from an excessive nose down attitude inducing negative loading on the wing. In such a situation, the wing may rapidly adopt a nose high attitude relative to the trike during any attempted recovery, the restraint forces required from the pilot being excessively high. If the control bar is not restrained, it is known from previous accidents that sufficient forces are generated to fail the front strut and 'A' frame bar as they come into contact. Once the wing exceeds its normal travel and the front strut and control bar fail, then the wing can pitch-up far enough for the propeller to make contact with the keel. In addition, tension is lost to the flying wires and bending loads are induced into the monopole. The monopole on G-MYGG had failed in rearwards bending, the failure position coinciding with that of the safety cable. The fact that the safety cable had failed suggested that the break-up sequence was rapid and highly dynamic.

Aircraft Documentation and Operational Information

The microlight's documentation was examined and found to be in order. It was being flown under the authority of a Permit to Fly, issued by the CAA on 23 November 1992. The annual Certificate of Validity, required under the terms of the Permit, was valid until 17 November 1995, at which time its next annual inspection by a qualified BMAA inspector was due. It had flown for a total of some 150 hours and 164 flights, at the time of the accident.

The Permit to Fly was subject to certain conditions, which included:

"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 aeroplane", and that **"the aeroplane is permitted to fly only for non-aerobatic operation. Non-aerobatic operation includes:**

(i) any manoeuvre necessary for normal flying

(ii) intentional stalls from level flight

(iii) steep turns in which the angle of bank does not exceed 60 degrees".

The manufacturer's Aircraft Manual for this type contains detailed notes on stall characteristics and stall recognition. It also stresses the importance of avoiding whip stalls and wing overs, and the associated danger of structural failure during these manoeuvres.

Warnings are contained within the Aircraft Manual, as follows:

"Pitch Angle - nose up/down not to exceed 30°. ALL AEROBATIC MANOEUVRES ARE PROHIBITED including: Whip stalls, tail slides, loops, rolls and spins. Angle of bank not to exceed 60°". These warnings, also placarded on the 'A' frame and easily seen by the seated pilot, are supported elsewhere in the manual by the statement **"POSITIVE LOADING MUST BE SUSTAINED AT ALL TIMES"**

The Aircraft Manual further states:

"NOTICE: This flex wing aircraft is certified for non-aerobatic flight only. Maximum bank angle 60°, Maximum pitch angle 30° up or down. No spins, whip stalls, tail slides or wing overs. WARNING: Loss of flight control may result from negative loading which can occur from a steep pitch and/or roll manoeuvres in excess of the above values. It is dangerous to conduct steeply banked reverse turns (figure of 8), wing overs and deep stalls and to fly the aircraft at speeds beyond VNE".

The Aircraft Manual also contains the following information on Power Operation at Light Weight:

"When operating solo, pilots should take care to operate the throttle sensibly. Excessively steep climb outs are unsafe since they lead to nose-high attitudes and engine failure in this situation may result in insufficient time/height to recover. In addition, engine failure at steep climb attitudes may lead to a whip stall or tail slide situation, which can and has resulted in structural failure and break up of the aircraft in flight. The flight limitations of this aircraft must never be exceeded, and pilots are warned that when operating at low cockpit loads the high power available means great care must be taken to ensure the limits are observed."

The references to engine failure are equally applicable to practice exercises where the throttle is closed rapidly to simulate an engine failure.

Rear Seat Ballast

The aircraft manufacturer defines a minimum operating weight (234 kg) to ensure full flight control of the aircraft with only one pilot aboard. It notes that ballast can be added using a loaded Mainair Boss Ballast bag, which is a CAA approved container that straps securely into the rear seat and is securely attached to the airframe. This is the only approved means by which ballast may be carried.

The Aircraft Manual indicates that the Empty Weight of the aircraft was 146 kg. The post-mortem report assessed the pilot's weight as 68 kg. The zero fuel weight was therefore 214 kg. No accurate assessment of the fuel on board at the start of the flight was available. A significant quantity of fuel had splashed around the accident site from the ruptured tanks. With full fuel loaded prior to departure (43 litres/31 kg), approximately 13 litres/10 kg would have been burned off during the elapsed flight time, leaving 21 kg in the aircraft at impact. The operating weight at that time would therefore have been 235 kg, which is only slightly over the minimum specified operating weight for satisfactory flight control.

Around the time of the accident, the Boss bag was not available for use on G-MYGG. The aircraft was equipped with a convertible seat padding system which was able to be converted from dual seating to a solo seat, prior to flight. However, when in the solo position, the pilot is located slightly further aft than in the dual configuration, resulting in a change in the normal control operating posture. It was therefore decided to keep the student in the same forward seat position as he had used for dual training, and to introduce an empty fuel "jerry" can into the rear seat as a back rest, as it was assessed that ballast weights would not be required. The can had also been used for the solo flight during the day before the accident, and it was believed to have been secured with the rear seat lap belt, and a canvas strap through the handle and around the monopole. The instructor indicated that the student had secured the can in position for the previous day's flying, and it had remained in position when the aircraft was hangared overnight.

As the can was found at the accident site to have been separated from the trike unit, and the rear lap harness was found to be unfastened, it could not be determined positively from the wreckage how the can had been secured. No signs of contact between the can and airframe/propeller were found, but the slight deformation to one side of the can had been caused recently, but not by ground impact. It was therefore considered most likely that the can had detached from the microlight at about the time of wing separation and that it had been in the rear seat when this occurred. However, the possibility that the can may have become dislodged and distracted the pilot could not be dismissed. Use of such cans is reportedly commonplace when flying this type of microlight, as they are often used for carriage of additional fuel or to provide ballast, even though they are not officially approved for the purpose.