Mainair Blade 582, G-MZCN

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Aircraft Type and Registration:	Mainair Blade 582, G-MZCN
No & Type of Engines:	1 Rotax 582-2V piston engine
Year of Manufacture:	1996
Date & Time (UTC):	13 January 2001 at 1430 hrs
Location:	Near Enson, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 1
Injuries:	Crew - Fatal - Passengers - Serious
Nature of Damage:	Serious damage
Commander's Licence:	Private Pilot's Licence (Microlight)
Commander's Age:	40 years
Commander's Flying Experience:	68 hours (all on type) Last 90 days - 8 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

History of flight

The pilot had arrived at his home microlight airstrip at Ince for some local flying in his aircraft, G-MZCN. At the airfield, three other pilots were preparing their aircraft for a return flight to Sittles Farm near Lichfield to enable one of them to deliver an aircraft. The pilot of G-MZCN asked if he could accompany them in his aircraft and this was agreed. He marked the route on his map; after departure, the aircraft would clear Liverpool to the east and fly down the Special Low Level Route (between Liverpool and Manchester) to Ashcroft Airstrip before turning onto a south-easterly heading direct to Lichfield; the total distance was about 75 miles. At an estimated airspeed of 60 MPH and with a headwind component, the outbound flight was expected to take approximately 1 hour 30 minutes. The pilot of G-MZCN was heard to comment that he could use one tank of fuel on the outbound flight and the other for the return flight. Then, sometime prior to departure, he invited an acquaintance to come along as his passenger in the rear seat; this passenger was also a qualified PPL (M) holder. Of the four aircraft involved in the flight, two were 3-axis microlight aircraft and two, including G-MZCN, were flexwing microlight aircraft. The other three aircraft had RTF but there was no facility on G-MZCN for radio communication between aircraft or intercom between the two personnel on board.

The pilot of G-MZCN rigged his aircraft and the passenger supported the 'wing' while the pilot attached the 'trike' unit to it. The passenger had flown with the pilot once before and considered him a steady and conscientious individual in whom he had full confidence. He saw the pilot topping up the rear fuel tank; he confirmed that this tank was full of fuel but was not aware of how much fuel was in the underseat tank. The pilot accomplished the engine start and pre-departure checks and the take-off, following the other three aircraft, was normal.

Take-off was at approximately 1250 hrs and the early part of the flight was uneventful with the four aircraft remaining in visual contact, albeit widely spread. However, after they had left the Low Level Route, the pilot of one of the 3-axis microlight aircraft noticed that his fuel pressure gauge was giving erratic indications and he decided to land at Ashcroft airstrip as a precaution; after informing the other radio equipped aircraft, the pilot returned to Ashcroft. On landing, he noted from his Global position System (GPS) that the flight time from Ince had been 1 hour 15 minutes and that it was indicating another 1 hour 15 minutes flight time to Sittles Farm. The display indicated a headwind component of 22 to 25 kt, which was stronger than had been expected by the pilots.

The other three aircraft continued their flight and the passenger of G-MZCN retained intermittent visual contact with the other flexwing aircraft. Then, north of Stafford (some 15 miles short of destination), the passenger was aware of a engine power reduction in G-MZCN and that the pilot was reaching back with his right hand towards the position of the fuel selector lever. There did not seem to be any improvement to the engine power level and the pilot brought his hand back to the control bar. Almost immediately, the pilot banked the aircraft to the left and the passenger assumed that he had made a decision to carry out a forced landing. The passenger was not looking at the aircraft instruments and estimated the aircraft to be banked approximately 40° and with a high rate of descent. Looking ahead, he could see a field in which he assumed the pilot was intending to land. At the far boundary of the field, the passenger saw a fence and he felt that the landing was going to be "heavy". The pilot levelled the wings just before ground contact and the landing was hard. The passenger's next recollection was being underneath the aircraft, unable to move and aware of leaking fuel. However, after a short period, two men arrived at the scene and the passenger was able to crawl clear when the aircraft was raised. He then helped the other men to lift the 'trike' and released the pilot from his harness. Once clear of the aircraft, the passenger put the pilot in the 'recovery position' but could not detect any signs of life.

The pilot of the other flexwing aircraft did not see G-MZCN make a forced landing. However, he confirmed that the two aircraft were flying at a similar height of approximately 1,000 feet agl and at 60 MPH; he did not consider the weather conditions to be particularly cold. The pilot estimated that the headwind component at their height was about 17 kt. He had changed his fuel tank selection after approximately 1 hour 45 minutes flying time, which occurred close to Stafford. When he realised that G-MZCN was not still with him, the pilot retraced his route for a short time but was unable to locate him. He landed at his intended destination at approximately 1450 hrs.

Weather information

An aftercast provided by the Met Office at Bracknell showed a large anticyclone centred over the North Sea with a moderate south-easterly airstream covering the UK. Visibility was excellent with no cloud below 5,000 feet amsl. The surface wind was 080°/8 kt with a temperature of +6° C; at 1,000 feet amsl, the wind was 110°/18 kt with a temperature of +2° C; at 2,000 feet amsl, the wind was 120°/20 kt with a temperature of -1° C. Throughout the day, the surface wind at Liverpool was calm.

Pilot experience

The pilot had commenced his training on 4 April 1999 and passed his general flight test on 8 October 2000. He was issued with his PPL on 20 December 2000. All his flying training and subsequent flying was on flexwing aircraft.

Medical information

There was no evidence of any existing medical condition, which may have contributed to the accident. The pilot had died from a flexion injury to his neck, which had resulted in a dislocation; this injury was not survivable and no first aid measures could have affected the outcome. The pathologist commented that the injuries of the pilot were very similar to those sustained by another pilot who died after an accident involving a Pegasus microlight aircraft, G-MYBR on 21 August 1999. He also considered that the pilot of G-MZCN was well clothed and should not have suffered as a result of the cold.

Accident site

The microlight had touched down beyond the centre of an oblong shaped grass field, but along its shorter axis, on a track of approximately 310°M: the surface wind at the time was light and the field sloped gently down in the direction of travel. There were trees and a barn on the approach to the field in which G-MZCN landed, which precluded full use of the available distance, and a large grass covered field immediately beyond. Witness marks on the surface indicated that the touchdown had been firm but it had not been heavy enough to cause damage to the trike landing gear. The left wheel had made contact with the ground shortly before the right and nose wheels and it was apparent that the nose wheel had been used in an attempt to steer the microlight to the left. However, G-MZCN had continued in a straight line for a short distance before toppling over to the right after which it slid to a halt. The ground marks extended over a distance of approximately 100 ft. The aircraft came to rest some 100 ft from a shallow ditch and hedge, which bordered the field.

Aircraft Information

This microlight was a Mainair Blade 582 flexwing, powered by a two cylinder two stroke engine driving a 4 bladed pusher propeller. It could accommodate two occupants in the faired trike unit in a tandem seating arrangement located immediately ahead of the engine; the rear seat was at a slightly higher level than the front seat. Both seats were equipped with lap strap only restraints for the occupants. G-MZCN was manufactured in July 1996, since when it was estimated (from the pilot's personal log book) that it had flown for some 360 hours, the aircraft log books not having been completed for the year 2000. It had last been examined and test flown for the most recent annual validation of its Permit to Fly on 22 January 2000.

Wreckage examination

The wreckage was examined initially in the field (after it had been righted during the rescue) and later in more detail after recovery to the AAIB. Relatively minor damage was present to the trike and wing, the most significant being bending failures of the wing support pylon and front strut, kingpost, right wing tip and trike keel tube. A failure of the forward right rigging wire to the cross bar of the control 'A' frame had occurred but all such damage was consistent with being occasioned during the accident. It was readily apparent that the propeller had not been rotating during the landing, that the underseat fuel tank was empty and that the rear tank contained some 15 litres of

fuel. The fuel selector valve was found at the OFF position, but a fireman who attended the site shortly after the accident reported that he had turned the valve to this position by rotating it clockwise through some 90°, indicating that it had been found selected to the lower tank position. A spring loaded detent is provided to secure the selector at the desired positions, but it was found to be ineffective in that the leaf spring did not engage properly in the detent. There was no evidence to indicate that this had been damaged in the accident.

Fuel system (see Figure 1)

The fuel capacity of this microlight is 44 litres, of which approximately 43 are useable, and the fuel is contained in two 22 litre translucent plastic tanks, one located beneath the seats and the other at the rear of the trike. These are plumbed through a selector valve, mounted on the right forward side of the engine, which is out of view behind the pilot. The selector valve configuration is such that the OFF position is mid-way between the rear and lower tank positions, which themselves are 180° apart. The fuel line from each tank contains a priming hand pump for use prior to starting the engine on the ground. These pumps, however, are not accessible in flight but an engine operated diaphragm fuel pump is fitted downstream of the fuel selector valve for normal operation. Basic fuel gauging is achieved by a calibrated scale on the translucent rear tank, which is visible from the front (pilot's) seat by leaning out to the right and looking aft. A float driven indicator is incorporated into the filler cap of the underseat tank and this is designed to read zero before the tank runs dry. This latter indicator is judged to be difficult to see from the front seat, particularly with an occupant in the rear seat. Small mirrors may be attached to the wheel spats in order to view the fuel level in this tank through a window in the fabric fairing surrounding the tank. An optional capacitive fuel gauging system is also available from the manufacturer, which provides for indicators on the instrument panel, but neither this system nor mirrors were installed on G-MZCN.

Fuel operating procedures

The customary procedure for managing the fuel in flight is to use the rear tank first so that the rate of consumption may be readily assessed. Additionally, normal operating procedures are for the pilot to ensure that he has sufficient altitude and with a suitable landing area identified before selecting an alternative fuel tank.

Examination of the pilot's flying logbook indicate that the pilot had flown at least one flight where he would have been required to change fuel selection in the air.

Tests

After recovery to the AAIB, a closer examination revealed no evidence of fuel leaks or other damage to the engine or propeller. It was also established that the underseat fuel tank contained approximately 0.5 litre of fuel. As the engine and its support structure had not suffered any significant damage it was decided to run the engine, using the original fuel, in order to establish its basic serviceability and fuel consumption rates at various engine speeds. Initially, a small quantity of fuel was decanted into the underseat tank from the rear tank, and the lines from both tanks were primed using the rubber squeeze bulbs installed in each line. After starting the engine with the fuel selector set to the rear tank, it ran smoothly at a normal temperature and with both ignition systems operating correctly. Following selection of the underseat tank, the engine continued to run but stopped a short time later when the fuel became exhausted. The unusable fuel that remained in the underseat tank was found to be the same, at 0.5 litres, as the quantity found following the accident. (The fuel tanks had not been damaged and it was established that fuel was very unlikely to have

leaked from the underseat tank whilst the trike was resting on its side). After selecting the rear tank, an attempt was immediately made to re-start the engine by using the starter motor but a successful start took in excess of 1.5 min. In flight this time would have been longer, or the engine may not have re-started at all, as a large capacity battery was used in the tests to avoid draining the small on-board battery. Advice from the manufacturer indicated that, should the engine stop in flight, the propeller will not windmill and thus an 'air start' relies entirely on the battery. On this microlight a pull starter is not fitted.

Information supplied by the manufacturer indicated that in order to fly at an indicated speed of 60 mph at an 'average' weight, an engine speed of some 5,200 RPM would be required, but at higher weights and airspeeds an engine speed of nearer 6,000 RPM would be more appropriate. Fuel consumption is known to increase non-linearly with engine speed. Using the original fuel, the engine was run for several periods at speeds ranging from 4,500 to 6,500 RPM, and the fuel consumption rates converted into the time taken to consume a full tank. Based upon this information, single tank endurance was estimated to have been in the region of 1 hour 15 min to 1 hour 35 min; the time taken by G-MZCN between take off and the accident was some 1 hour 40 min.

Airworthiness

The Blade 582 microlight was designed in accordance with the United Kingdom's British Civil Airworthiness Requirements (BCARs) section 'S' and operated under a Permit To Fly issued by the CAA. Relevant extracts from BCARs and comments are detailed below:

1. S 995 (b): 'The portion of the line between the fuel cock and the carburettor must be as short as possible.' As may be seen in Figure 1, this was achieved in the design. However, this requirement naturally places the fuel selector behind the pilot.
2. S 1305: 'The following are the required power-plant instruments: (2): A fuel quantity indicator for each fuel tank, visible by the pilot when strapped in.' In G-MZCN, indication of the fuel quantity in each tank is not within the pilot's normal field of view and therefore is not considered readily visible in flight.
3. S 995 (a): 'There must be a means to allow the pilot to shut off rapidly in flight the fuel to the engine.' With the configuration on the Blade 582, it is not considered that the location of the fuel selector is conducive in allowing a pilot to quickly isolate the fuel supply.
4. S 995 (c): 'Each fuel cock must have either positive stops or effective detents in the ON and OFF positions.' On G-MZCN, the selector valve had positive stops at each tank position but the detent at the centre OFF position was ineffective.
5. S 1307: 'A safety harness must be available to each occupant, capable of restraining the wearer against the forces resulting from the accelerations prescribed for emergency landing conditions.' An appendix to the section includes diagrams showing recommended installation geometry for shoulder harnesses. The Mainair Blade is equipped with lap straps only for both front and rear seat passengers. This is a common arrangement for Mainair aircraft although some other types of flexwing aircraft have shoulder harnesses or diagonal straps for the rear seat passenger. In practical terms, there is a sometimes a requirement for the rear seat occupant to have mobility, for example during dual instruction. In the accident involving G-MZCN, it is possible that forward movement of the rear seat passenger may have been a factor in the injuries sustained by the pilot. A previous accident to a Pegasus microlight aircraft, registration G-MYBR and reported in AAIB Bulletin 1/2000 resulted in similar fatal injuries to the pilot. However, G-MYBR had sustained extensive damage and the passenger, who survived, was wearing his shoulder harness. The pathology report for

that accident included a comment that the movement of the passenger may have been a factor in the pilot's injuries. However, the pilot of G-MBYR had also sustained a severe injury to the front of his neck which may have been caused by striking a branch or part of the aircraft; the fatal flexion injury could have resulted from this impact.

Joint Aviation Requirements - Very Light Aircraft (JAR-VLA) became an alternative code from 26 April 1990. These requirements are very similar to those detailed in BCARs. One addition is that the fuel selector should not pass through an OFF position in order to change a tank selection.

Discussion

The examination of the wreckage both at the accident site and after recovery to the AAIB at Farnborough revealed no evidence of any pre-existing defects within the structure of G-MZCN. Similarly, tests carried out on the engine showed this to run normally, thus establishing that it had been serviceable prior to the accident and that the fuel/oil mixture being used for the flight was correct. Nevertheless, evidence shows that the engine stopped in flight and the pilot subsequently made a forced landing. The pilot had been flying at an altitude which restricted the time available for any remedial action and required him to select a suitable landing area and set up his approach with no delay. The surface wind was calm but the wind at cruising altitude was about 17 kt; this gradient would have caused the pilot difficulty in judgement during his descending turn. However, the resulting landing should have been survivable based on the limited injuries sustained by the passenger and the minimal damage to the passenger compartment. One possibility for the pilot's injuries could have been the involuntary forward movement of the passenger's upper body.
A similar injury also caused the death of another pilot in an accident involving a Pegasus XL-Q, registration G-MYBR, flexwing aircraft on 21 August 1999. The passenger of G-MYBR was wearing a shoulder harness. Nevertheless, the pathologist surmised that forward movement of the passenger could have been a factor in the injuries sustained in that accident. However, the impact was much more severe than the one involving G-MZCN and the pilot of G-MBYR had sustained a severe injury to the front of his neck indicating that he had struck an object. Nevertheless, with the normal seating configuration of flexwing aircraft the provision of an upper body restraint for the passenger would reduce the possibility of forward movement with resultant danger to the pilot. It would be appropriate for the CAA to require that upper body restraint is required in microlight aircraft where the passenger sits close behind but at a slightly higher level than the pilot. In view of the above, the following recommendation is made:

Recommendation No 2001-52: It is recommended that the Civil Aviation Authority require manufacturers of UK registered microlight aircraft to provide upper body restraint to the rear seats of aircraft where forward movement of a passenger could cause injury to the pilot.

The quantity of fuel found in the underseat tank after the accident was established to have been the same as the unusable fuel and thus it was concluded that the reason for the engine failure was fuel exhaustion whilst selected to this tank. Following fuel exhaustion, there would have been insufficient height and therefore time available for a successful restart using the other fuel source. Therefore the pilot made the correct decision in concentrating on his forced landing rather than attempting to regain power. Nevertheless, G-MZCN still had at least 15 litres of fuel available on board when the engine stopped through fuel exhaustion. It is basic airmanship for a pilot to be aware of his fuel consumption and monitor his tank quantity and selection. However, the pilot of G-MZCN had no fuel gauging or low level warning system within his normal field of view. A more experienced pilot would have monitored his flying time more closely and may have used his rear fuel tank first where he could more easily monitor the consumption. On this flight, the pilot was

expecting to use only one tank on his outbound flight and may have been concentrating on following the other aircraft. This may have meant that he was not accurately monitoring his progress and he may not have been aware of the decreased groundspeed; the lack of radio also meant that he was also not aware of any communication between the other three aircraft relating to progress. The manufacturer is now developing a single fuel tank system for the aircraft but the findings of the investigation into this accident have highlighted the potential for inexperienced pilots to mishandle the fuel system with the two-tank system. Despite the training practices recommended by the BMAA with regard to fuel system monitoring, there have been several reports from pilots of this type who have inadvertently run the selected tank dry and had to carry out forced landings. In view of the absence of any form of visual 'reminder' about the fuel state in the normal field of view of the pilot on this occasion, the apparent difficulty of quickly finding and operating the fuel selector and the long period of time required by the engine before restarting following fuel exhaustion of the selected tank, the following recommendation has been made:

Recommendation No 2001-53: It is recommended that the Civil Aviation Authority, as the issuing Authority of the Permit to Fly for microlights in the UK, should review the requirements applicable to the design of fuel systems of the type fitted to the Mainair Blade 582 with the intention of ensuring that, at all times when in flight, information concerning the fuel state is presented to the pilot in an easily assimilated manner and that the operation of a fuel selector, due to its location, does not detract from safe conduct of the flight.