Fairchild M-62A Cornell, G-BVCV, 15 August 1998 at 1533 hrs

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Aircraft Type and Registration:	Fairchild M-62A Cornell, G-BVCV
No & Type of Engines:	1 Ranger Engineering Corp 6-440-C2 piston engine
Year of Manufacture:	1942
Date & Time (UTC):	15 August 1998 at 1533 hrs
Location:	Woburn Abbey, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - 1
Injuries:	Crew - Fatal - Passenger - Serious injury
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	1306 hours (of which 142 hours were on type)
	Last 90 days - 30 hours
	Last 28 days - 10 hours
Information Source:	AAIB Field Investigation

History of the flight

The aircraft and its crew had attended the de Havilland Tiger Moth Club rally at Woburn Abbey and the intention was to return to their home base, which was a farm strip near Winchester. The passenger later recalled that upon his arrival at the farm strip, the pilot had already prepared the aircraft for flight and that four or five empty 'jerrycans' were lying nearby. Although the aircraft had not been cleared to operate on motor fuel, it was the pilot's practice to obtain fuel for his aircraft from a local filling station, but he would top up the tanks with Avgas in the event that he visited an airfield where this was available. The aircraft subsequently departed for an uneventful flight to Woburn Abbey and during the 55 minute flight the engine behaved normally. However, on arrival the aircraft flew a go-around, before landing, during which an eyewitness noted that the engine exhaust produced a brown/grey emission whilst the engine was at full power.

The weather conditions for the return flight were excellent. The estimated meteorological conditions at Woburn were: scattered cloud with a base of 2,500 feet, visibility in excess of 10 km,

and a surface wind of 5 to 7 kt from the north west. These estimates were in close accord with the 1520 hrs automatic terminal information service (ATIS) broadcast from nearby Luton Airport which reported a surface wind of 330û/08 kt, CAVOK and a temperature of +19ûC, although the temperature had earlier been up to 21°C. Runway 01 was in use at Woburn which has a grass surface of approximately 600 metres in length. The airfield is situated in extensive parkland with numerous trees.

Prior to the return flight, the pilot conducted a thorough pre-flight check of both the engine and the airframe. After engine start the aircraft taxied out and was one of a number awaiting take off. During the period at the holding point, which was estimated to be between 5 and 10 minutes, the pilot completed a power check of the engine and magnetos before lining up for take off. As power was applied against the brakes, an aircraft engineer who was standing nearby heard the engine run up normally, but saw a light mist or haze emanating from the engine exhaust. The subsequent take off appeared normal to the crew and the aircraft entered the climb, however at about 150 feet agl they heard the engine begin to misfire and there was a reduction in engine power. Another aircraft engineer, standing close to the threshold of Runway 19, saw the aircraft take off and shortly afterwards heard the engine misfiring. Coincident with this change in engine noise, puffs of dark smoke appeared from the engine exhaust. The pilot immediately initiated a turn to the left with a bank angle estimated to be between 10û and 15û but the aircraft ceased climbing. The ground air radio operator twice asked the pilot if he had a problem and the pilot eventually responded by saying words to the effect of "Standby, I'm busy". With the aircraft now in level flight, but still very low, and with the engine still 'stuttering' the pilot told his passenger that he intended to continue the left turn back to the airfield. However the passenger stated that shortly afterwards the engine stopped and the aircraft entered an abrupt descent.

These various witness accounts were corroborated by video evidence which showed the aircraft take off and climb to a height of approximately 150 feet agl at which stage puffs of dark smoke could be seen coming from the engine exhaust. The aircraft then entered a gentle turn to the left before commencing a slow descent. After turning through approximately 220û, the left wing dropped and the aircraft appeared to enter an incipient spin from a height of less than 100 feet.

As the aircraft struck the ground, the airfield crash alarm was sounded and the police and airfield emergency services responded immediately. When they arrived at the crash site, about 800 metres to the west of the runway, there was no fire although elements of the aircraft structure had been badly disrupted.

Survivability

The pilot and his passenger were wearing leather flying helmets and both had 5-point harnesses, with the pilot in the front seat and the passenger occupying the rear seat. It was the pilot's normal practice to raise his seat to the fully up position for ground operations and take off in order to improve his field of view over the nose of the aircraft. Once airborne he would normally lower the seat to a mid position in order to provide greater protection from wind blast.

The front cockpit was substantially destroyed as a result of the ground impact; the rear cockpit had deformed, but had then sprung back into shape. Neither 5-point harness had failed. Witness marks were noted on both instrument panels and these may have been caused by the heads of the occupants impacting on these panels. A major aspect of the pilot's facial injuries appeared consistent with contact with either the coaming of the instrument panel or the frame of the windshield.

The accident was not considered survivable for the pilot in the front cockpit since this area took the full force of the impact. It was also considered unlikely that the provision of a military style flying helmet would have afforded protection against his facial injury.

Description of the aircraft

The Fairchild M-62A Cornell was developed as a training aircraft for the US Army Air Corps during the Second World War. It was a low wing monoplane with a fabric covered, welded steel tube fuselage, and a plywood covered wooden centre section and outer wing panels. This model had a 2-place tandem seating arrangement with open cockpits and a fixed landing gear which incorporated a steerable tailwheel. It had conventional manual flight controls.

It was powered by a Ranger 6-440-C2 six cylinder, in line, air cooled piston engine driving a two bladed, fixed pitch, wooden propeller. The engine was rated at 175 horsepower at 2,450 RPM, at sea level.

This aircraft was built in 1942 and delivered to the US Army Air Corps. Later that year it was transferred to a Uruguayan military flying school at Montevideo, where it remained for many years after the end of the Second World War in the service of the local aero club. It was eventually bought by the current owner, dismantled and shipped to the United Kingdom in June 1991. Subsequent restoration work included re-skinning of the wings and rebuilding of the fuselage, in addition to engine strip and reassembly. The aircraft, which was the sole example of its type on the UK register, was granted a Certificate of Airworthiness in the Private Category in April 1996. The oil consumption was subsequently found to be excessive and the pistons and rings were therefore renewed in April 1997. This improved the oil consumption, although it still remained high. The pilot and the engineer who carried out much of the maintenance were of the opinion that the engine ran in a 'rich' condition, as a brown/grey emission was often observed from the exhaust when the engine was at full power.

Examination of wreckage

The initial contact with the ground had been made by the left wing tip, with fragments of the navigation light found nearby. A leading edge imprint extended from this point for approximately 7 to 8 metres, with wood and fabric debris being found either side, indicating progressive disintegration of the wing on impact. This was followed by a propeller slash and what appeared to be a left landing gear imprint, and beyond this was a shallow crater made by the engine impact. The aircraft had performed a cartwheeling action before coming to rest in an upright attitude, facing the direction from which it had arrived. The distance between the initial impact and final position was approximately 17 metres.

Following an on-site examination, the wreckage was recovered to AAIB's facility at Farnborough for a more detailed examination.

The witness and video evidence indicated that the aircraft had been experiencing power problems and so the engineering investigation concentrated on the engine and fuel system. There was no evidence that suggested any structural problems and there was no evidence of a pre-impact disconnect of the flying control operating system. The comparative absence of damage to the flaps suggested that they had been retracted at the time of ground impact. Fuel was present in each of the wing fuel tanks, and some spillage had occurred at the accident site. The fuel selectors in the cockpits were found close to the 'right tank' positions, however the interconnecting linkage between the selector knobs and the selector valve had been severely disrupted in the accident. Subsequent disassembly of the selector valve found it selected to the right hand fuel tank. No blockages were present in the fuel lines, and the fuel and air filters were clean.

Fuel samples from the tanks were analysed by the fuel laboratories at DERA Pyestock. The results indicated that the fuel was consistent with motor gasoline (four star petrol). Avgas was not detected in the samples analysed following the accident, although none would have been detected if it had comprised less than approximately 20% of the fuel mix. The volatilty of the fuel, quantified in terms of vapour pressure, was found to be towards the top of the range specified for motor gasoline, which is considerably higher than that specified for Avgas. It is this property which makes motor gasoline more susceptible than Avgas to 'vapour lock', ie fuel starvation due to bubbles of fuel vapour forming in the fuel lines at elevated temperatures.

Note: The use of motor gasoline in aircraft is covered by CAA Airworthiness Notice 98. This permits the use of such fuel in specified aircraft/engine combinations as listed in Schedule 1 of the Notice. The Fairchild Cornell was not included in the Schedule.

Examination of the engine

The engine was examined at an organisation that specialises in engines for vintage aircraft. The ignition timing was checked and both magnetos were found to be retarded 18° before top dead centre (BTDC), compared to the maintenance manual requirement of 22°. Whilst this may have caused a reduction in the power output of the engine, it would not have caused the sudden power loss that occurred prior to the accident. When the magnetos were removed from the engine, it was noted that the left hand magneto was difficult to turn through the mechanical resistance imparted by the impulse mechanism. However the associated coupling (to the accessory gearbox) was in good condition, indicating that the stiffness had presented no problems in operation. Both magnetos subsequently performed satisfactorily on test.

Most of the spark plugs were found to be fairly heavily 'sooted' with carbon, which may have been the result of a long term rich - running condition, or perhaps high oil consumption. The plugs were tested and found to produce satisfactory sparks.

The engine was then disassembled, with no significant defects found in any of the components. Some metallic debris was found in both the pressure and scavenge oil filters although the origin of this was not determined and all the bearings were in good condition, with no evidence of lubrication failure. However the surface finish of the cylinder walls suggested that the honing process had not been conducted in the normal manner, which in turn may have resulted in a higher than normal oil consumption. It was noted that the combustion deposits on the piston crowns and cylinder heads of the rear two cylinders took the form of loose, flakey carbon, with a light coloured deposit on the valves. The nature of these deposits suggested a hot, lean condition for a short period. Whilst it was difficult to explain the difference in appearance between these and the remaining cylinders, it was considered that the rear cylinders may have experienced reduced

cooling during engine operation on the ground. The exhaust valves in cylinder Nos 1 and 2 were not sealing properly in that there was evidence of combustion debris trapped between the valves and seats. However, there was no evidence of the valves 'sticking'.

The carburettor was a Stromberg unit and had survived the impact in good condition. The throttle butterfly was found in the closed, ie idle, power setting. Internally, the carburettor was very clean, and had probably seen little service since its last overhaul. The fuel inlet filter was clear, and the main jet and metering jet were of the correct size. The float chamber was empty of fuel apart from a small amount of yellowish, slightly oily liquid, which was subsequently analysed by the DERA fuel laboratories. The results indicated that it was 'weathered' motor fuel, probably the result of the lighter fractions of a small quantity of fuel evaporating off after the accident. The carburettor was mounted on a test bench which supplied fuel at various pressures to the inlet. It was found that there was a tendency for the float chamber to overfill causing minor flooding at about 2.5 psi, although this would have had little effect on engine operation. Pressures in excess of 10 psi were required to force the float valve open. A small ridge was subsequently found on the conical face of the float valve, which may have accounted for the failure to seal completely.

The engine driven fuel pump was a Chandler Evans unit which, according to its data plate, was capable of delivering 200 US gallons/hr. This type of pump had not been approved by the engine manufacturer and the overhaul manual specified PESCO or ROMEC pumps, rated at 22 gallons/hr. The available documentation indicated that a PESCO pump had been fitted to the engine prior to its rebuild in the UK. It was not established why the owner did not refit this pump, or from where he had obtained the Chandler Evans unit. The engine operating instructions stated that the fuel delivery pressure, as indicated on a cockpit gauge, should be 2.5 to 3.5 psi. Any significant increase over these values would raise the possibility of excessive fuel being delivered to the engine as the result of pressurising the carburettor. Accordingly, the pump was tested in conjunction with the carburettor on a rig constructed by DERA at Pyestock, with the aim of exploring the relationship between pump RPM, delivery pressures and fuel flow. The results indicated that the specified pressures gave realistic fuel flows. In addition, it was found that with the pump running at approximately take-off RPM, the maximum fuel pressure (which occurred with zero fuel flow from the carburettor) was less than 6 psi, which did not cause flooding of the carburettor. These tests also calibrated the surviving fuel pressure gauge from the rear cockpit, with satisfactory results.

Previous engine failure

During the investigation, it became apparent that the aircraft had suffered a similar power loss after take off approximately one year earlier. On that occasion the pilot (not the owner) had previously landed at an airfield and had left the aircraft standing for about 2 1/2 hours on what was described as a 'hot, sunny day'. During the subsequent take off the engine suddenly lost power at around 150 to 200 feet agl, with the RPM reducing from 2,150 to approximately 1,400. The pilot lowered the nose and retarded the throttle to a mid position. The engine then recovered to about 1,800 RPM, which allowed a slow rate of climb. After an estimated 20 seconds, the engine fully recovered so that full power was available. Having circled the airfield for a while, with the engine apparently operating normally, the pilot decided to return to the farm strip near Winchester. The remainder of the flight was uneventful. Subsequent checks failed to establish the cause of the power loss and so vapour lock was suspected. The fuel type (ie Avgas or motor gasoline) being used at the time was not known.

Discussion

The brown-grey smoke trail produced from the exhaust at full throttle conditions contributed to the impression that the engine generally ran in a rich condition. The loss of power after take off on the accident flight was accompanied by puffs of dark smoke from the exhaust. There was thus a supposition that a 'rich cut', ie excessive fuel, may have been responsible for the power loss. In the event, no compelling supporting evidence was found. The sooted condition of the plugs, whilst possibly suggesting a long term rich mixture condition, may equally have been the result of the relatively high oil consumption. The fuel pump, whilst not of a type approved by the engine manufacturer, was found when tested to produce the relatively low fuel delivery pressures required by the engine. Excessive fuel delivery would only occur at fuel pressures in excess of around 10 psi, which did not occur in the RPM range within which the engine operated. A sticking float valve could produce the same result, but such an event seems unlikely given the generally clean condition of the carburettor.

The nature of some of the combustion deposits in the rearmost two cylinders suggested a hot, lean condition over a short period, which could have been the time between engine start and the accident. The use of motor fuel, with its high volatility relative to Avgas, could have increased the vulnerability of the fuel lines to vapour lock, particularly over the length of pipe between the pump and the carburettor, which passed close to the crankcase and was thus exposed to the elevated engine bay temperatures that would be expected to occur on the ground. There was a marked similarity in the engine behaviour which occurred on the accident flight with that which had occurred in the incident a year earlier. On both occasions the aircraft had flown earlier in the day and had then been parked in warm sunshine for a few hours before taking off again, with the loss of power occurring shortly after take off. If vapour lock conditions existed within the fuel system, then bubbles of fuel vapour could have been introduced into the carburettor venturi, resulting in a weak mixture in the engine. These vapour bubbles may have been interspersed with liquid fuel, which could have caused the observed puffs of smoke from the exhaust due to the attendant unstable running conditions.