No: 12/89 **Ref: EW/C1115** **Category: 1c**

Aircraft Type and Registration:	York GA Isaacs Fury 11 Replica, G-BLMU
No & Type of Engines:	1 Lycoming 0-290-3 piston engine
Year of Manufacture:	1984
Date and Time (UTC):	14 June 1989 at 1613 hrs
Location:	Barton Aerodrome, Manchester
Type of Flight:	Private (pleasure)
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Total Flying Experience:	18,000 hours (of which 2½ were on type)
Information Source:	AAIB Field Investigation

HISTORY OF THE FLIGHT

On the day of the accident the owner had flown the aircraft for 35 to 40 minutes before landing back on runway 32 at Barton. A meteorological aftercast indicates that the weather was fine with a surface wind of 310°/08 kt, visibility 20 km plus, cloud 1 okta Cu at 3,500 feet, and temperature plus 20°C.

The owner was about to hangar the aircraft when he was asked by an acquaintance if he could fly the Fury. The acquaintance, (pilot of the accident flight) was very experienced, and had been invited to fly G-BLMU on previous occasions. The owner briefed the pilot and recommended a climb-out speed of 80 kt instead of 70 kt due to the light turbulence that he had experienced on the earlier flight. The fuel state was discussed. The owner looked into the rear tank and saw what he estimated as 5 gallons in that tank. The pilot for this flight then went to the boot of his car and gave the owner a jerry can from which he added 2 to 2.5 galls of 4 star Mogas to the front tank. It was later ascertained that this had been obtained from a vehicle filling station. From the records available it has not been possible to determine, with confidence, the fuel uplift and usage over the 5 flights since the last reported refuelling to full tanks. The owner had changed to Avgas some 3 months earlier because of the difficulty of obtaining

approved Mogas.

The pilot was helped to strap into the aircraft, and he was re-briefed. The engine was started and a full run-up was completed before the aircraft taxied to the threshold of runway 32, and it took off immediately. The aircraft became airborne after a short run and climbed away normally. At a height variously estimated to be 2-400 feet agl, witnesses noted a loss of power and saw the aircraft yaw to the left and enter a steep nose down descent before it crashed into a field on a southerly heading. The aerodrome fire service were quickly on the scene but there was no fire. The pilot was seriously injured and was not able to be interviewed for over a month. When he was interviewed he had a little recollection of the pre-flight preparation, but none of the actual flight.

EXAMINATION OF THE AIRCRAFT

The aircraft had crashed on a heading of 178°(M) in a steep but not extreme nose-down attitude and banked to the left. The port wings had been destroyed and the aircraft had pitched over and cartwheeled and had come to rest inverted about 25 feet beyond its initial impact point with the aft fuselage detached from the cockpit rearwards. The pilot's seat and harness had been released by the break-up of the structure in the area of the cockpit. The upper torso restraint had been attached to a bar across the baggage compartment behind the pilot's head. The bar had bent under harness loads and had been pulled out of its end locations. Thus, though it had failed, it had provided some degree of restraint in the crash.

At impact the aircraft had had significant forward speed and there was no evidence to suggest a stall or spin condition. Examination of the aircraft and ground marks showed that the structure had been intact at impact and all control surfaces were found to be properly attached and connected to the pilot's controls.

The condition of the wooden propeller lacked any indication of power at impact. One blade was still attached with very little damage (and no rotational damage) and the other had broken off in one piece. The investigation, therefore, concentrated on identifying a cause for power failure.

Fuel Starvation (See sketch of fuel system)

The aircraft had two fuel tanks situated between the cockpit and firewall, the forward being an additional modification. The aft tank, with its own fuel cock, fed the front tank. A fuel line from a small sump in the front tank fed the engine driven pump through another fuel cock and a combined strainer and water-drain. No defect was found in the fuel lines. The strainer contained a small amount of debris but this was found to have a negligible effect on flow. The fuel primer was found closed and locked. The tanks lay upside-down after the crash. The filler caps had been dislodged by impact and the front tank had been punctured. Fuel had been seen draining away while the pilot was being rescued. Nevertheless fuel samples were recovered from the lines and both tanks; 2 litres from the aft tank and 0.3 litre from the front tank. However, the fuel level indicator rod attached to the float in the

front tank was found bent, where it passed through the filler cap, at a position which suggested a low level of fuel in that tank at impact. The indicator rod in the aft tank was undamaged.

On the ground, and possibly in the climb, there would be a tendency, with the aft fuel cock open, for the fuel which had been put into the front tank to drain to the aft to equalize levels with the aircraft in a nose-up attitude. Some approximate calculations were carried out on the distribution of fuel between the two tanks. The sump in the front tank, from which the engine was fed, was about 5 ins below the level of the lowest point in the aft tank with the fuselage level. In level flight the amount of unusable fuel would be very small. With the aircraft in its normal nose-up attitude on the ground, with the aft fuel cock open, the unusable fuel would be about 2.6 gallons (imp) (0.4 galls in front and 2.2 galls aft). The unusable fuel amount in the climb is not known. With fuel in the aft tank at the level reported by the owner before the refuelling total contents could well have been almost 7 or 8 gallons. The volume of the jerrycan used for the final refuelling was measured as 4.7 galls. 1 gallon remained in the can after the accident and so up to a maximum 3.7 gallons could have been added in the refuelling though it is not known how much was in the jerrycan before the refuelling.

The fuel pump itself was found to be intact with no mechanical failure or evident deterioration. The carburettor was found to have only a small amount of fuel in the bowl but as it had been semi-inverted for some time it was possible that fuel would have escaped. The entry strainer to the carburettor was intact and clean. No defect or contamination was found in the carburettor.

Vapour Lock

The day was warm, 20°C air temperature, and the sunlight was direct and strong, further heating exposed surfaces. Airworthiness Notice 98 allows the use of MOGAS to BS 4040 in the Isaac's Fury aircraft (with the Lycoming 0-290 as fitted). It is specified for all such listed aircraft that such fuel should be obtained from a suitable airfield source and that the "temperature of the fuel in the tank prior to the commencement of the flight may reasonably be assumed to be less than 20°C". Analysis of the fuel samples showed the fuel in the aircraft to be a mixture of MOGAS and 100LL. The fact that this was the case with the fuel in the aft tank is consistent with the transfer of fuel from the front tank to the rear after the final refuelling. The fuel remaining in the jerrycan was found to conform to BS 4040: 1978 within the limits of the test carried out and had a measured Vapour Pressure approximately twice that of Avgas 100LL which is typically the case with MOGAS.

The fuel system contains no boost pumps and may suffer slight negative operating pressures especially in its tail-down attitude on the ground or in the climb at low fuel levels. During take-off and into the climb at full throttle fuel flow rates will increase with forward speed as the engine speed and air intake flow increase. The increased fuel flow in the lines will lead to more negative pressures upstream of the engine driven pump. Analysis of the small quantities of fuel recovered from the fuel lines indicated that these were an approximately 50/50 mix of Avgas and Mogas. The vapour pressure, and susceptibility to vapour locking of such a mixture would be intermediate between the two fuels.

No direct evidence was found that the fuel system had suffered a "vapour lock" condition.

Mechanical Failure

The engine reciprocating and rotating components, its accessory drives and valve gear were found to be intact.

Ignition Failure

The aircraft was fitted with an electronic tachometer which was electrically driven from either magneto.

A lead had been taken off each input terminal at the magneto switch (off the earthing line from each magneto) and these leads were connected to a three way switch (left ON, OFF, right ON). The central, common terminal was connected to the tachometer which was earthed. An initial continuity and insulation (Meger) check of this system revealed no defects and the tachometer itself had a high resistance but when the left magneto was bench tested with the system wired as in the aircraft it ceased to produce sparks when the tacho selection switch was switched to "LEFT". With the tacho switch switch to "OFF" or "RIGHT" the magneto performed well, producing sparks under simulated load conditions over the full engine operating speed range and it showed no deterioration over 15 minutes of high speed running. At the end of the test its behaviour with the tacho switch at "LEFT" changed; it did continue to generate sparks but they weakened markedly.

The right hand magneto also performed well when subjected to the same testing and was unaffected by operation of the tacho switch.

The tachometer wiring was tested electrically and a short circuit to earth was found with the switch selected LEFT. The tacho switch was disconnected from the magneto switch and re-checked. No short circuit was found. However a short circuit was found in the magneto switch between the terminal to which the tacho switch had been connected and the switch body. While the magneto switch was being partially dismantled two small slivers of metal, probably brass, were found. With these removed and the tacho-switch system wired as before no short circuits could be found and the magneto's operation was unaffected by tacho switch position. No fully adequate explanation could be found for why a possible sporadic short in the magneto switch should be affected by the operation of the tacho switch.

On 17 May 1989 the aircraft had suffered failure of the left hand magneto and the pilot had carried out a precautionary landing. A new coil had been fitted to that magneto. Following the return of the aircraft to Barton airfield it was not flown again until the two flights on the day of the accident.

Summary

Although some evidence was found to suggest the possibility of problems with the fuel level in the front tank, or with the use of MOGAS in warm weather and partial ignition failure, in no case was the evidence complete and sufficient to explain a sudden power loss.

G-BLMU
Fuel System (Schematic).