AIRCRAFT ACCIDENT REPORT 10/88

**Air Accidents Investigation Branch**

Department of Transport

# Report on the accident to Cessna 441, G-MOXY short of runway 26 at Blackbushe Airport on 26 April 1987

*LONDON*

HER MAJESTY'S STATIONERY OFFICE

## List of Aircraft Accidents Reports issued by AAIB in 1988/9

| | | |
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| 2/88 | Boeing Vertol BV 234 LR G-BWFC 2.5 miles east of Sumburgh, Shetland Isles, November 1986. | |
| 3/88 | Bell Model 222 G-META at Lippitts Hill, Loughton, Essex, May 1987 | August 1988 |
| 4/88 | Cessna F 172M 00-JEL in the sea, 3 miles east-north-east of Ryde, Isle of Wight, April 1987 | August 1988 |
| 5/88 | Sikorsky S-76A helicopter G-BHYB near Fulmar A Oil Platform in the North Sea, December 1987 | December 1988 |
| 6/88 | Hughes 369HS, G-GASB at South Heighton near Newhaven, Sussex, August 1987 | November 1988 |
| 7/88 | Fokker F27 Friendship G-BMAU 2nm West of East Midlands Airport, January 1987 | |
| 8/88 | Boeing 737 G-BGJL at Manchester International Airport, August 1985 | |
| 9/88 | Aerospatiale AS 332L Super Puma G-BKZH 35 nm east-north-east of Unst, Shetland Isles, May 1987 | |
| 10/88 | Cessna 441 G-MOXY at Blackbushe Airport, April 1987 | |

**Department of Transport**
**Air Accidents Investigation Branch**
**Royal Aerospace Establishment**
**Farnborough**
**Hants GU14 6TD**

30 December 1988

*The Right Honourable Paul Channon*
*Secretary of State for Transport*

Sir,

I have the honour to submit the report by Mr M M Charles, an Inspector of Accidents, on the circumstances of the accident to Cessna 441, G-MOXY, which occurred short of runway 26 at Blackbushe Airport on 26 April 1987.

I have the honour to be
Sir
Your obedient servant

D A COOPER
*Chief Inspector of Accidents*

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**Air Accidents Investigation Branch**

Aircraft Accident Report No 10/88
(EW/C1011)

| | |
|---|---|
| Registered Owner: | Moxy Dump Trucks (UK) Ltd |
| Operator: | Brown Air Services Ltd |
| Aircraft: Type: | Cessna Conquest |
| Model: | 441 |
| Nationality: | British |
| Registration: | G-MOXY |
| Place of Accident: | Blackbushe Airport |
| Latitude: | 51° 19'N |
| Longitude: | 000° 49'W |
| Date and Time: | 26 April 1987 at 1145 hrs<br>All times in this report are UTC |

## Synopsis


The accident was notified on 26 April 1987 and the investigation commenced that afternoon. The AAIB team comprised Mr M M Charles (Investigator in Charge), Mr D J W Mearns (Operations) and Mr C A Protheroe (Engineering).

The accident occurred at Blackbushe airfield following a go-around from an approach to land on runway 26. The aircraft appeared to begin the go-around normally but was then seen to bank to the left and start turning left. The turn continued through 135° of heading, at a low height, with the bank angle increasing progressively, until the aircraft crashed into trees, semi-inverted, approximately 550 metres from the runway 26 threshold. The reason for the initiation of the go-around was an unsafe main landing gear indication caused by a defective microswitch. The reason for the subsequent loss of control could not be determined.

The effectiveness of the investigation was considerably reduced by the lack of flight recorders. There was no evidence of pilot incapacitation. Extensive examination of the wreckage revealed no flap or flying control malfunction, neither was there any evidence of failure of either engine or propeller control mechanism. The curved flight path of the aircraft from go-around to impact and progressive increase in bank angle suggest that an asymmetric thrust condition was most probable.

# 1. Factual Information

## 1.1 History of the Flight

Two days before the accident flight the Brown Air Operations Manager asked the pilot to fly to Blackbushe early on Sunday 26 April to pick up some friends of the owner. The pilot spent part of Saturday morning at the airport carrying out his pre-flight preparations but later that evening the flight was cancelled. At about 1000 hrs on the Sunday morning the Operations Manager rang the pilot to say that the flight was now required. The aircraft departed from Leeds Bradford Airport at 1100 hrs .

No difficulties were reported during the flight south and, on his first call to the Blackbushe Aerodrome Flight Information Service Officer (AFISO), the pilot reported his position as over Reading and requested the Blackbushe weather and joining instructions. He further requested permission to join the circuit overhead as he was unfamiliar with the airfield. The aircraft was cleared to join overhead at 1500 feet and let down on the dead side to 1000 feet for a left hand circuit and landing on runway 26.

The aircraft was seen to join the circuit by the AFISO and eye witnesses in the area, who watched it flying a very wide circuit pattern. The AFISO acknowledged the pilot's call of "base leg runway 26", with "check undercarriage down and locked, report finals" to which the pilot replied "three greens". The next report from the pilot was "finals runway 26" shortly after which the AFISO gave his standard call of "cockpit checks complete, undercarriage down and locked, land at your discretion runway 26", and he passed the surface wind velocity which the pilot acknowledged.

An eye witness about 700 metres from the runway threshold and 200 metres north of the centreline watched the aircraft make its final approach. He noticed the main landing gear lower to what appeared to be a 3/4 down position and then immediately retract, while the aircraft continued down the approach path towards the runway. Most witnesses thought that the aircraft appeared to be flying at a normal approach speed although one person considered that it was slow.

On short finals at an estimated height of 100 feet the pilot reported that he had a problem and that he would carry out a go-around. One eye witness reported that the aircraft yawed to the left momentarily at the start of the go-around. Many eye witnesses reported that, as soon as the aircraft's nose was raised for the go-around, a bank angle of at least 60° to the left developed progressively and the aircraft began a turn to the left. The bank angle increased and the turn tightened taking the aircraft across the A30 road with witnesses reporting that the engines were "revving loudly". At some stage during this turn the pilot made his final transmission "I'm sorry, I'm going in" or similar words. After the aircraft had

Table 1
Trim potentiometer settings

| POTENTIOMETER | LEFT UNIT VOLTAGE ACTUAL | RIGHT UNIT VOLTAGE ACTUAL | VOLTAGE NOMINAL |
|---|---|---|---|
| idle speed | -1.57 | -1.59 | -1.53 |
| flight idle | -1.45 | -1.84 | -1.6 |
| max speed | 0.01 | 0.01 | zero +/-0.1 |
| max power | 0.19 | 0.30 | 0.35 |

It is notable that the two trim potentiometers on the computer which have the greatest effect on power, *ie* 'flight idle' and 'max power', were set low on the left computer compared with the right; the settings of these potentiometers affect the whole of the fuel schedules.

The flight idle schedule, *ie* the voltage measured at the flight idle tap on the power lever potentiometer, was significantly down on the left computer compared with the right, which was only fractionally down on the limit values (Table 2). These deviations clearly resulted from one or more fixed offsets, and followed the trends indicated by the flight idle trim pot adjustments.

Table 2
Power lever schedule - flight idle tap

| TEST REF 3.6.2. -- | LEFT VOLTS | LEFT % ERROR | RIGHT VOLTS | RIGHT % ERROR |
|---|---|---|---|---|
| 9.7 | -1.431 | -22% | -1.89 | -1% |
| 9.8 | -1.522 | -20% | -1.91 | -1% |
| 9.9 | -1.55 | -20% | -1.943 | -1% |
| 9.10 | -1.419 | -22% | -1.807 | -1% |
| 9.11 | -1.386 | -22% | -1.774 | -1% |
| 9.12 | -1.545 | -20% | -1.932 | in limits |
| 9.13 | -1.577 | -19% | -1.964 | in limits |
| 9.15 | -1.376 | -22% | -1.766 | in limits |

In contrast to the flight idle schedule, the take off schedule, which controls the voltages at the max power tap on the power lever, was within limits throughout the range on both computers (Table 3).

Table 3
Power lever schedule - max power (take-off) tap

| TEST REF 3.6.2. -- | LEFT VOLTS | LEFT % ERROR | RIGHT VOLTS | RIGHT % ERROR |
|---|---|---|---|---|
| 9.7 | -3.222 | in limits | -3.233 | in limits |
| 9.8 | -3.566 | in limits | -3.579 | in limits |
| 9.9 | -3.693 | in limits | -3.707 | in limits |
| 9.10 | -3.180 | in limits | -3.192 | in limits |
| 9.11 | -3.054 | in limits | -3.065 | in limits |
| 9.12 | -3.653 | in limits | -3.660 | in limits |
| 9.13 | -3.779 | in limits | -3.788 | in limits |
| 9.15 | -3.014 | in limits | -3.034 | in limits |

It is significant that, unlike the flight idle schedule, the take off schedule is not influenced directly by any of the trim potentiometers. The fact that both take off schedules were within limits also indicates that both the left and right TT2 conditioner circuits were operating correctly, since these circuits control the voltage at the take off (max power) tap on the power lever potentiometers, and therefore influence the take off schedule.

The errors evident in the If parameters measured during the test of the torque loop (Kt) circuit reflect the adjustment states of the 'max power' trim potentiometer settings (Table 4).

Table 4
Torque loop, kt

| TEST REF 3.6.2. -- | FUEL FLOW PARAMETER | LEFT VALUE | LEFT % ERROR | RIGHT VALUE | RIGHT % ERROR |
|---|---|---|---|---|---|
| 11.6 | If (mV) | 9.8 | -60% | 21.6 | -13% |
| 11.8 | If (mV) | 39.88 | -25% | 48.81 | -9% |
| 11.12 | If (mV) | 0.0 | -100% | 25.93 | -6% |

## 1.6 Aircraft information

### *1.6.1 Leading particulars*

| | |
|---|---|
| Manufacturer: | Cessna Aircraft Corporation, Wichita, Kansas, USA |
| Type: | Cessna 441 Conquest II |
| Constructor's number: | 441-0154 |
| Date of manufacture: | 1979 |
| Engine Manufacturer: | Garrett Turbine Engine Co., Phoenix, Arizona, USA |
| Engine type (2): | TPE 331-8-402S |
| Propeller manufacturer: | Hartzell Propeller Inc. Piqua, Ohio, USA |
| Propeller type: | left: Hartzell HC 53 TN 5M (3 blade, reversible, feathering)<br>right: Hartzell HC 53 TN 5E (3 blade, reversible, feathering) |
| Certificate of Airworthiness: | Issued in the Transport Category (Passenger) at 4644:56 hours total time on 16 September 1986 valid until 5 August 1987 |
| Certificate of Registration: | Issued on 20 September 1983, in the name of Moxy Dump Trucks Ltd. |
| Total airframe time since new: | 5135 hours |

| | | | |
|---|---|---|---|
| Total engine times: | left: | since new: | 4319 hours total |
| | | since overhaul: | 2186 hours |
| | right: | since new: | 4661 hours total |
| | | since overhaul: | 2052 hours |

| | |
|---|---|
| Maximum weight authorised for take-off: | 9850 lb (4468 kg) |
| Maximum weight authorised for landing: | 9360 lb (4246 kg) |
| Estimated weight at the time of the accident: | 8760 lb (3974 kg) |
| Centre of gravity (cg) limits at accident weight: | 178.07 inches aft of datum (AOD) to 171.31 inches AOD |
| Estimated cg at time of accident: | 174.14 inches AOD |
| Approach speed: | 99 kt IAS |
| Air Minimum Control Speed (Vmca): | 91 kt IAS |

### 1.6.2 *Description of engine control systems*

The Garrett TPE 331 series engines are fixed shaft turboprop engines driving the propeller via a reduction gearbox mounted integrally with the front section of the engine. They are designed to operate at, or close to, 100% RPM throughout the flight regime. The dash 8 series engines fitted to the Cessna 441 are controlled by an electronic (analogue) fuel control computer which processes the pilot's inputs, engine speed, temperature, compressor delivery pressure and torque data, and provides appropriate signals to drive control valves in the mechanical fuel control unit and the propeller governor.

Propeller (and hence engine) speeds are set by the condition (speed) levers in the cockpit. When operating in normal (computer) mode, two principal condition lever settings are used in flight: max RPM (100% nominal) for take off and landing, and a 96% setting for reduced noise in the cruise. Settings between these speeds are also possible, but a baulk is provided behind the cruise position to prevent inadvertent movement of the lever into the ground regime. If the condition lever is moved behind the baulk into the 'start & taxi' detent, the propeller speed is reduced to approximately 65% to permit quieter operation for start-up and taxi. Further rearward movement of the condition lever, behind the taxi detent, closes the fuel emergency shut-off valve and selects the propeller pitch to 'feather'.

The pilot's power levers move freely between the maximum power position and the flight idle stop providing electrical fuel-demand signals to the fuel computers, which control the amount of fuel being delivered to the engines and hence the thrust produced. Movement of the power levers into the ground (beta) range, *ie* aft of the flight idle stop, is prevented by a baulk.

Whereas in the flight regime the propeller control system acts as an engine governor, when the power lever is moved back behind the baulk into the beta range the normal propeller governing functions are suspended. Instead, control over propeller pitch is passed to the power lever which, instead of acting as a power scheduling device, functions directly as a propeller pitch controller, enabling the blades to be moved beyond the normal low pitch stop right through into reverse as the power lever is brought back to the fully aft position. During operation in the beta range, engine power is controlled by the 'underspeed governor' - a computer function which controls fuel flow to maintain the engine RPM at a value appropriate to the condition lever setting, thus preventing engine stagnation as propeller loads change.

At engine speeds above 80% the computer modifies the EGT signal, introducing 'correction' offsets to give a "single red line" pseudo EGT output of 400°C, and provides torque and temperature limiting to impose a *flat rate* on the engine of 635 SHP.

Although the computer system operates in tandem with the mechanical part of the fuel control system, it actually exercises considerable authority over the amount of fuel which the engine receives. For this reason, each computer has a self-monitoring function designed to identify hazardous fault conditions and trip the computer off line, causing the system to revert to manual mode operation.

Each engine can operate entirely in manual mode using a simplified mechanical control system which forms an integral part of the mechanical fuel control unit. Propeller speed control in manual mode is set to a fixed datum of 100% RPM regardless of the condition lever position, achieved by means of a conventional fly-weight propeller governing system. During manual mode operation the single-red-line EGT compensation system is disabled and all limiter functions are suspended, removing the imposed flat rating and allowing the engine to operate (potentially) up to its maximum power of approximately 900 SHP.

A propeller synchrophaser system, engaged by means of a separate switch on the instrument panel, provides control signals to the fuel computers to adjust the propeller speed of the left (slave) propeller to match the RPM of the right (master) propeller, and to maintain a fixed phase relationship between the propellers. The flight manual advises against the use of the synchrophaser during take off or landing, and the system is automatically de-activated whenever the undercarriage is selected down. Early aircraft (including G-MOXY) have an in-built delay of approximately 15 seconds following synchrophaser activation before the system is given full authority. This is intended to minimise power oscillations as the system attempts to capture and control the phase relationship.

On aircraft fitted with later versions of the computer, the synchrophaser's authority over the fuel control function was removed in order to reduce a tendency for an unstable interaction to set in between the limiter circuits and the fuel control loop in the computer, and the synchrophaser delay was removed. These improvements were also available as a modification, covered by service news letter SNL 85-7, but this modification had not been carried out on G-MOXY.

### *1.6.3 Significant maintenance history*

Appendix 2 details significant items from the technical records of the aircraft. It can be seen that, particularly in the early life of the aircraft, there were a number of instances of engine control instabilities producing power surges, albeit involving engines and components different from those fitted at the time of the accident. In May 1986, approximately 1000 hours prior to the accident, the records note that the left landing gear down lock microswitch was defective and was rectified.

## 1.7 Meteorological information

The Blackbushe AFISO made the following weather observation immediately after the accident:

| | |
|---|---|
| Sky clear | |
| Wind velocity: | 320° /6-8 knots |
| Visibility: | 20 km |
| Surface temperature: | +19° C |
| QFE/QNH: | 1008/1020 mb |

Two eye witnesses near Blackbushe reported unusual wind conditions described as mini whirlwinds or dust devils. The first example was from a stallholder at the nearby market who reported that a sudden intense wind had blown his stall over. The second event was observed by a family walking on Yately Common near the approach path to runway 26. They reported that, some 15 minutes before the accident, they had observed a mini whirlwind for some minutes throwing leaves about 20 feet up into the air and moving backwards and forwards at an angle to the runway.

## 1.8 Aids to navigation

Not relevant

## 1.9 Communications

The pilot contacted Blackbushe on 122.3 MHz when the aircraft was overhead Reading and remained on that frequency which was not recorded.

## 1.10 Aerodrome information

The airfield was operated under an Aerodrome Licence (Ordinary) by Blackbushe Airport (85) Ltd. At the time of the accident runway 26 was in use and a landing distance of 1157 metres was available.

The aircraft crashed in a wooded area to the south of the airfield and could not be seen from the nearby A 30 road. The Category 2 Airfield Rescue and Fire Fighting Service immediately deployed their appliances and, after searching for some time, located the aircraft.

## 1.11 Flight recorders

The aircraft was not required to be fitted with either a flight data recorder or a cockpit voice recorder and neither was fitted.

## 1.12 Wreckage and impact information

### *1.12.1 Wreckage examination on site*

The aircraft had cut a swath into a dense wood of immature trees south of the A 30 road running east/west along the southern airfield boundary. The whole wreckage was contained within an area of 45 metres in length by 15 metres wide. The impact point was approximately 550 metres south of the extended centreline of runway 26. By matching impact marks on trees and the ground with damage to the aircraft it was determined that, on initial impact with the trees, the aircraft was banked steeply to the left, slightly beyond the vertical, and was descending at an angle of about 30°. Its track was approximately 125° magnetic, 135° left of the runway heading.

The aircraft had continued to descend without any significant change of attitude or flightpath until the left outer wing struck the ground and the engine hit the base of a group of saplings. These heavy impacts had disrupted the outer left wing, releasing all of the fuel from the wing tank, and caused the aircraft to cartwheel to the left, bringing the nose and cockpit into heavy contact with the ground. The complete tail section broke away from the fuselage at that time due to inertial overload. The continued yawing motion then caused the right wing and engine to impact the ground, rupturing the fuel tanks in the right wing, before the aircraft came to rest some 40 metres from the initial ground impact point, facing back in the direction from which it had come. There was no direct evidence of the aircraft's speed but from the impact parameters it was estimated to be between 70 kt and 90 kt at the time of contact with the trees.

The greater part of the main wreckage was formed by the passenger cabin and the right inner wing, which survived the impact largely intact. Also relatively intact, but partially separated from the fuselage, were the right engine, the right outer wing and the extreme rear fuselage and empennage. The rest of the main wreckage comprised the remnants of the cockpit and the left inner wing, to which the left engine was attached by wires, pipes and control cables. The whole of the aircraft was found within the main wreckage zone. All fractures in the structure were caused by overload consistent with the impact and the evidence indicated that the aircraft was complete and structurally intact at the time it entered the trees.

The cockpit had broken partially away from the fuselage and remained attached by the remaining floor structure, control cables and electrical looms. There was good evidence that the pilot's seat and rails were securely attached to the floor at the time of impact and that the seat slider locks were effectively engaged in the rails. The cockpit floor and seat rails had been disrupted and released the pilot's seat with the pilot still strapped securely to it. The co-pilot's seat had suffered slight damage. All of the passenger seats were intact and undamaged.

There was a considerable amount of debris in the cabin and some small items were found in the remains of the cockpit, however, all the debris comprised material which would normally have been present in an aircraft of this type, *eg.* catering materials and manuals. There was no evidence that any of the controls had become obstructed by loose articles.

*1.12.2* *Detailed examination of wreckage*

*1.12.2.1* *Flying controls and trims*

The primary flying controls had been extensively disrupted but there were no indications of obstruction or abnormality in any of the systems and all damage was consistent with the impact. Witness marks found on the control column assembly indicated a control wheel deflection of approximately 125° to the right of neutral and, although less conclusive, that a large up-elevator input was being held at impact. The rudder pedal positions at impact could not be determined.

All trim systems had suffered extensive impact damage but microscopic examination of the cockpit mechanisms provided the following impact positions:

Pitch trim: slightly forward (nose down) of neutral

Aileron trim: neutral

Rudder trim: approximately 2 mm right of neutral on the cockpit indicator

*1.12.2.2* *Flaps*

The flap drive system was badly disrupted on the left side and both flap surfaces had separated from the wing. The right flap surfaces were partially attached and the drive system was largely intact. All failures were caused by overload consistent with the known impact conditions and no evidence was found of pre-impact disconnection, jamming, or failure which could have resulted in an asymmetric condition.

The flap selector in the cockpit was found in the first detent but had been damaged during the impact and would have tended to move into that detent if disturbed from a lower flap setting position. The flap indicator had been broken but microscopic examination of the indicator bezel revealed an impact bruise near the full flap position. No evidence was found of any leakage or malfunction of the hydraulic system. The hydraulic pressure caption on the annunciator panel was illuminated at impact, indicating that the manifold was pressurised at that time and that the flaps were at an intermediate (in transit) position. Impact bruising of the flap tracks and the position of the actuating cylinder confirmed that the flap was near the fully deployed position at impact.

1.12.2.3 *Autoflight and electrical pitch trim*

The autoflight and electrical pitch trim systems were damaged to an extent which precluded any possibility of testing the control electronics. The actuators were also damaged but the break-out clutches fitted, which should allow the pilot to override a runaway, suffered little damage. All clutches operated effectively once they had been exercised, giving break-out torque values which were consistent and similar in each direction, but which were up to three times the limit values quoted by Cessna. The initial values, after a prolonged period of inactivity, were particularly high and in some cases six times the quoted limit.

1.12.2.4 *Landing gear*

All landing gears were fully retracted at impact. `No evidence of any pre-impact defect or malfunction was found affecting the hydromechanical systems, but the green indicator lamp contacts in the left main landing gear downlock microswitch failed to close when the switch was compressed. This defect, which would have prevented illumination of the appropriate "landing gear locked down" light, was not associated with impact damage. The upper part of the switch body, including the wires emerging from the top of the switch and a tie-wrap securing the wires to the switch casing, had at some time in the past been covered with a layer of epoxy adhesive which had begun to peel away at the edges.

The emergency actuation handle was bent whilst in its stowed (normal) position suggesting that no attempt had been made to use the emergency lowering system.

1.12.2.5 *Propellers, propeller governors and pitch control units*

The propellers were of different types, but were functionally identical, and were both certified for use on Cessna 441 aircraft. The left propeller blades had struck and severed several tree limbs, indicating that the propeller was under some degree of power at impact. Only one blade strike was found from the right propeller, but the nature of the impact provided little potential for blade contact to occur. Both propellers exhibited generalised twisting and bending of the blades which reflected the passage through the tree canopies and the subsequent impact in soft ground, without allowing any reliable quantitative assessment of power level to be made. However, the damage to each propeller was similar, suggesting that the power being delivered by each engine during the impact was broadly symmetrical.

Both propeller pitch change mechanisms were extensively broken, but there was no evidence of any pre-impact abnormality. The pitch settings were subject to disturbance during the initial tree contact and no reliable evidence of their pre-impact settings was found.

The right hand governor unit comprised a dash 5 governor fitted with a dash 7 actuator, whereas the left unit was a dash 4 governor with an actuator of unknown type (data plate knocked off during the accident). The manufacturer stated that the dash 5 governor is a dash 4 modified to increase the oil relief valve setting in order to cure a tendency for some dash 4 governors to hunt slightly. The dash 5 is considered interchangeable with the dash 4 and it is permitted to have mixed types on an aircraft. The left unit performed satisfactorily when subjected to the full functional tests identical to those carried out on newly manufactured units. The right unit performed within specification except for some slight hunting which was insufficient to have produced any significant symptoms in the air.

### *1.12.2.6 Engines*

Neither engine displayed any external evidence of abnormality except for damage directly attributable to the impact which had disrupted the transmissions and detached the accessories and fuel control units. The strip examination of the engines revealed evidence of long standing blade leading edge erosion and light tip rubbing of the turbine wheels which was typical of that found in serviceable engines of similar age and which would not have affected performance significantly. Impact induced rubbing was found on the compressor and turbine sections of both engines. The combustion chambers, crossover ducts and transition liners from each engine were all in good condition.

Both engine compressor sections exhibited signs of having ingested tree debris. Large quantities of burnt and semi-burnt fibrous ingestion material were found on the forward faces of the combustor nozzles and very large volumes of char debris were present in the combustion sections proper. The left engine had ingested more than the right. The evidence clearly indicates that both engines were running when the aircraft crashed.

Both transmissions were extensively broken by the impact. The torque shafting of both transmissions had failed in shear. The torque meter gears on both engines had jumped out of engagement and had 're-indexed' relative to the mating gear, indicating that each had been subject to a sudden torque peak typical of those resulting from heavy propeller strikes. The right engine fuel control drive gear and starter-generator quill shaft had both sheared in a manner consistent with sudden engine stoppage during the impact.

There was no evidence of pre-impact failure, malfunction or abnormality which could have affected significantly the performance of either engine. All damage indicated that both engines were serviceable and producing some degree of power prior to impact. However, the ingestion of vegetation and the consequent potential for engine run-down before the occurrence of significant impacts prevented any accurate assessment being made of the degree of power being developed when the aircraft first entered the trees.

*1.12.2.7* *Fuel computers and transducers*

Both engine fuel control computers were recovered undamaged from their mountings below the cabin floor and the synchrophaser control box was also recovered intact except for superficial damage to one of the mounting flanges. The cable looms were cut approximately 300 cm from the connectors allowing these units to be removed from the airframe without disturbing the connectors. The detailed results of the examination of the fuel computers are contained in Appendix 3. In summary, both units were operational and the essential characteristics of each were similar. The left computer trim potentiometers had been adjusted to give slightly higher fuel flow demands when compared with the right computer, but with both computers demanding more fuel than that nominally required.

*1.12.2.8* *Mechanical fuel controls*

Both mechanical fuel controls were knocked off their mounts during the impact, damaging the fuel pump casings on each unit. Examination of an orthogonal set of X-ray photographs of each fuel control unit, taken before the units were disturbed, revealed no evidence of obstructed flapper valves, orifices or of any other abnormality. It was not possible to establish the positions of every solenoid valve because of obstruction of the X-ray paths by other components within the units.

The fuel pumps were replaced with serviceable units to permit the fuel control units to be mounted on a rig for testing. The results of the tests and subsequent strip examination of the units is contained in Appendix 4. In summary, the overall operation of each unit was typical of 'serviceable' units received for overhaul and, although two unusual test points affecting the left unit were noted, there was no evidence that either unit had malfunctioned.

#### 1.12.2.9 *Electrical system*

The impact caused extensive damage to the nose of the aircraft, in which much of the electrical equipment was located. Both batteries were crushed and embedded in the remains of the nose section but, some time later it was found that they had retained a considerable residual charge. The circuit breaker panels had been subjected to extensive mechanical damage during impact and no reliable data could be obtained from them.

#### 1.12.2.10 *Fuel system*

There was evidence that a large quantity of fuel was present in each wing tank at the time of the accident. At impact both firewall shut-off valves were open and both cross-feed valves were closed. The engine mounted fuel pumps on each engine exhibited evidence of rotation at impact. All fragments of the vent valves were recovered. No evidence of any defect was found and both of the valve seals were in good condition.

#### 1.12.2.11 *Fire extinguisher system*

Both engine fire extinguisher bottles were fully charged.

#### 1.12.2.12 *Cockpit examination*

The right engine power lever was bent behind the left, consistent with the left lever being forward of the right at the time of ground impact (the tree impacts would have provided some potential for disturbance of the linkage), and the right lever was bruised adjacent to the flight idle stop. The left lever flight idle stop was extremely worn on one side and the sliding part of the lever which abuts the stop showed matching wear on the baulk stop, thereby reducing the effective engagement of the stop. Because the lever was bent, the precise geometry of engagement and the effectiveness of the baulk could not be checked.

All cockpit switches of potential significance, including those controlling the fuel computers, synchrophaser, and torque and exhaust gas temperature (EGT) limiters were damaged and their pre-impact positions could not be established. All instruments were damaged during the cockpit impact. The tree impacts, which occurred early in the sequence, had the potential to affect many of the transducers feeding the instruments and produce spurious readings. Only the engine instruments yielded evidence of value and these are summarised below:

| INSTRUMENT | LEFT | RIGHT |
|---|---|---|
| Torque | - | 300 ft.lb. |
| Fuel Flow | 175 lb/hr | 175 lb/hr |
| RPM | 105% | 105% |
| EGT | 200°-300° C | 300°C |

All the indicator bulbs were examined microscopically for indications of incandescence at impact. None of the bulb filaments was clearly deformed in a classical hot stretch condition, but those displaying reasonably clear evidence of ductile deformation were assessed as 'ON' at impact. Others which showed more doubtful evidence of ductility were assessed as 'probably ON', and the remainder were considered to be 'OFF'. The result of the bulb filament analysis showing only those assessed as ON or probably ON (ON?) is below:

ANNUNCIATOR PANEL BULBS

| CAPTION | LEFT | | RIGHT | |
|---|---|---|---|---|
| | Bulb 1 | Bulb 2 | Bulb 1 | Bulb 2 |
| F Computer | ON | ON | off | ON(?) |
| Hyd Press on | ON | ON | - | - |
| Hyd Flow | ON(?) | ON(?) | ON(?) | ON(?) |
| X-fer pump fail | ON(?) | ON(?) | ON(?) | ON(?) |
| Fuel level low | ON | ON | off | off |
| Beta | ON | ON | ON(?) | ON(?) |

Note: Each caption was fitted with two bulbs

## 1.13 Medical and pathological information

The post-mortem examination revealed that death was due to multiple injuries. There was no evidence from the post-mortem or from the pilot's medical history which might suggest a contributory factor in this accident.

## 1.14 Fire

There was no evidence of pre-impact fire or overheating anywhere on the aircraft. There had been a very small area of post-impact smouldering beneath the left outer wing which had discoloured the paint, but no fire of any magnitude had occurred. Large quantities of fuel had been released from both wings and as a precaution the Rescue and Fire Fighting Services applied a foam blanket around the aircraft.

## 1.15 Survival aspects

Because of the degree of destruction to the cockpit area the pilot could not have survived the accident. The rear cabin was essentially intact and it is possible that passengers (if carried) could have survived the impact.

## 1.16 Tests and research

Not applicable

## 1.17 Additional information

### *1.17.1 Cessna Information Manual*

The Cessna Information Manual includes the following in Section 4, Normal Procedures concerning a baulked landing:

"BAULKED LANDING

1. Power levers - ADVANCE for takeoff power.

Note

When operating in normal mode with optional engine torque and temperature limiting, advance the power levers slightly ahead of the point where takeoff power is attained. When operating in any other configuration, advance the power levers only sufficiently to attain takeoff power. When operating in normal mode, the red line EGT marking is applicable.

2. Baulked Landing Transition Speed - 99 kt IAS.

3. Wing Flaps - T.O.

Note

* Experience indicates that retracting the landing gear during an operational VFR go-around, when an immediate landing is contemplated, has been conducive to gear up landings.

* Always follow the Before Landing Checklist.

4. Landing Gear - RETRACT during IFR go-around or simulated IFR go-around after establishing a positive rate of climb.

5. Trim airplane for climb.

6. Wing Flaps - UP as soon as all obstacles are cleared and airspeed is above 115 kt IAS."

### 1.17.2 *Background history of engine behaviour*

The investigation brought to light a small number of incidents concerning unexplained engine behaviour, spanning many years and involving several different operators, which had not been reported through the Mandatory Occurrence Reporting system. These ranged from sudden, sustained power surges to moderate oscillations - often associated with synchrophaser engagement or reversion from computer to manual mode. The reports include instances when deselection of computers during a ground run caused an engine to run to full power resulting in the aircraft jumping the chocks before the pilot could restore control by switching on the computer; instances when deselection of computers during air tests have caused large thrust changes resulting in significant yawing motion; and, an instance when the synchrophaser was inadvertently left on during take-off and, when the system engaged after landing gear retraction, there was a sudden torque reduction of the left engine to about 800 ft.lb., followed by continued torque fluctuations about this value.

### 1.17.3 *Operational instability of the engines*

The possibility of instability arising from synchrophaser/computer interaction is acknowledged by the manufacturers in the aircraft maintenance manual, which states that "there may be a tendency for the left engine to oscillate" when the engine is torque limited with the synchrophaser turned on and the computer ON in torque/temperature limiting mode. The manual states that "this is a characteristic of the synchrophaser/torque limiter system", and refers the reader to the pilot's operating manual. Further reference to this condition is made in the section dealing with the torque limiter, in which it is stated that, "Even with the stabilising circuit", introduced by modification SK 441 79 (not fitted to G-MOXY), "there may still be an unstable interaction between the torque limiter and the synchrophaser. This could occur when the power lever is pushed far forward during a torque limited climb......". The manufacturer has stated that the unstable interaction referred to is actually a hunting of the left engine, involving torque swings of +/- 150 ft.lb.

## 2. Analysis

### 2.1 Introduction

The accident occurred at Blackbushe airfield following a go-around from an approach to land on runway 26. The aircraft appeared to begin the go-around normally but was then seen to bank to the left and start turning left. The turn continued through 135° of heading, at a low height, with the bank angle increasing progressively, until the aircraft crashed into trees, semi-inverted, approximately 550 metres from the runway 26 threshold.

The effectiveness of the investigation was considerably reduced by the lack of flight recorders. There were none fitted to the aircraft and neither were they required by law. The latest amendments to Annex 6 to the Convention on International Civil Aviation recommend that all public transport category, multi-engined turbine powered aircraft under 5700 kg, and first registered after 1 January 1990 should be equipped with flight data and cockpit voice recorders. CAA proposals for amendments to the ANO will require these recorders to be fitted on this category of aircraft if registered after 1 February 1990, but only if certificated to carry ten or more passengers. G-MOXY (certificated with 2 crew seats and 9 passenger seats) would have fallen outside these criteria. It is considered that where possible all multi-engined turbine powered public transport aircraft should be fitted with a flight data recorder and a cockpit voice recorder in accordance with Annex 6.

Examination of the wreckage revealed a defective microswitch in the left main landing gear indication circuit which would have resulted in the pilot being presented with an unsafe indication following the landing gear down selection. When the pilot called "base leg, runway 26" the AFISO replied "check undercarriage down and locked, report finals" to which the pilot repeated "three greens".

A repair had been made to the microswitch previously and it is also possible that the failure occurred as soon as (or even before) the landing gear selection was made. In this case the pilot could have made a routine "three greens" reply without actually checking the landing gear indication until the aircraft was nearer the final approach path. Whenever the failure occurred or was noticed, the defect provides an explanation for the pilot's next comment that he had a problem and was going-around.

While giving a reason for the go-around, the defective microswitch does not explain the subsequent behaviour of the aircraft and this analysis examines possible causes for the loss of control.

## 2.2 Primary flying control malfunction

Analysis of the wreckage eliminated the possibility of an asymmetric flap condition and also confirmed that there had not been a disconnection in any of the flying control circuits. No evidence was found of any pre-impact restrictions in the flying control circuits. Although the break-out torques of the autoflight disconnect clutches were significantly higher than those specified by Cessna, this would only have assumed significance if the autoflight system had been in use, which is unlikely, and was malfunctioning. There was clear evidence that full right aileron and substantial up elevator were applied at impact. Such control positions are consistent with corrective action for an aircraft steeply banked to the left, and indicate that the pilot was not prevented from applying these control inputs.

The possibility of a yaw damper malfunction is not considered likely, but cannot be ruled out completely from the wreckage examination. Therefore, the abnormally high breakout torque of the actuator disconnect clutch is of potential significance in so far as it could make it difficult to override a malfunctioning yaw damper. However, even if the actuator disconnect clutch had required the highest measured break-out torque, it would still have been possible for the pilot to override such a malfunction with a pedal load of up to 100 lb. It is therefore considered that a restriction of the flying control circuits is unlikely to have contributed to the accident.

## 2.3 Meterological factors

The weather at the time of the accident was good with the only unusual reports being those of mini whirlwinds/dust devils near to the time of the accident. The possibility of the aircraft encountering such a phenomenon was considered. It was felt that such localised thermal activity would have been flown through rapidly by the aircraft and would have produced nothing more than a brief disturbance. The probability of any prolonged disturbance to the aircraft was considered to be negligible.

## 2.4 Pilot incapacitation

In the interval between the start of the go-around and the impact the pilot said "I'm sorry, I'm going in" or similar words. Such a phrase indicates that he was fully aware of his predicament and that he was capable of coherent thought and speech. The apologetic nature of the phrase could also be taken to imply that he felt that he had done all that he could to control the aircraft but was not succeeding. This was supported by evidence of the control positions at impact which indicated that recovery action had been taken. The post mortem examination also found nothing to suggest that there was any medical factor in the accident. It is therefore concluded that pilot incapacitation was unlikely to be a factor.

## 2.5 Asymmetric thrust

It is clear that lateral and directional control of the aircraft was lost but, in the absence of flying control defects or pilot incapacitation, it is difficult to imagine what could have caused such loss of control if both engines had responded normally when power was applied for the go-around. The evidence is that both engines and propellers were free from significant mechanical defects and that, at impact, the propellers appeared to have sustained similar damage consistent with some power being available. However, the amount of power being delivered during the early stages of the impact cannot be deduced directly from the engine and propeller evidence because of the potential for power absorption, without producing specific damage, during the aircraft's passage through the trees. Furthermore, the possibility that the pilot pulled back the power levers before impact cannot be dismissed.

Several witnesses reported that engine noise was clearly audible during the period between the initiation of the go-around and the impact. Furthermore, the fact that the aircraft was able to cover a distance estimated at 680 metres during this period, in a tight turn with flap extended, suggests that a substantial amount of power was available. However, the curved flight path and progressive increase in bank angle also suggests that the pilot was faced with a large asymmetry of thrust, due either to a loss of power from the left engine or to excessive power from the right engine. The potential causes of such asymmetry were examined further.

### *2.5.1 Propeller system malfunction*

The examination and full functional testing of the propeller governors did not reveal any abnormality except for a tendency for the right governor to hunt very slightly under certain conditions. This is unlikely to have been a factor in the accident.

There was no evidence of a malfunction of either propeller pitch control unit or of a disconnection of the associated linkage to each power lever which could have been a potential cause of an undemanded beta or reverse pitch condition. A malfunction of the negative torque sensing (NTS) system was also considered but no evidence was found of abnormality affecting either torque sensor system and, because of the way in which this system operates (see Appendix 4), NTS operation could have only have resulted from a genuine power failure; a condition which was ruled out by other evidence.

The amount of wear on the left power lever baulk could possibly have allowed inadvertent beta selection when the power lever was brought back to the flight idle stop. Whilst such an occurrence would have produced an asymmetric condition rolling the aircraft to the left, this would have accompanied a power reduction rather than the power increase for go-around which occurred in this case, and would probably have produced a more dramatic rate of roll. Furthermore, unless the propeller subsequently hung on the start locks, which would require an accompanying RPM decay to below that needed to keep the centrifugal locks retracted, the propeller could be restored to normal thrust immediately by advancing the power lever. It is therefore concluded that whilst the wear on the baulk provided potential for an inadvertent selection of beta pitch in the air, such a condition does not fit the circumstances of this accident. It is considered that the evidence of 'beta' caption illumination was a manifestation of relative movement between the propeller pitch control valves and the propeller oil-transfer (beta) tubes during in the initial stages of the impact, rather than a genuine beta selection in the air.

There was, therefore, no evidence to indicate that a malfunction of either propeller system was a factor in the accident.

2.5.2 *Partial power failure.*

The roll to the left during the go-around suggests that less thrust was being provided by the left engine than the right. The evidence that some power was being delivered to its propeller at the time of impact with the trees indicates that the left engine did not suffer a complete failure. Examination of the left engine eliminated any sudden partial power loss resulting from component failure in the engine core, leaving a reduced fuel flow as the only alternative cause of a power reduction. A number of potential causes of reduced fuel flow were considered.

2.5.2.1 *Fuel availability*

All of the airframe fuel valves were correctly set for the stage of flight. Plenty of fuel was on board the aircraft and the engine mounted fuel pumps on both engines were rotating at speed on impact. Although the the 'fuel transfer' and 'fuel low level' warning captions were illuminated at impact, these are considered to reflect the extreme aircraft attitude with potential for erroneous indications rather than an indication of a genuine problem. It is therefore concluded that the low pressure fuel systems supplying both engines were serviceable and charged fully with fuel at the time of the accident.

2.5.2.2 *Mechanical fuel control unit malfunction*

Both mechanical fuel control units were extensively rig tested and found to be out of adjustment when compared with the limit values applied to new production units. However, the overall operation of each unit was typical of 'serviceable' units received for overhaul and throughout the tests fuel flows were equal to or in excess of nominal values, with a slight rich shift of the right unit relative to the left. Two unusual test points affecting the left unit were noted, the potential significance of which has more bearing on control system stability than on power loss, and is discussed later at paragraph 2.5.3. At no time during the tests was there any suggestion of a partial fuel flow reduction. Consideration was nevertheless given to the effects of potential failure conditions of an intermittent nature which may not have been evident during the tests.

Any damage to the bellows unit, blockage of filter screens or passages was considered to be more likely to produce consistent errors which would have been noticed previously, or would have left post-impact evidence, and was therefore discounted in the context of this accident. The possibility of one of the solenoid valves sticking and producing a sudden reduction in fuel flow was not supported by evidence although it could not be entirely dismissed.

2.5.2.3 *Electronic fuel computer malfunction*

Both electronic fuel computers were subjected to the full certification test schedule and were found to be operational. The essential characteristics of each was similar, with both computers demanding more fuel flow than that nominally required. The left computer trim potentiometers had been adjusted to give higher overall fuel flow demands than the right computer, thus compensating for the slight opposite bias in its associated mechanical fuel control unit.

The potential for electrical malfunctions to affect the fuel demand from the computers was considered in detail. Checks of all transducers and potentiometers confirmed that they were all within limits with the exception of the EGT harnesses which could not be checked fully because of impact damage and missing compensator resistors. However, it was considered that a defective EGT probe or compensating resistor would have had a relatively small effect on the limiter circuits. This in turn would have produced a small reduction in the maximum power available but it is unlikely that this would have caused a significant power asymmetry.

2.5.3 *Operational instability of the engines*

The possibility of engine instability arising from synchrophaser/computer interaction is acknowledged by the manufacturer even in those installations modified by SK441, which was not fitted to G-MOXY. The unstable interaction (apparently) involves torque swings of +/- 150 ft.lb. However, synchrophaser operation is inhibited until the landing gear is raised. Therefore, for such instability to have been a factor in the accident the synchrophaser would have had to be switched on for the approach, contrary to the flight manual recommendations. Furthermore, the pre-mod versions of the computer had a time delay built into the system to prevent active connection between the synchrophaser and the computer for between 15 and 20 seconds, although this delay was found to be as little as 7 to 10 seconds in a random check of another Cessna 441. Unless the timer circuit in G-MOXY was defective, any synchrophaser induced instability would therefore be unlikely to occur until a significant period had elapsed following landing gear retraction at the start of the go-around. Even if such instability had occurred, fluctuations of +/- 150 ft.lb. should not have presented a control difficulty and would have given rise to oscillatory symptoms rather than a steady state change of thrust.

In addition to the known synchrophaser instability there was a period in the early life of G-MOXY (then registered as G-BHLN) when there were persistent pilot reports of torque fluctuations of 300 to 400 ft.lb. with the synchrophaser off when operating at the torque limit. Furthermore the symptoms were encountered when "torque limiting in manual mode". The problems persisted despite a number of computer and fuel control unit changes, suggesting strongly that the symptoms were the result of system performance characteristics rather than a fault condition in any of the equipment.

This accident has brought to light a background of incidents, spanning many years and involving several operators, concerning unexplained engine behaviour ranging from sudden, sustained power surges to moderate oscillations, often associated with synchrophaser engagement or reversion to manual mode. Whilst some of these reports are difficult to substantiate, it is considered that sufficient evidence of a circumstantial nature has arisen concerning the engine control system to warrant a re-appraisal by the airworthiness authorities of the system's control margins, involving operation in all modes, but particularly at high power under limiting conditions, both with and without the synchrophaser.

### 2.5.4 *Engine operation above rated power*

It was noted that certain types of failure could have allowed the right engine to operate up to a power level which was significantly above rated power. Given the serviceability of the fault monitor circuits in both computers of G-MOXY, the possibility for a full runaway condition was limited to two potential fault conditions both affecting components in the mechanical fuel control: a blocked flapper valve, and sticking of the manual mode solenoid in the 'computer mode' position. There is known to be at least one report of temporary loss of engine control which was attributed to a sticking solenoid caused by a build up of carbon from the engine P3 air. However, post-accident examination of flapper valves and solenoids did not reveal any evidence of obstruction, carbon build up or sticking and it was concluded that these potential fault conditions were not factors in the accident.

The most likely cause of an increase in potential power available was a reversion to manual mode operation, when the absence of the limiting provided by the computer removes the flat rating of 635 shp imposed on the engine. In this event it would have been possible to obtain approximately 830 shp from the right engine if the power lever had been advanced fully without regard to engine limitations. Manual mode could have been selected by intentionally switching off a computer or by the activation of the fault monitor circuits. Although no evidence was discovered of any failure which might have activated the fault monitor circuits, many of the failures considered would be unlikely to retain such evidence post-impact. It is not known whether the computers in G-MOXY were on or off immediately before the accident and illumination of the computer fail captions was not conclusive because disruption of critical transducers during the impact sequence could have been expected to result in the fault monitors tripping the computers off line.

The greatest potential for computer disengagement by activation of the fault monitors occurs when the engine is responding to inputs from the power or condition levers. If, in the context of this accident, the right computer had tripped off line because of a transient fault as power was applied for the go-around, the pilot should have been alerted by the amber computer caption. However, this caption is located just below the glare shield on the right instrument panel and it is possible that it could have gone unnoticed by the pilot. Assuming that both power levers were fully advanced, the resulting asymmetry of approximately 195 shp (ie. the left engine producing rated power and the right engine about 830 shp) is much less severe than the total engine failure case and should have presented no control difficulties, unless the pilot's subsequent actions exacerbated the situation.

2.5.5 *Possible pilot action*

Given that there was no evidence of a flap or flying control failure and that a complete engine failure as such did not occur, it must be asked whether the action of the pilot could have caused or contributed to the accident.

The procedures listed in the Cessna Information Manual for carrying out a balked landing include retracting of the flaps to the take-off position. At impact the flaps were found to be almost fully extended. It is possible that the take-off flap selection was never made, however, it is also possible that take-off flap was selected when the nose was raised during the go-around. An uncommanded roll to the left at such a moment might reasonably have been diagnosed by the pilot as asymmetric flap and prompted him to reselect full flap in the hope of restoring the situation. Whatever the case, the presence of full flap would have been likely to make control of the aircraft more difficult in the event of an asymmetric power condition.

If the engine had failed to respond to the power demand on go-around for a significant period of time (or had produced less than rated power) the asymmetry resulting should have been readily controllable, provided that the IAS was not slower than the 99 kt approach speed published in the aircraft information manual. There was only one witness who said that the aircraft appeared to be slow on the approach. The remaining witnesses stated that the aircraft appeared to be at a normal approach speed as the landing gear was retracting for the go-around. However, the majority of aircraft using Blackbushe are of lower performance and a slow speed approach by an aircraft, such as the Conquest, might give the impression of a normal speed to most witnesses. Nevertherless, it seems unlikely that the IAS at the start of the go-around was sufficiently low as to cause loss of control of the aircraft in the event of a partial loss of power from the left engine.

Unstable power fluctuations of either engine might have been expected to produce oscillations in yaw which would be evident to witnesses. With the exception of one individual, who saw the aircraft yaw momentarily to the left at the start of the go-around, witnesses were not aware of yaw oscillations and were consistent in reporting a progressive increase in left roll until impact. Cockpit indications should have allowed the pilot to identify an engine producing fluctuations in power and then take corrective action. As engine oscillations are typically associated with high power settings, a retardation of the appropriate power lever might be expected to reduce the power setting to a region of stable engine operation and leave the pilot to cope with a relatively mild thrust asymmetry. The possibility remains that the pilot may have been sufficiently distracted by a combination of engine and landing gear malfunctions that, after retarding the left power lever, he allowed the IAS to decay to the point at which control was lost.

If the right engine had suffered a failure of the fuel control system, as described in paragraph 2.5.4, (allowing the engine to produce approximately 830 shp) the effect on the aircraft when full power was selected at go-around would have been to cause a yaw to the left. It is possible that such an aircraft response could have been mistaken by the pilot for a partial failure of the left engine. If this had occurred, and the pilot reacted by bringing the power lever of the left engine back to flight idle, the resulting power asymmetry (approximately 830 shp) would have been much greater than he had previously experienced. In addition it would have been much greater than the asymmetry on which minimum control speeds are based and it would not be surprising if control difficulties resulted.

## 2.6 Summary

There was no evidence of incapacitation of the pilot. Extensive examination of the wreckage revealed no flap or flying control malfunction, neither was there any evidence of failure of either engine or propeller control mechanism. The curved flight path of the aircraft from go-around to impact and progressive increase in bank angle suggest that the pilot was faced with a large asymmetry of thrust. A number of potential reasons for such asymmetry was considered but, the investigation was considerably hampered by the absence of flight recorders, and there was insufficient evidence to enable a cause to be determined.

## 3. Conclusions

(a) Findings

(i) The pilot was properly licenced to conduct a private flight on the aircraft.

(ii) The pilot had recently completed the type conversion flying training and was well experienced on twin turboprop aircraft.

(iii) The aircraft had a valid Certificate of Airworthiness, Transport Category (Passenger) and a valid Certificate of Maintenance.

(iv) The weight and centre of gravity of the aircraft were within the permitted limits.

(v) The pilot reported a problem during his approach to runway 26 at Blackbushe and initiated a go-around.

(vi) A defective microswitch on the left main landing gear would have resulted in the pilot being presented with an unsafe indication following the landing gear down selection.

(vii) With the exception of the defective microswitch no other evidence was found of any technical malfunction or failure.

(viii) Control of the aircraft was lost during the go-around and the aircraft crashed some 550 metres south of the extended centreline of runway 26.

(b) Probable cause

The accident resulted from a loss of control at low altitude. The reason for the loss of control could not be determined but it was considered that an asymmetric thrust condition was most probable.

## 4. Safety Recommendations

It is recommended that:

4.1 The Civil Aviation Authority should initiate action to re-appraise the stability margins of the engine control systems, involving operation in all modes, but particularly at high power under limiting conditions, both with and without the synchrophaser.

4.2 The Department of Transport should require that all multi-engined turbine powered public transport aircraft should, where possible, be fitted with a flight data recorder and a cockpit voice recorder, in accordance with the recommendations contained in Annex 6 to the Convention on International Civil Aviation.

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