Accidents Investigation Branch

Department of Transport

Report on the accident to Edgley EA7 Optica G-KATY at Ringwood, Hampshire, on 15 May 1985

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1/85	Britten-Norman Islander BN 2A–26 G–BDVW At Sanday Island Airfield, Orkneys June 1984	July 1985
2/85	Aerospatiale Puma 330J G–BJWS Aberdeen Airport October 1982	August 1985
3/85	SA 318B Alouette Astazou G–AWAP Gat Sand, The Wash June 1983	October 1985
4/85	British Airways S–61N G–ASNL In the North Sea, 75 nm North East of Aberdeen March 1983	May 1986
5/85	Mid-air collision between Cessna F150M G–BFEL and a United States Air Force A–10A near Hardwick, Norfolk on 29 February 1984	April 1986
6/85	De Havilland DHC–5D Buffalo C–GCTC at the Royal Aircraft Establishment, Farnborough, Hants on 4 September 1984	June 1986
7/85	Fokker F27–200 G–GHMZ Creil Airfield, France on 2 October 1984	
1/86	Edgley Optica G–KATY Ringwood, Hampshire on 15 May 1985	

Department of Transport
Accidents Investigation Branch
Royal Aircraft Establishment
Farnborough
Hants GU14 6TD

The Rt Honourable Nicholas Ridley
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr R C McKinlay, an Inspector of Accidents, on the circumstances of the accident to Edgley EA7 Optica G–KATY, which occurred at Ringwood, Hampshire, on 15 May 1985.

I have the honour to be
Sir
Your obedient Servant

G C WILKINSON
Chief Inspector of Accidents

Contents

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Accidents Investigation Branch

Aircraft Accident Report No. 1/86
(EW/C916)

Operator:		The Hampshire Constabulary
Aircraft:	*Type:*	Edgley EA7 Optica
	Model:	Serial 004
	Nationality:	United Kingdom
	Registration:	G–KATY
Place of accident:		Ringwood, Hampshire
Date and time:		15 May 1985 at 1040 hrs
		All times in this report are GMT

Synopsis

The aircraft was orbiting the town of Ringwood whilst carrying out a police task to photograph the disposition of traffic during market day. During the third or fourth orbit the aircraft was seen to descend slowly from about 800 feet to between 150 feet and 100 feet, and enter a steep but apparently controlled turn to the right. A few seconds later the bank angle suddenly increased to about 90° and the aircraft spiralled steeply into a wood, destroying the aircraft and killing both occupants. Twenty to thirty seconds after impact a severe fire broke out.

The report concludes that it was not possible to identify the cause of either the initial descent or of the subsequent loss of control. However, the loss of control occurred at a height which was too low for recovery to be made. The balance of available evidence suggests that the aircraft was serviceable immediately before the impact but that the pilot was forced to descend by a partial or transient power loss, either occasioned by mishandling of the fuel tank selector or some other cause. A contributory factor could have been the ease with which a mis-selection of the fuel tank selector can be made in certain circumstances.

1. Factual Information

1.1 History of the flight

G–KATY was the first production-model Optica produced by Edgley Aircraft Limited and was bought by Air Foyle at Luton, who leased it to the Hampshire Constabulary. On 2 May 1985 the Air Support Unit (ASU) of the Constabulary collected the aircraft and took it to their base at Lee-on-Solent in order to evaluate it for police work. The Optica was formally accepted by the Hampshire Constabulary on 14 May, and had been tasked with carrying out a photographic survey of the traffic congestion in the area of Ringwood during market day on 15 May.

The pilot arrived at Lee-on-Solent at 0730 hrs and helped to wheel the aircraft out of the hangar to be refuelled by the Naval bowser. Fifty litres of fuel were put aboard, making the total contents 160 litres and raising the weight of the aircraft to nearly the maximum permitted take-off weight of 1236 kg. The pilot then made a telephone call to Hurn Air Traffic Control (ATC) informing them of his photographic mission within their Special Rules Zone, timed to be at Ringwood at 1029 hrs and operating between 500 and 1,000 feet. A little while later the pilot was seen making his pre-flight inspection of the aircraft prior to boarding it and sitting in the left hand seat. The photographer, on only his second flight, was helped by an experienced observer in the ASU to prepare his equipment and strap into the right hand seat. A small camera accessories bag was strapped to the front of the centre seatback, above two police radios which were fastened to the centre seat squab. The photographer had a Hasselblad camera around his neck and Mamiaflex camera attached firmly to his left leg, well clear of the aircraft's dual controls. The observer particularly ensured that the photographer was alert to the danger of his equipment interfering with the aircraft controls and the precautions to prevent such an occurrence. The aircraft took off at 1014 hrs.

Southampton ATC routed them along the south coast towards Christchurch where, at 1027 hrs, Hurn (Bournemouth) ATC turned them north towards Ringwood. At 1032 hrs the flight reached the Ringwood area and began a series of orbits turning right around the outskirts of the town. The en-route phase of the flight had been conducted at 700 feet amsl using the regional pressure altimeter setting (QNH) of 1011 mbs, and both the nature of the task and witness statements suggest that the initial orbits were conducted at about 800 feet above ground level (agl).

At 1037 hrs the pilot asked Hurn ATC if he could operate between 1,000 and 1,500 feet. ATC approved this request and instructed the aircraft to remain in the immediate vicinity of Ringwood. At around this time the aircraft began a final orbit of the town beginning, as before, just to the north of the A31 road (see Appendix I). During this orbit, which was slightly tighter than the previous ones had been, the aircraft descended gradually until, when crossing the main A31 road at between 100 and 150 feet agl, it assumed a 45° banked turn to the right. A few seconds later, having turned through some 40°, the bank suddenly increased to 90°, the nose began to drop and the aircraft spiralled downwards into the trees. Both occupants died instantaneously from injuries sustained in the impact. Some 20-30 seconds later a fire broke out which destroyed much of the cockpit area.

1.2 **Injuries to persons**

Injuries	Crew	Passengers	Others
Fatal	2	–	–
Serious	–	–	–
Minor	–	–	–

1.3 **Damage to the aircraft**

The whole of the airframe suffered extensive disruption during the tree and ground impacts.

Further extensive damage was caused by the post impact fire, fed by fuel from the ruptured wing tanks.

Because of its location within the fan duct, the engine was protected during the impact and suffered only superficial damage, although the fan assembly had partially shattered.

1.4 **Other Damage**

Several trees were damaged during the impact and the ground beneath the forward part of the wreckage was scorched during the post impact fire.

1.5 **Personnel information**

1.5.1	*Commander:*	Male, aged 37 years.
	Licence:	Private Pilot's Licence issued 1 February 1978 and permanently valid. Operated with an 'Exemption' from the necessity to hold a Commercial Pilot's Licence when flying on police duties. (See Appendix II).
	Aircraft rating:	Landplanes Group A.
	IMC rating*:	Issued 10 December 1979. Renewed 7 February 1985.
	Night rating:	Issued 3 February 1983. Valid.
	Last medical examination:	15 February 1985. Class III, no limitations, valid to February 1987.
	Flying experience:	445 hours total; 393 hours in command; 15 hours on type.

Since the issue of his licence in 1978 the pilot, a police constable, had flown privately and, during the same period, acted as an observer for the Hampshire Constabulary ASU. By October 1979 he had accrued the necessary 100 flying hours as pilot in charge and was reassigned as one of the ASU pilots.

Throughout both his initial flying training and also his police duties, he was noted for his particular attention to detail and good airmanship.

1.5.2 *Photographer:* Male, aged 44 years

The photographer, a detective constable, who had joined the police force in March 1962, was one of several such detectives who were available for occasional flying duties with the ASU. This was the second of only two flights, both in the Optica, which he had been required to make.

1.6 Aircraft information

1.6.1 *Description*

The Optica is a light single engined observation aircraft. The cockpit is an almost fully glazed teardrop shaped pod, similar to that of a Bell 47 helicopter and carries side-by-side seating for 3 persons. The left and centre seats are fitted with full flying controls. The pod is mounted ahead of, and forms a part of, the intake for a ducted fan power plant. An Avco Lycoming IO 540, 260 HP, engine is mounted within a nacelle, supported on stator members inside the outer duct. The mainplanes are mounted at mid-height on the duct annulus, which forms the wing centre section. There is no rear fuselage; instead, the two fins and the top-mounted tailplane are supported by twin booms attached to the mainplanes. The aircraft has a fixed tricycle undercarriage, electrically actuated slotted flaps outboard, and fixed slotted flaps inboard permanently set to 10 degrees extension. A conventional electrically operated stall warning device is armed whenever the outboard flaps are extended beyond 8°: with flaps retracted, stall warning is provided by aerodynamic buffet and the electrical system is disabled.

1.6.2 *Aircraft history*

The aircraft was given a certificate of airworthiness in the Public Transport (Passenger) Category on 24 April 1985. The technical records indicate that the aircraft had flown a total of 61 hours up until the day of the accident, and there are no 'technical log' entries which have any relevance to the accident. The aircraft's previous history appears, from the records, to have been uneventful. Technical problems were limited to the replacement of a nose wheel, the sealing of a minor leak in one of the fuel tanks and a blown landing lamp filament.

1.6.3 *Aircraft performance*

Those performance figures which are considered pertinent to this accident are:

Cruise speed:	Normal:	100 kt
	Economy:	70 kt
Loiter speed:		65 kt
Gliding speed:		70 kt

Stall speed:	Bank angle:	0°	20°	40°	60°
	Speed (KIAS):	43	46	56	76

Glide distance: (at 72 kt and maximum AUW)	Idle power	1.89 nm per 1,000 feet
	Engine off	1.62 nm per 1,000 feet

1.6.4 *Weight and balance*

Maximum weight authorised for take-off:	1,236 kg
Actual take-off weight:	1,234 kg
Estimated weight at time of impact:	1,223 kg
Estimated fuel remaining at time of accident:	145 litres
Type of fuel:	100 LL
Centre of Gravity (C of G) limits at accident weight:	20.0-28.0% MAC
C of G at time of accident:	22.2% MAC
Cabin load:	159 kg
Ballast:	19 kg, in the forward position.

When the cabin load is less than 183 kg, two ballast weights totalling 19 kg must be carried at the attachment points in the nose of the aircraft.

1.6.5 *Flight instruments*

The Optica is fitted with a standard flight instrument panel (see Appendix III), situated on the centre display panel to the left of the radio equipment. It comprises an airspeed indicator, an artificial horizon, an altimeter, a turn and slip indicator, a compass indicator and a vertical speed indicator.

The combination of these instruments would enable a suitably qualified pilot to control the flightpath without reference to the visual horizon or ground features. It is however usual to make only occasional reference to these instruments when flying visually.

1.6.6 *Intercommunications and radio telephone (RTF) equipment*

The aircraft was fitted with the following RTF and navigation equipment:

(a) King KY 196: VHF communications

(b) King KX 155: VHF communications ILS, VOR

(c) King DR 87: ADF

(d) King KNS 80: ILS, VOR, Area Navigation

(e) King KMA 24: Marker receiver

(f) King KT 76A: ATC transponder

As well as the above equipment the ASU had constructed a plywood platform, secured to the centre seat squab. Attached to this were two, normally hand held, police transceivers and an interface switch-box capable of 'mixing' the communications provided by these sets and those from the normal aircraft equipment.

1.7 Meteorological information

1.7.1 An aftercast provided by the Meteorological Office at Bracknell states that the weather prevailing when the accident occurred was:

Surface wind:	Southerly 8-12 kt
2,000 feet wind:	220°/20-25 kt
Visibility:	Hazy, between 5 and 9 kilometres
Cloud:	1-2 oktas stratus, 1,000-1,500 feet 2-4 oktas cumulus, 1,500-2,000 feet 5-8 oktas stratocumulus, base 3,000 feet
Freezing level:	5500 feet
Turbulence:	Light turbulence may have occurred at low level.

1.7.2 Prior to the flight, the following meteorological forecast was provided:

0800-1600 hrs local time

Surface wind:	190°/210°/15 kt
2,000 feet wind:	230°/20 kt
Visibility:	4-8 kilometres, increasing to over 10 kilometres.
Cloud:	1-3 oktas stratus, base 700-900 feet 4-6 oktas stratocumulus, base 2,000-3,000 feet. Becoming: 5-7 oktas cumulostratus, base 1,800-2,000 feet.

Footnote: VHF: Very high frequency radio. ADF: Automatic Direction Finding equipment (navigation). ILS: Instrument Landing System (navigation). VOR: VHF Omni Range (navigation). Marker: A radio identification point. Transponder: Airborne Radar transceiver equipment enabling identification of the ground radar return of the aircraft.

Freezing level:	6,000 feet
Turbulence:	Moderate
Maximum temperature:	15°C
Weather:	Overcast with mist, at first becoming cloudy.

1.8 Aids to navigation

This flight was conducted by visual ground reference only and such radio aids as were available are therefore not relevant to the accident. However, whilst in the Hurn Special Rules Zone[1], the aircraft was given radar headings to assist with navigation and provide separation from other aircraft.

1.9 Communications

As a part of his pre-flight preparation the pilot telephoned Hurn Airport ATC and informed them of his required flight details. He told them that his expected time of arrival (ETA) at Ringwood was 1029 hrs and requested clearance to fly to, and operate in, the area at heights between 500 and 1,000 feet. This was approved by Hurn ATC.

Whilst airborne, using the call sign "Boxer 3", the aircraft's communications with firstly Southampton ATC and then Hurn ATC, who confirmed the Special VFR[2] clearance, were normal and were conducted on 128.85 MHz and 118.65 MHz respectively. The flight remained under the control of Hurn ATC until the time of the accident, 1040 hrs. Following the aircraft's arrival in the Ringwood area the only significant communication with Hurn occurred at 1037 hrs when the pilot requested, and was granted, permission to operate between 1,000 and 1,500 feet. A transcript is given at Appendix IV.

No messages were recorded as having taken place on the frequencies provided by the two additional police transceivers.

Footnote:

1. VFR:

   Special Rules Zone: An area within a Flight Information Region within which aircraft are required to comply with instructions of ATC.

2. Special VFR:

   An occasion, permitted by ATC, when a flight may be conducted, using VFR[3] when in IMC[4] in an ATC controlled area.

3. Visual flight rules. (Flight conducted by external visual reference).

4. Instrument meteorological conditions (normally requiring flights to be conducted by reference to flight instruments only).

1.10 Aerodrome information

Not relevant.

1.11 Flight recorders

Neither a flight recorder nor a cockpit voice recorder was required or fitted.

1.12 Wreckage and impact information

1.12.1 On-site examination

The distribution of the wreckage and the pattern of damage indicated that the aircraft had entered the trees whilst in a steep spiralling descent to the right, approximately 11 metres to the southwest of the point where it finally came to rest. The degree of damage sustained in the impact is compatible with a speed of between 60 and 90 knots. The aircraft had entered the trees tracking 065° Magnetic, banked approximately 110° to the right and pitched nose-down approximately 70°. The initial contact had torn away the right wing tip and increased the rate of yaw to the right. Further heavier tree contacts on the right wing had followed immediately, tearing away the greater part of the wing leading edge, part of which forms the right hand fuel tank. Immediately before coming to rest the left side of the cabin had struck a tree, causing severe damage, and the left wing leading edge and its fuel tank were damaged by contact with another tree.

The post impact fire was fed by fuel released from the ruptured wing tanks, which had soaked into ground beneath the inner right wing and cockpit areas, and beneath the left wing leading edge and tip. The fire destroyed parts of the wreckage in these areas. It was not possible to ascertain positively the source of ignition, but impact damaged electrical systems were the most likely source.

The tail booms, tailplane, fins and engine pod were unaffected by the fire.

The aircraft was complete at the time that it struck the trees and all extremities were present in the wreckage or lodged in the trees at the point of initial contact.

The wing flaps were fully retracted at impact.

Because of the unusual nature of the engine and fan installation, the shielding effect of the fan outer duct and the progressive nature of the multiple tree impacts, it was not possible to make an accurate assessment of the degree of power being developed at the time the aircraft first struck the trees. The available evidence suggested only that it had been rotating at a low to medium power setting at the time of the impact with the ground.

Both ballast weights were securely fitted in the nose position.

1.12.2 *Subsequent examination*

1.12.2.1 *Structure*

No evidence has been found to suggest that failure of any part of the primary structure occurred prior to ground impact. Furthermore, all of the aircraft's extremities were present in the main wreckage area and there were no indications that anything had separated from the aircraft prior to the impact. The rear part of the cabin in the region where it attached to the duct annulus was largely burned away during the post-impact fire and consequently evidence regarding structural integrity in this area was lost.

All structural deformation conformed to a pattern consistent with the aircraft having a relatively high forward speed component combined with high rotational energy about the yaw axis (yaw to the right) at the time of impact. This energy resulted in the tail section and tail booms swinging in a parallelogram motion to the left, pivoting about the forward ends of the tail booms which crippled at their attachments to the wings, and in the engine tearing out to the left. The tail assembly nodded forward as a result of its high centre of inertia, crippling the tail booms just forward of the fins. The cabin had been pushed to the right by the tree impact, which caused massive local damage to the lower left side of the cabin.

1.12.2.2 *Power plant*

Reconstruction showed that there had been no major failure of the fan. A small segment of the leading edge of one blade was not recovered and the possibility that this had detached before impact could not be ruled out. It is emphasised, however, that there is no evidence which suggests that such a separation did occur, and the degree of fragmentation and the nature of the dense undergrowth at the accident site were such that successful recovery of all blade fragments was not possible.

The engine was protected from the impact forces by the fan duct and by the crankshaft extension, upon which the fan is mounted. Damage was confined primarily to the exhaust system and was of a superficial nature which did not affect the basic engine unit or its essential accessories. The engine was in good condition with no indications of pre-impact abnormality.

There was clear evidence of damage indicative of engine rotation during the impact on the fan hub assembly and adjacent structure, on the fan blade tips and the blade sealing shroud on the outer duct, on the fan blade roots and on the alternator pulley. The manufacturers state that the engine does not windmill in the event of an engine failure in the air. However, the degree of power which this damage represented could not be accurately assessed because of the multiple impacts and the shielding effect of the outer duct.

The throttle and mixture control runs were damaged during the accident. The stretching of the cable runs as the engine pod tore free during the impact resulted in the mechanisms being slammed to full travel, damaging the throttle stop and producing overload failure of both throttle and mixture controls. The fuel selector valve operating system was intact and connected but had suffered impact damage throughout its length. There was no evidence of any pre-impact failure or disconnection of the throttle, mixture or fuel selector operating systems. Because of the disturbance of the throttle and mixture controls during the multiple impacts it was not possible to determine their pre-crash settings.

The engine was installed in an instrumented test bed and run for a period in excess of 3 hours during which time its performance was normal in all respects. (See paragraph 1.16.)

1.12.2.3 Fuel and the fuel system

The engine-mounted fuel system was intact and the pipework and its associated connections were sound. Fuel was found in the main supply lines and in the engine driven pump. The injector lines and nozzles were free of obstruction. A very small quantity of water (approx 3 drops) was found in the pipe union at the number two injector nozzle, but the rest of the engine-mounted fuel system was completely free of water. The injector unit inlet filter contained a small quantity of solid debris (of larger dimensions than the airframe filter mesh size) and some lint, but the filter was not obstructed and its ability to pass fuel would not have been significantly affected. The engine-mounted fuel system, with the exception of the injector filter, was completely free of contamination.

The fuel tanks and sump areas were destroyed in the fire, preventing an assessment of their pre-impact serviceability from being made. The pipe runs were considerably damaged but all damage was compatible with the impact.

The fuel selector valve was in the OFF position but bruising of the stop-pin inside the valve and the nature of the damage to the valve operating system, indicate that it was forced into the OFF end of the range during the impact. The selector knob was at the left tank position and was crushed between adjoining structure. The baulk pin, which prevents the knob from being moved to the OFF position accidentally, was not damaged and the nature of the distortion around the knob was such that it could only have occurred if the knob were in the LEFT TANK position prior to the distortion. (See 1.16.2.)

The airframe filter, which is housed in the lower half of the selector valve, was fitted upside down. Consequently the element was not seated correctly and allowed fuel to by-pass the filter element. The incorrectly fitted element did not obstruct the passage of fuel through the valve or affect the performance of the valve adversely, apart from allowing debris to pass the element.

The electric fuel pump was strip examined, found to be in good condition and operated satisfactorily on test.

No solid contamination was found anywhere else in the fuel system but significant quantities of water and fuel were recovered from the electric fuel pump, and traces of water were found in the LEFT TANK port of the selector valve. This water was analysed and compared with the results of similar analyses carried out on water samples from the river tributary adjacent to the crash site and the Fire Service water tender which had attended the scene of the accident. The results of the analyses suggest strongly that the water found in the fuel system entered through damaged pipework and originated from the fire hoses deployed in fighting the post-impact fire.

Fuel samples taken from the bowser which refuelled G–KATY were analysed and found to be satisfactory.

1.12.2.4 *Flying controls*

All control surfaces were present at impact and there was no evidence of any pre-impact damage on any of the control surfaces.

The flying control operating systems were extensively damaged during the impact and post-impact fire, particularly the control runs in the cabin. The control runs were progressively sectioned out of the wreckage and examined for evidence of pre-impact disconnection, failure and for signs of obstruction. Parts of the aileron push/pull rod system were burned away in the fire, but the remainder of the control runs were present in the wreckage. There were numerous overload failures throughout each system but all were entirely consistent with the forces of impact and there were no indications of any pre-impact failure or disconnection.

The control columns were examined for signs of fouling. The columns curve forward and downwards from the hand grip before curving back to attach to a torque shaft mounted laterally beneath the seat structure. Fore and aft (elevator) movement of either column causes the torque shaft to rock about pivot points above the shaft axis, and consequently, the lower section of the control columns move up and down in an angular motion relative to the cabin floor. Both columns were slightly heat damaged at their lower ends but the paint was unbroken and there were no indications of obstruction on either column. The torque shaft mechanisms around the control column attachment points were protected against foreign object intrusion by box-shaped shrouds, with rubberised fabric gaiters, around each column attachment area. Each of these shrouds was in position, the gaiters were intact and there were no signs of paint damage or fouling inside the shrouds or at the edges of the control column apertures.

No evidence of obstruction could be found anywhere in the flying control operating systems. However, two areas of damage similar in character to that which could be produced by a control jam were identified: an area of fretting between a conduit and the underside of the cabin decking beneath the seats, and a small area of light bruising on the edge of a lightening hole corresponding to superficial damage on the elevator control rod which passed through it. The fretting damage was situated in the region of the control circuits, but did not affect their operation. The damage to the elevator control rod had been subsequently painted over and had therefore clearly occurred at some time before the accident flight.

1.12.2.5 *Trim system*

The trim system in the cabin was crushed and distorted in the impact and both operating cables were severed at the rear of the centre pedestal. The system had suffered disturbance during the impact sequence and the evidence of the positions of the various trim system components was conflicting. No reliable assessment of pre-impact trim setting could be made.

1.12.2.6 Police communications equipment board

The board was still secured to the centre seat by the lap strap and by a single bungee rubber strap. It had moved forward partially off the squab and its forward edge had impinged upon the centre control column producing an indentation in the edge of the board. These features were consistent with the forces of impact.

1.13 Medical and pathological information

There was nothing evident in the medical history of either occupant which might suggest a contributory factor to this accident. Also, post-mortem examination revealed that the deaths of the pilot and the photographer were as a consequence of the impact and were virtually instantaneous.

1.14 Fire

There was no fire in the air, however, some 20 to 30 seconds after the impact a severe but localised fire erupted, engulfing the forward sections of both wings and the cockpit of the aircraft.

It is difficult to establish exactly the sequence of events as the fire progressed, but such evidence as was available suggested the following progression.

Because of the aircraft's momentum to the left, caused by the rate of yaw to the right, the fuel released from the starboard fuel tank was thrown towards the cockpit area. This fuel ignited and an intense fire developed, consuming the greater part of the fuselage centre section and forward duct structure, the upper and rear sections of the cockpit pod and severely damaging the instruments and radios. The residual fuel in the starboard tank also ignited and further fire developed along the port wing leading edge and tip, fed by fuel released from the left tank.

It was not possible to identify precisely the source of ignition, but it is probable that the fuel had been ignited by contact with impact-damaged electrical supplies in the cabin area, rather than by contact with hot engine parts.

The first call to the Fire Service was received at 1045 hrs and the first appliance from Ringwood arrived at the scene at 1049 hrs and dampened down what little remained of the fire. The Lyndhurst Brigade also attended the scene.

1.15 Survival aspects

This accident was not survivable.

1.16 Tests and Research

1.16.1 Engine test runs

The engine was mounted in a test bed (with minimal disturbance from its post-crash condition) and its performance checked using the manufacturer's published test schedule for the engine model.

Following initial start-up, fuel was seen to be leaking from the fuel pressure switch mounted on the engine driven pump. (The leak rate could not be measured because of the fire risk.) Subsequent investigations showed that the pressure switch had been forced against the adjacent nacelle ring frame during the accident, with consequent damage to the sealing arrangement. The pressure transducer was removed, the connection blanked off and the engine runs carried out with the unit removed.

The test schedule was completed without further incident and the engine was found to perform normally in all respects.

A series of three further test runs was also carried out, during which the engine's sensitivity to water contamination of the fuel was investigated. These runs were made at the following power settings:

1. Flight idle

2. 2,000 RPM/18.0 inches Hg manifold pressure (equivalent to level flight at between 60 and 70 kt)

3. At the engine economy-cruise power setting

With the engine running at condition 2 above, an individual "slug" of water less than 25 ml in volume produced no discernible effect. A 60 ml slug of water produced no effect for about 15 seconds, after which the engine ran roughly for about 5 seconds and then stopped. Slug volumes between these limits produced no effect for 15 seconds followed by increasingly severe rough running lasting between 5 and 10 seconds, after which the engine recovered and ran cleanly.

The general response to water contamination at power settings 1 and 3 above followed a similar pattern to that of power setting 2, but the delay period before the onset of rough running and the engine's sensitivity to water slugs greater than 30 ml reflected the different fuel flow rates involved. At power setting 1 the delay period was typically 45 seconds, followed by 5 seconds of rough running and the engine was stopped by a slug of 30 ml volume, whereas at power setting 3 the delay was typically 10 seconds, followed by 5 to 25 seconds of rough running, and a slug of 80 ml was required to stop the engine.

Throughout the test runs, which involved a total engine run time in excess of 3 hours, the engine performed without fault.

1.16.2 *The fuel selector*

The ergonomics of operating the fuel selector in another similar production-model Optica was examined. The rotary selector is positioned on the pedestal between the left and centre seats, behind the throttle and mixture controls and only just forward of the front of the seat backs. (See Appendix VI.)

The selector has three positions: LEFT TANK, RIGHT TANK and OFF, selected by twisting the rotary, eliptically shaped, knob such that its forward end indicates the selection made. Between the RIGHT TANK and OFF positions, there is a sprung button protruding upwards from the back plate, forming a baulk, which must be depressed in order to allow the front of the knob to pass over it into the OFF position.

In order to effect a selection, the pilot must lift his right shoulder and position his elbow in the space between the seat backs in order to grasp the rotary knob. The manner in which the knob thereby comes to hand is such that the knuckle of the pilot's index finger, placed along the side of the knob, can inadvertently depress the sprung button, thereby allowing an OFF selection to be made. If this is achieved, the reselection of RIGHT TANK from the OFF position, is infinitely more difficult and may need the use of both hands; one to twist the selection knob, the other to depress the baulk button.

It was customary procedure, within the ASU, to conduct the first half hour of flight using fuel from the left tank and then change the tank selection every half hour thereafter.

The operation of the engine with the fuel selector in abnormal positions was also investigated, with the intention of establishing the engine response to full or partial closure of the fuel selector valve, such as might occur if the selector was inadvertently moved beyond the baulk during a selection to right tank.

It was found that the engine running at a power setting giving 2,100 RPM (static), a setting similar to that which would have been used during the orbits prior to the accident, selection to OFF caused rapid RPM decay and stoppage approximately 10 seconds after the selection was made. Further tests, during which the selector was moved progressively towards fully OFF, established that there was a partial restriction of the fuel flow. With the engine running at 2,100 RPM, movement of the selector into this regime caused hunting (a cyclic surging of RPM) and/or stoppage of the engine after a delay of approximately 30 seconds. It was established that if, at the onset of hunting, the throttle was rapidly closed to give a fan RPM of between 1,000 and 1,500 RPM the engine would generally cease to hunt and would run normally at the reduced power setting. Conversely, increasing power under these conditions led to the onset of hunting or, in more extreme cases, caused rapid engine run-down and stoppage. The use of booster pump at the onset of hunting at 2,100 RPM (leaving the throttle set) produced a temporary return to normal running lasting about 20 to 30 seconds, followed by hunting and run-down of the engine.

As an extension of the above tests, the selector was operated in such a way that the baulk was intentionally over-run, and the selector knob released when it was judged (from the resistance to further movement) that the stop (or baulk) had been reached. The intention was to establish the most probable position of the selector following an inadvertent selection beyond the RIGHT tank position. In all cases it was found that the selector came to rest within the critical regime where the valve was partially closed, and on a significant number of occasions it was exactly aligned with the position which had produced even running at the lower power settings, but had been unable to sustain normal operation at the higher settings.

The selector knob on the aircraft tested differed from that fitted to G–KATY, but operated in a similar manner. Those differences which could be identified would have made the test aircraft less prone to accidental movement beyond the baulk than was likely to have been the case on G–KATY. It was not possible to compare the rigging and system stiffnesses of the two aircraft, preventing a direct read-across of the test results to G–KATY.

Examination of the fuel selectors on five other Optica aircraft (2 in build and 3 in the process of flight testing and development), showed wide variations in ease of operation and effectiveness of the baulk. On one aircraft, on which the interference geometry between the baulk button and selector knob was almost identical to that on G–KATY, the axial restraint of the selector shaft was much less than the others. It was found that on this aircraft, if the knob was lifted lightly as it was rotated, the knob easily rode over the rounded top of the baulk button without any need to separately depress the baulk.

1.17 Additional information

1.17.1 History of the Air Support Unit (ASU)

The ASU began operations in 1979, initially as an experiment for one year to evaluate the feasibility of light fixed wing aircraft in support of police operations. The Unit consisted of six police officers, three of whom were qualified and therefore nominated as pilots, and three nominated as observers. The employment of a professional pilot had been considered but the number of flights over a given period did not seem to justify the employment of a professional pilot. Also, the requirement for an immediate response capability demanded more than one such pilot but the cost was thought to be excessive. The ASU therefore decided to use such pilots, albeit Private ones, as could be found within the Force, but demanded of the applicant 100 hours pilot-in-command (P1) experience, before application could be made to the CAA for an exemption from the requirements of the ANO to allow the holder of a PPL to carry out aerial work.

The Unit was part-time and flew only when required to perform particular tasks. The tasks being flown during this period were generally pre-planned photographic, surveillance, search, traffic monitoring or major incident control.

The aircraft used were hired from local companies and consisted of Cessna 172, 182 and 175 high wing, single engined, four-seat aircraft and Cessna 150 and 152 high wing, single engined, two-seat aircraft.

At the conclusion of the first year's operation the Chief Constable decided that the experiment should be extended for a further year. It was during this period that the subject pilot, who by then had satisfied the Hampshire Constabulary's own requirements was appointed as a pilot for the ASU.

At the conclusion of the two-year experiment the ASU was accepted as an integral part of police operations and has continued to function since that time, albeit on the original part-time basis.

In 1983 it became clear, as the requests for the services of the ASU increased, that further consideration should be given to a method of servicing the need for an "immediate response" aircraft, and increasing the "observer" strength. At the same time particular interest was being shown by ASU members in the progress of the Edgley Optica design, and on the basis of a proposal from the Home Office a recommendation was made to the Chief Constable that an evaluation trial of such an aircraft should be carried out by the Hampshire Constabulary in co-operation with the Home Office.

The recommendation was provisionally accepted and further evaluation was carried out in two parts:

(a) The use of fixed wing aircraft in support of police operations, its cost-effectiveness, and how such an aircraft serviced the need of aerial support in the "immediate response" role; and

(b) the suitability of the Edgley Optica in particular.

Following the evaluation, the Optica was formally accepted by the ASU on 14 May 1985.

1.17.2 *ASU pilot licensing and training*

Since 1977 the CAA had been issuing "Exemptions" to other police forces to enable police officers to fly aircraft in connection with their duties. In 1980 the Hampshire Constabulary requested such an exemption for their ASU and this was granted by the CAA. Without such an exemption it was possible that pilots might breach the aerial work restrictions applicable to holders of Private Pilot's Licences. The exemptions were renewed each year until 1984 when the Civil Aviation Authority declined to issue any further exemption certificates, by that time considering that they were unnecessary provided that the pilots were used on only an "as required" basis, and that their flying was in pursuit of normal police duties and unremunerated.

The pilots were initially tested by the Chief Examiner attached to Southampton Airport and observers attended a week's training in map reading, navigation, basic flying techniques, and later attended an air reconnaissance course with the Royal Air Force.

From the start of the evaluation all the ASU pilots have been periodically tested in accordance with normal Private Pilot's Licence holder's requirements.

Finally, when the Optica was hired for the exclusive use of the ASU, the insurance company demanded that the pilots should have a minimum of 400 hours experience, and the aircraft owners required that 100 hours must have been on police flying. It was necessary to convert the pilots to type and this required continuous flying training and therefore the constant attendance of the pilots. The concept of the trial required the pilots to be employed full time as pilots for the period of the trial. They were therefore engaged in "aerial" work and an Exemption was issued to cover the period of the trial and initial introduction into police service. This was issued and an example is given at Appendix II.

1.17.3 *Low level flying*

Rules of the Air, Rule 5, (see at Appendix V), lays down the minimum heights at which aircraft may operate. However, the accident flight was carried out in pursuit of police duties and under the Special Visual Flight Rules (SVFR). As a result of these conditions, all restrictions to the aircraft's minimum height above ground were lifted except for that one providing that the aircraft shall maintain "such a height as would enable the aircraft to alight clear of the (residential) area and without danger to persons or property on the surface, in the event of failure of a power unit".

The flight path of the aircraft was around the periphery of the town during the 5 minutes preceding the accident and the flight had been cleared by Bournemouth ATC to operate between 500 and 1,000 feet, on a SVFR clearance.

The experience gained by the ASU has clearly shown that throughout the entire range of Police support tasks, there is nothing to be gained by operating a fixed winged aircraft at heights below 500 feet. Indeed, there is considerable disadvantage in doing so as the objective on the ground is more quickly lost than when viewed from a greater height and also the area viewed is commensurately smaller.

However, despite the requirements described above, a Home Office memorandum DT/69 1000/17/16, dated 30 July 1976, states that:

> "The maximum authorised height for police transmissions from aircraft is 500 feet above ground level. This limit is necessary to reduce the risk of interference to other users."

This clearly restricts the ability of the ASU to support ground operations, both vehicular and pedestrian.

1.17.4 Police photographic flights

Such tasks are requested by the Divisional Authority of the Constabulary in question. The task is specific and does not constitute a roving commission to fly around at will, or perform any flight manoeuvre not required by the briefed task.

In the case of the Ringwood area task, the crew were briefed to photograph individual road junctions. Having accomplished the particular area shots, the aircraft would have been expected to climb in order to position for pictures of the overall scene, to assist with the subsequent correlation of the detailed photographs. The detailed photographs are normally taken from an optimum height of about 1,000 feet and the overall scene from 1,500 feet.

1.18 New investigative techniques

None.

2. Analysis

2.1 General

The departure of the aircraft from Lee-on-Solent and the flight to Ringwood appear to have proceeded normally. Similarly there is no indication of either an operational or technical problem occurring during the preliminary orbits of Ringwood. The sequence of events leading to the accident appears to have begun during the final orbit, when the aircraft started to descend.

This analysis evaluates the relevant areas of the engineering evidence and examines possible operational reasons for the initial descent and the final spiral. The training and operational aspects of ASU flying are also discussed.

2.2 The flight profile

The aircraft arrived in the area of Ringwood at 700 feet having been cleared to operate between 500 and 1000 feet. Witness statements variously indicate that the initial orbits were flown at somewhere between 1000 and 500 feet, but the difficulty of judging height from the ground is well known. However, the height at which the aircraft arrived and the demands of the task to be carried out suggest an intermediate height, at neither extreme of the ATC clearance but toward the upper end, perhaps about 800 feet.

The pilot informed Hurn ATC of his arrival at Ringwood at 1032 hrs. The next and last transmission was at 1037 hrs when the pilot requested clearance to operate up to 1500 feet. This accords with the normal practice of the ASU, in climbing so as to position the aircraft for a final picture of the overall scene. During this transmission, the pilot made no mention of any difficulties and apparently believed that he could attain the new height which he had requested. However, a few seconds before the accident, the aircraft was seen to be flying at a height between 100 and 150 feet and, from the timing shown by the resulting ground emergency calls and also from some witness statements, this occurred at 1040 hrs. It is therefore reasonable to assume that the descent began between 1037 and 1040 hrs.

The Optica has a quoted optimum "loiter speed" of 65 kt and it is assumed that the aircraft was orbiting at about this speed. Witnesses on the ground gave evidence as to the flightpath of the final orbit which is shown at Appendix I. Although orbits were more of a racetrack pattern than a circle, the mean radius of the final orbit was 0.3 miles. The circumference of that orbit was therefore approximately 2 miles which, flown at an average 65 kt, takes about two minutes. Some witnesses, however, stated that the initial orbits were wider than the final one, so a little more time may be allowed for each of those. Assuming that both the arrival time (1032 hrs) and the time of the accident (1040 hrs) are correct, it can be seen that only 3, or a maximum of 4, orbits were carried out and that the descent must have begun at the start of or slightly before the final orbit.

In summary, from the available evidence, the aircraft performed 2 or possibly 3 orbits at around 65 kt and at a height of 800 feet before carrying out the final one, during which it descended to 100-150 feet agl.

2.3 The initial descent

There is no direct evidence as to the cause of this descent, there are however, four possible reasons for such a descent taking place, and these fall readily into the following categories: intentional, inadvertent, incapacitation and enforced. However, the identification of the hypothesis most compatible with all the known facts may not, because of some undiscovered factor, lead to the correct solution. These possibilities are considered below.

2.3.1 *An intentional descent*

Because of recent publicity, the aircraft was well known to the local population and they were aware that it was flown by the police. As the accident occurred on a market day, the town was very crowded and there were several senior police officers present to cover an anticipated event unconnected with the Optica's task. The presence of these officers was known to the Optica's crew and they were therefore unlikely to jeopardise their career prospects by intentional and unauthorised low flying. Furthermore, there was no operational reason to descend below the normal reconnaissance height and the pilot had requested climb clearance which would suggest that the task required an increase in height rather than the converse.

2.3.2 *An inadvertent descent*

In order to maintain visual attitude in conventionally configured, single engined aircraft, it is common to use the engine cowling or the edges of the windscreen as the aircraft reference point but, because of the bubble type cockpit and rear mounted engine, the Optica offers neither of these visual cues. Furthermore, on the day in question, the limited visibility may have obscured the horizon, making the task more difficult. Nevertheless, in the two minutes taken for the descent it would be unusual for the pilot not to consult his altimeter at any stage.

The appreciation of aircraft height can be degraded by a mental condition, well known to military pilots as "target fixation", wherein the attention is concentrated so exclusively upon one object on the ground that all other visual cues pass unnoticed. However, for this to be considered as a factor, it would have been necessary that the pilot, ignoring the task in hand, saw and concentrated exclusively upon one object, person or event on the ground. Such evidence as is available suggest that this is unlikely.

Furthermore, whereas a considerable height loss can pass unnoticed at medium heights, it is hard to imagine that in this case the appearance of ground features level with the aircraft would not have alerted the pilot to his low height and cautioned him against entering the steep turn which followed.

2.3.3 *Incapacitation*

The post-mortem examination of both crew members provided no evidence of pre-impact illness, however their condition following the fire may have disguised some evidence. In any event, temporary spells of nausea, giddiness or even unconsciousness are unlikely to be revealed by post-mortem examination, and so this must remain a possibility.

The likelihood of this occurrence is however reduced by the smooth and apparently controlled manner in which the aircraft manoeuvred. The photographers, unlike the observers of the ASU, are not trained to control the aircraft in the event of pilot incapacitation, and it is therefore unlikely that the photographer flew the aircraft for the final orbit. This suggests that the pilot was handling the controls and therefore sufficiently conscious to fly the aeroplane in the controlled manner seen.

2.3.4 *An enforced descent*

This condition can only have been brought about by:-

(a) Jamming of the flying controls; or

(b) Engine malfunction

2.3.4.1 *Jamming of the flying controls*

Detailed examination of the control surfaces and runs revealed no indication that any jamming had occurred. The wreckage examination did not rule out the possibility of control obstruction by loose articles in the cockpit, although neither control column had any bruising indicative of this having occurred. Furthermore, the relative positions of the front of the seat to the rear of the control column suggests that an object lodged in that position would be easily removed and would in any case have produced a progressively steepening dive and probably some fairly violent manoeuvres as an attempt was made to dislodge it. The possibility that the police communications equipment board had moved forward and had fouled the centre control column was also considered but the deep identation found at the front of the board made during the impact would have obliterated any lesser evidence of fouling that may have occurred in flight. It has therefore not been possible to reach any firm conclusion as to whether such an obstruction occurred before impact, but the fact that one bungee strap and the lap restraint strap were still in position after the severe impact suggests that the board was adequately restrained in flight. None of these possibilities accords with the balanced and smooth flight observed and furthermore no distress call was made. Consequently it is considered unlikely that obstruction of the flying controls was the cause of the initial descent.

2.3.4.2 *Engine malfunction*

One of the characteristics of this engine and fan assembly is that the fan will not windmill and thus a dead engine will not continue to rotate. The evidence of fan and engine rotation at impact therefore shows that the engine was running under some power at least during the final part of the descent. The height loss achieved in the probable time span also suggests that the average power provided by the engine was better than idle RPM. It does not, however, prove that the engine had not stopped and then been re-started using the key starter, and this could not be determined from the statements of witnesses who were approximately equally divided in opinion as to whether the engine noise was constant and normal or unusual. Furthermore, the ducted fan design of the Optica produces a radically different noise footprint than conventional light aircraft. The aspect of the Optica to the witness makes a considerable difference in the noise perceived.

The examination of the engine components, and the subsequent test-bed runs, showed that, as found, the engine was capable of its normal performance. Furthermore, the duration of abnormal running due to water contamination would not exceed 30 seconds before either the engine stopped or recovered, a time interval which does not match the duration of the descent. There is therefore nothing to suggest that, with standard operational handling, the engine would do anything except run normally.

Nevertheless, although unsupported by solid evidence, it remains a possibility that there was some loss of power caused by a transient condition, which in common with most transient problems once remedied, are difficult or impossible to repeat under test-bed conditions. However, the malfunction may be the consequence of an engine control selection and two facts lend credibility to this suggestion.

Firstly, witnesses who watched the aircraft only seconds before the accident stated that the crew were 'fiddling' with something in the middle of the cockpit and, although the witnesses were unable to establish exactly what the crew were doing, all the engine controls are in that area. Secondly, the aircraft had been flying for just under half an hour which is the time that the crew would consider selecting the fuel supply from one tank to the other. The subsequent examination of a similar selector clearly showed how easily a misselection could be made and the relative difficulty of rectifying it. Furthermore, should this hypothesis match the actual course of events it would exactly accord with the established evidence above.

If indeed there was a malfunction co-incident with this selection, an explanation of why the pilot continued the orbit is needed. If he had just made the selection, he may have considered that the occurrence was a direct consequence and, as such, could quickly be remedied. Then again, if the occurrence immediately followed initiation of the requested climb to 1500 feet, the pilot may well have reasoned that a return to level flight would cure the problem. In either of these cases, it is likely that the pilot would continue the orbit until it became apparent that the problem could not be cured and so a forced landing was imminent.

In summary therefore, whereas the possibility of a power loss caused by a transient malfunction cannot be eliminated, the evidence as is available tends to support the hypothesis of inadvertant mis-handling of the fuel tank selector.

2.4 The steep turn

The circumstances of the final steep turn depend upon what is believed to be the reason for the initial descent.

There have been three incidences recorded by the operator of inexperienced passengers in the right hand seat of an Optica, during a steep turn to the right, grabbing something because of a feeling of insecurity engendered by a combination of the perspex sided cockpit and the inertia-reel upper torso restraint. On one of these occasions, the passenger grabbed the centre control column, causing a sudden increase of bank angle. This action may have been repeated by the photographer who was on only his second flight. In this event, with normal control inputs to achieve the 45° bank turn, the sudden increase in bank angle would cause the nose of the aircraft to drop and enter a spiral, in exactly the manner which was seen to occur.

On the other hand, it could be supposed that during a descent occasioned by engine malfunction, the pilot would be looking for an area in which to make a forced landing. On initial inspection, the fields to the west of the town appear ideal for this purpose, however, closer inspection reveals a mass of high tension cables and narrow ditches. This would lead the pilot to the field just west of the accident site, but again closer inspection showed that it too was inhospitable, for the same reasons. The one remaining field is a few metres to the north-east of the copse into which the aircraft crashed and would require the immediate application of controls to achieve a sharp turn to the right, in order to position the aircraft for a landing. This is exactly what the aircraft appeared to do. However, because of either the attention needed to locate a landing area, or perhaps the inability to apply power, the aircraft may have been flying at a speed lower than the recommended optimum gliding speed of 70 kt. Even at 70 kt the aircraft would stall at about 56° of bank in a balanced turn, and at 60° of bank would stall at 76 kt.

However, when stalled under test conditions, the aircraft does not generally show a tendency to drop a wing and therefore the application of an unexpected control input by the photographer might be considered the more likely of the two possibilities.

Regardless of the cause for the sudden 90° of bank, the fact remains that the aircraft had insufficient height for the pilot to recover from either event before impact with the ground.

2.5 Summary of factors

Detailed examination of the aircraft and its systems failed to identify any defect which could be considered relevant to the accident. Analysis of the evidence found on the individual components of the aircraft, although in part circumstantial, also suggests that, prior to the impact with the trees, the aircraft was serviceable, but the occurrence of a transient power loss could not be dismissed.

The investigation benefitted from the evidence of more than 300 witnesses but this provided no direct evidence as to the reason for the initial descent or the final spiral. However, it is considered that the most likely reason for the initial descent was a transient engine malfunction however caused, and that the final spiral was either as a result of interference with the controls or a stall in the turn.

2.6 Pilot training and experience

There is no doubt that the training of the ASU pilots was conceived and carried out in a most professional manner. The requirements for both a Night Rating and an Instrument Meteorological Conditions Rating were essential qualifications for this type of work and the ASU had previously enjoyed an accident-free record. Nevertheless, the use of private pilots to perform aerial work of such a demanding and precise nature does leave itself open to question. Private pilots as presently licenced, are not necessarily less safe than professional pilots, but the continuity of training and the experience gained in the acquisition of a professional licence is likely to provide a greater level of competence. However, a professional licence would not necessarily best qualify pilots for this type of operation, as their experience may have no relevance to the type of flying involved. It is therefore apparent that a specialist licence, pertinent to the requirements of the task is needed. There are a number of other areas in the non public transport sector of aviation which would benefit from specialist licencing. A specialist pilot would be better qualified to assess the relative priorities of such a demanding task and would be less likely to be caught out in times of high workload or operational hazard. Such a system would also help to resolve any conflict which might arise between such a pilot's professional duties as a pilot and the general duties of his employment.

2.7 Low level flying

Rule 5(2) (b) of Rules of the Air provides that Rule 5 (1) (e) shall not apply to an aircraft in the service of a Police authority.

However, there is seldom an occasion when the police need to fly a fixed winged aircraft below, or even as low as, 500 feet above the ground. The greater the altitude, the longer the observer can keep the subject in view, and this far outweighs any advantage gained by very low level flight. Moreover, as soon as the aircraft descends, or even lands, the advantage of having an airborne control, one of the greatest assets of an ASU, is immediately lost. However, the Home Office memorandum prohibiting the use of transmitters above 500 feet clearly conflicts with the ASU tasks and consequently is the only reason for flights to be conducted below that height. It is therefore suggested that, in the interests of flight safety, the necessity for the police to be exempted from the provisions of Rule 5 (1) (e) be reviewed for the case of fixed wing aircraft and that the Memorandum be amended accordingly.

Ringwood is, by geographical coincidence within a Special Rules Area and, for this reason alone, the flight was given an SVFR clearance which made the height at which the aircraft was operated legal. Under the provision of Rule 5 (2) (a) (see Appendix V), it was exempted from the necessity to maintain 1500 feet above the highest fixed wing object within 2000 feet of the aircraft whilst flying over a congested area. Ringwood town on a market day must fall into the category of a congested area. The purpose of Rule 5 (2) (a) is to allow ATC to sequence aircraft flying under the Visual Flight Rules (VFR) into, out of, or through an area largely populated by aircraft flying under the Instrument Flight Rules (IFR). In the particular case of Hurn ATC, an SVFR clearance is normally given when inter alia, the visibility is less than 10 kilometres, as it was on this occasion. It is apparent therefore that it was only the SVFR clearance which rendered this flight, below 1500 feet, legal. The police do have a useful task to perform with their fixed wing aircraft and empirically the optimum height for this to be achieved is around the 1000 feet agl. Whilst it is not acceptable for police aircraft to operate over built up areas at a height below which they cannot glide clear there is a need for such aircraft to fly closely round the perimeter of towns to observe various features within the town. Provided they can glide clear of the populated area it would seem sensible to exempt them from Rule 5 (1) (a) (ii) to enable them to fly as close as possible to their area of interest without creating an unacceptable hazard.

It is therefore suggested that the CAA gives consideration to issuing an exemption to Rule 5 (1) (a) (ii) for flight in the service of a police authority inside or outside controlled airspace.

3. Conclusions

(a) *Findings*

(1) The pilot held a valid Private Pilot's Licence with a valid medical certificate.

(2) The aircraft had a valid Certificate of Airworthiness in the Transport Category (Passenger) and had been maintained in accordance with an approved schedule.

(3) Both the pilot and the photographer died of the injuries sustained during the impact before the ground fire began.

(4) The aircraft had been properly loaded and the C of G was within the prescribed limit.

(5) There was sufficient fuel on board and the engine performed normally during post-accident trials, but the possibility of a transient malfunction in flight could not be ruled out.

(6) There was no indication that either structural or mechanical failure had occurred or of flying control malfunction or jamming.

(7) Communications throughout the flight were normal and did not therefore provide evidence of any in-flight emergency.

(8) Impact disturbance prevented an assessment of the pre-impact settings of the engine controls but they had been fully connected prior to the impact.

(9) The design of the fuel tank selector was such that an inadvertant selection to OFF was possible.

(10) The final loss of control was caused by either the aircraft stalling in the turn at a high angle of bank, or the nose dropping or inadvertant interference with the controls by the photographer alarmed by his apparent insecurity.

(11) The pilots employed for ASU work on fixed winged aircraft should be specifically licenced for the task.

(12) Rule 5 (2) (b) does not adequately cover police activities in that Rule 5 (1) (a) (ii) is exempted only under the provisions of Rule 5 (2) (a).

(13) The Home Office ruling, with regard to police radio transmissions seriously detracts from the ability of ASU aircraft to carry their primary task of co-ordination.

(b) *Cause*

The report concludes that it was not possible to identify the cause of either the initial descent or of the subsequent loss of control, however, the loss of control occurred at a height which was too low for recovery to be made. The balance of available evidence suggests that the aircraft was serviceable immediately before the impact but that the pilot was forced to descend by a partial or transient power loss, possibly occasioned by mishandling of the fuel tank selector or some other cause. A contributory factor could have been the ease with which a mis-selection of the fuel tank selector can be made in certain circumstances.

4. Safety Recommendations

4.1 The CAA should give consideration to the issue of licences specific to the task for non public transport operations.

4.2 The content of the Air Navigation Order and the Regulations Rule 5 (2) (b) should be reviewed with the intent of making it more compatible with the ASU task.

4.3 The Home Office ruling, with regard to the maximum height of air to ground radio transmission, should be reviewed in the light of the ASU task.

4.4 The design of the Fuel Selector be reviewed to minimize the risk of inadvertant selection to OFF and provide a satisfactory single handed selection from OFF to either tank.

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