Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Hawker Siddeley HS 125 Series 600B G-BCUX Report on the accident near Dunsfold Aerodrome, Surrey, 20 November 1975

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12/76	Piper PA28 Series 180 (Cherokee) G-AVSB at Denham Aerodrome, Bucks June 1975	October 1976
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ISBN 0 11 511805 5

No.	*Short title*	*Date of Publication*
14/76	Piper PA 23-250 Turbo Aztec 'D' N6645Y at Arkley, Hertfordshire November 1975	December 1976
15/76	Piper PA-31 Model 350 G-BBPV at Little Sandhurst, Berkshire October 1975	February 1977
16/76	Cessna F150 G-AVSS and Cessna F 150 nr Guildtown, Perthshire November 1975	April 1977
17/76	Bell 47G Helicopter G-BBKP at Grange Farm, Kingswood, nr Wotton-under-Edge Gloucestershire March 1975	February 1977
18/76	Beechcraft 95 – B55 (Baron) G-AZUJ at Birmingham Airport, England November 1975	April 1977

Department of Trade
Accidents Investigation Branch
Shell Mex House
Strand
London WC2R 0DP

8 February 1977

The Rt Honourable Edmund Dell MP
Secretary of State for Trade

Sir,

I have the honour to submit the report by Mr R D Westlake, an Inspector of Accidents, on the circumstances of the accident to Hawker Siddeley HS 125 Series 600B G-BCUX which occurred near Dunsfold Aerodrome, Surrey on 20 November 1975.

I have the honour to be
Sir
Your obedient Servant

W H Tench
Chief Inspector of Accidents

Accidents Investigation Branch
Aircraft Accident Report No. 1/77
(EW/C545)

Operator:		Hawker Siddeley Aviation Limited
Aircraft:	*Type:*	HS 125
	Model:	Series 600B
	Nationality:	United Kingdom
	Registration:	G-BCUX
Place of Accident:		Near Dunsfold Aerodrome, Surrey
Date of Accident:		20 November 1975

All times in this report are GMT.

Synopsis

The accident was notified by London Air Traffic Control Centre to the Department of Trade on 20 November 1975.

The Accidents Investigation Branch of the Department of Trade carried out an investigation and the following groups were established; Operations and Engineering.

The accident occurred when the aircraft flew into a large flock of Lapwings just after becoming airborne, and both engines lost power due to surge conditions brought about by bird ingestion. The pilot made a forced landing back onto the runway he was using for take-off but the aircraft overran the end and was substantially damaged as it crossed a deep ditch; it was destroyed by a subsequent ground fire. One of the two crew members was injured; the seven passengers were not hurt. During the overrun the aircraft crossed a main road and struck a passing motor car; the car was demolished and its six occupants were killed.

It is concluded that the cause of the accident was a serious power loss on both engines following multiple bird ingestion just after the aircraft became airborne.

1. Factual Information

1.1 History of the flight

The aircraft was making a demonstration flight at Dunsfold and took-off on Runway 07 at 1611 hrs with two pilots and seven passengers on board. Until the aircraft started its take-off run no birds had been noticed which could have been a hazard to the aircraft but nevertheless, in accordance with normal bird strike precautionary procedures, the aircraft took-off with its landing lights as well as strobe and navigation lights on. At the moment the aircraft started to roll eye-witnesses saw a large flock of birds rise from the grass verge north of and towards the eastern end of the runway, apparently having been disturbed by an incoming Harrier aircraft as it taxied west along the perimeter track after landing. This track lies about 120 metres north of and parallel to the runway at this point (see Appendix 1). These birds rose into the air in a fairly dense formation and wheeled south across the runway just as the HS 125 became airborne. Other witnesses noticed a second bird flock rise from the centre of the aerodrome at the same time and fly north.

The aircraft became airborne shortly before the halfway point of the runway and the commander had just reduced power from 100 per cent to between 98 per cent and 96 per cent and ordered the undercarriage raised when the aircraft, then at a height of 50 to 100 feet and a speed of approximately 150 knots, met either or both of the bird flocks. The commander heard and felt a series of bangs as birds hit the aircraft. The ground witnesses describe hearing the engines at high power prior to the aircraft encountering the birds, and then hearing a succession of noises (between one to three), variously described as a muffled explosion, bang, thump, boom or whoomf followed by the cessation of the high power engine noise. At the same time balls of flame, lasting between one to three seconds, appeared at the rear of each engine. Some witnesses also saw birds falling away from the aircraft, and after the accident the remains of 11 dead birds identified as Lapwings *(Vanellus vanellus)* were found at a point about 1,170 metres from the commencement of the runway, ie a little over half way. The largest of the dead birds weighed 303g and had a wingspan of 61cm.

Although neither pilot noticed any instrument indications following the bird strike the commander sensed an immediate decrease in acceleration which he considered was due to a complete loss of power on both engines; he also thought that some of the bangs were caused by the engines surging. He therefore decreased the climb attitude to maintain flying speed, partially reduced the throttle setting, and then re-opened to full throttle, but as far as he was aware there was no increase in thrust from either engine. He therefore decided to make a forced landing straight ahead and called for the undercarriage to be extended and for full flaps; simultaneously he closed the throttles and lowered the nose of the aircraft to assume the appropriate attitude for an approach to land.

The aircraft touched down on the mainwheels about 180 metres before the end of the runway at a speed the commander estimated as approximately 120 knots; after lowering the nosewheel onto the ground he applied full wheel brakes which he maintained throughout the whole of the landing run. The aircraft overran the end of the runway and continued in a straight line across grass fields and through hedges before striking a ditch on the west side of the A281 road, about 285 metres beyond the end of the runway; the impact with the ditch ruptured and initiated the detachment of the entire undercarriage. The aircraft then bounced across the road at an estimated speed of 85 knots and in so doing struck and demolished a passing private motor car; all six occupants of the car were killed. The aircraft continued on it underside for about 150 metres across a field on the far side of the road. Shortly before it came to a stop the commander closed the high pressure fuel cocks.

Noticing light behind him the commander assumed the aircraft was on fire and ordered an immediate evacuation; the forward entry door was opened when the aircraft came to a stop and all nine occupants safely evacuated it before the fire spread.

The accident occurred in daylight at 1611 hrs in position 51° 07'N 00° 31'W at an elevation of about 170 feet

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	–	–	6
Non-fatal	1	–	–
None	1	7	

1.3 Damage to aircraft

The aircraft suffered substantial crash damage and was largely destroyed by the subsequent ground fire.

1.4 Other damage

A Ford Cortina motor car was destroyed by impact with the aircraft. Damage was also caused to hedges and to a pasture field which was affected by fire and spilled fuel.

1.5 Crew information

(a)

Commander	Male
Age:	58 years
Licence:	Commercial Pilot's Licence valid to 23 February 1976
Limitations:	Valid only while the holder is employed as Test Pilot by Hawker Siddeley Aviation and for flights made in the course of that employment not being flights for the purpose of Public Transport or Aerial Work. Holder to wear spectacles for correction to distant vision and should have available a second pair whilst exercising the privileges of the licence.
Aircraft ratings:	Aircraft Part 1; Comet, Trident, Dove HS 104, Heron HS 114, HS 125. Instrument rating valid to 7 April 1976.
Last medical examination:	14 November 1975, assessed fit, valid to 31 May 1976.
Last certificate of test:	30 October 1975.
Total pilot hours:	11,848 hours.

	Total flying hours in command HS 125 aircraft:	1,327 hours
	Total flying hours in last 28 days:	20 hours
	Rest period:	No flying duties from 1320 hrs on 18 November 1975 to 1130 hrs on 20 November 1975
	Previous take-offs and landings at Dunsfold:	12, the most recent being on 7 March 1975
(b)	Co-pilot	Male
	Age:	43 years
	Licence:	Private Pilot's Licence valid to 11 January 1977
	Ratings:	Group 'A'
	Last medical examination:	14 November 1975, assessed fit, valid to 30 November 1976
	Total pilot hours:	1,030 hours
	Total flying hours as co-pilot on HS 125 aircraft:	891 hours
	Total flying hours in last 28 days:	22 hours
	Rest period:	23 hours
	Previous take-offs and landings at Dunsfold:	15, the last being on 12 September 1975

The co-pilot also held a Flight Engineer's Licence and had flown 3,530 hours in that capacity on Comet, VC10 and Trident aircraft.

1.6 Aircraft information

1.6.1 General

The aircraft, fitted with two Viper Mark 601 Turbo-jet engines, was constructed in 1974 and issued with a 12 month Transport Category (Passengers) Certificate of Airworthiness on 3 February 1975. It was owned and operated by Hawker Siddeley Aviation Limited and used as a demonstration aircraft. The records show that the aircraft's documentation was in order and that it had been maintained in accordance with an approved maintenance schedule. There had not been any significant or recurring defects during the aircraft's and engines' total operating time of 373 hours since construction; approximately 110 hours had been flown since its last Check A (200 hours or 4 calendar months inspection) which was completed on 23 September 1975.

At take-off the aircraft's wing tanks contained approximately 878 gallons of Avtur; the ventral and dorsal tanks were empty. The aircraft's weight was 3,650 lb below its maximum certificated take-off weight of 25,500 lb and its centre of gravity was 26.2 per cent Standard Mean Chord (SMC); limits – 18.7 per cent to 30.8 per cent SMC.

1.7 Meterological information

The following weather observation was recorded at Dunsfold Aerodrome at 1613 hrs:

Surface wind:	020°/4 knots
Cloud:	6/8 stratocumulus at 3,000 feet
	8/8 at 8,000 feet
Visibility:	20 kilometres
Weather:	Cloudy
Temperature:	+9.7°C

The natural light conditions were fair, the sun having set 5 minutes before the time of the accident.

1.8 Aids to navigation

Not applicable.

1.9 Communications

The VHF radio communications between Dunsfold Tower and Approach and the aircraft were normal. The last message from the aircraft was an acknowledgement by the pilot of his take-off clearance and airfield departure instructions.

1.10 Aerodrome and ground facilities

Dunsfold Aerodrome is situated 8½ miles south-southeast of Guildford and is at an elevation of 173 feet; almost 30 per cent of the surrounding countryside is woodland. The aerodrome has three runways which form a triangle with its apex to the south but only Runway 07/25, which is the northern side of the triangle and has a length of 2,127 metres, is in use. The two unused runways are for the main part rough with grass growing in the joints. Almost the whole of the runway area is encompassed by a perimeter track, the enclosed area being grass covered except for the runways themselves and a group of trees on the southwest side of the aerodrome. Together with further grass areas, which are outside the perimeter track at each end of Runway 07/25, the total area of the grass amounts to 95.5 hectares (236 acres). Further information relating to bird control at Dunsfold is at paragraph 1.17.1.

1.11 Flight recorder

There was no requirement for a flight recorder and none was fitted.

1.12 Wreckage

1.12.1 The aircraft

The aircraft had touched down approximately 180 metres before the upwind end of the take-off runway (07). Marks made by both main wheel tyres were evident at this point; some 60 metres further on the mark of the nosewheel tyre together with the regular pattern of heavier main tyre scuff marks indicated the commencement of Maxaret controlled braking. After leaving the runway the tracks of the wheels continued

slightly to the left of the runway extended centre line on to soft damp pasture fields. The aircraft had then passed through a thin hedge and fence and then through a more substantial hedge prior to ploughing into a thick hedge and a wide and deep ditch forming the west side of the A281 road.

The massive impact of the wheels in the ditch had initiated the detachment of the three undercarriage legs and the aircraft, with its detaching undercarriage, then struck a concrete post in the hedge and bounced across the road. The inner leading edge of the left wing of the aircraft had been torn open when it hit another concrete post on the east side of the road which initiated the release of a considerable amount of fuel. The aircraft then impacted heavily into the pasture land to the east side of the road, spilling fuel from its damaged left wing and shedding the remnants of its three undercarriage legs. It finally came to rest on the underside of the fuselage, after gradually turning to the right, some 620 metres from where it had first touched down. As the aircraft crossed the road it struck the offside of a southbound motor car, slicing off its roof. All six occupants of the car were killed instantly as it was dragged into the field on the east side of the road.

The ensuing ground fire burned much of the centre fuselage and the inboard areas of the wings. This ground fire caused most of the aircraft damage; other damage was related to the detachment of the undercarriage, to the tear in the left wing and to some damage to the wing leading edges. There was no evidence of bird strikes on the airframe. Subsequent inspection of the aircraft showed that the flaps were at 45° (normal landing position); the airbrakes were closed and the Maxaret brake units were serviceable.

1.12.2 Engines – on-site examination

The air intake of the left engine appeared to be reasonably free of debris, but some fairly substantial pieces of hedge were found to have lodged around the intake bullet of the right engine. Although the tips of several of the zero stage steel compressor rotor blades on the two engines appeared to have been slightly bent, the only positive indication of bird ingestion was the odour emanating from each engine. The cowlings were removed from the engines and nothing unusual was noted on their control systems or surfaces.

There were traces of foreign matter and water in the engines' fuel filters and fuel samples taken from them showed some divergence from specification both in colour and water reaction. This was not considered relevant as much of the aircraft's fuel system had been subjected to post-crash heating and to contamination by water whilst the ground fire was being extinguished; a sample of fuel from the bulk storage facility at Hatfield, from which the aircraft had last been refuelled, was found to be satisfactory.

1.12.3 Engines – subsequent examination

The engines were taken to the manufacturers for dismantling, examination, reassembly and test running. After dismantling the engines it was found that the first and subsequent stages of each compressor were damaged. This damage consisted of bending and nicking of the 'O' stage blade tip leading edges and minor nicking of the edges of the blades in subsequent stages. The type and pattern of this damage was consistent with one or more birds having passed through each compressor without causing blade detachment. Deposits from the ingested bird(s) were found in the internal areas of the blow-off valve system in each engine and there were also traces of other ingested material such as earth and wood in the diffusers and primary air tube drillings, which indicates that the engines had still been rotating at considerable speed after the aircraft had left the runway.

After superficial cleaning, each engine was then rebuilt to its pre-dismantled condition and prepared for functional testing. The test runs showed that although each engine

was surge-free at 96 per cent to 98 per cent rpm, both engines surged whilst being accelerated and decelerated through the blow-off valve closing point at 78 per cent rpm.

This reduction of the surge margin was attributed to a deterioration in the compressor characteristics caused by the damaged blading. With the blow-off valves manually opened, surge-free handling was achieved on both engines, albeit at reduced power. Corrected power checks on the engines showed that their performance at 100 per cent rpm was as follows:

Blow-off valve position	Thrust lb	
	Left	Right
Closed (surging at 78 per cent rpm)	3,426	3,500
Open (surge-free throughout)	3,070	3,210
Note: Thrust achieved during initial acceptance check (new).	3,695	3,702

1.13 Medical and pathological information

The commander suffered injuries to his back. After hospital treatment he was discharged after 13 days and was found fit to resume flying duties after 64 days.

The six occupants of the motor car that was struck by the aircraft died of multiple injuries.

1.14 Fire

A fire which started in the left wing root area spread quickly immediately the aircraft came to rest and the whole of the fuselage from just aft of the cockpit to the area of the engine nacelles was badly burned as were both inner wing areas. The evidence indicates that ignition of fuel occurred at the moment of impact between the aircraft and the motor car and both were on fire from that moment. An area of fuel soaked grass between the A281 road and the aircraft crash site also caught fire.

The duty crew of the aerodrome fire service saw the aircraft forced land and were at the accident site in approximately 4½ minutes. When they arrived the exterior of the aircraft was well alight on both sides as well as the interior furnishings in the centre section. The fire was extinguished within 14 minutes.

Three appliances from the aerodrome fire service supplemented later by five appliances and other vehicles from the Surrey Fire Brigade were used in fighting the fire. The Rapid Intervention Vehicle of the aerodrome fire service using aqueous film forming foam plus a monitor from a foam/CO2 tender using fluoro protein foam knocked the fire down in approximately 40 seconds. The internal fire was extinguished by jet/spray nozzle with the fire fighting personnel wearing breathing apparatus. 200 gallons of pre-mixed aqueous film forming foam, 75 gallons of fluoro protein foam compound and 1,250 gallons of water were used by the aerodrome fire service in dealing with the aircraft fire. The Surrey Fire Brigade used foam compound in dealing with the fire in the area of the motor car that had been struck. Seven members of the aerodrome fire service and forty-two members of the Surrey Fire Brigade were in attendance.

1.15 Survival aspects

The deceleration forces during the overrun were initially low, but when the aircraft struck the ditch beside the A281 road a severe load, sufficient to rupture all three

undercarriage legs, was imposed on the structure. Further substantial deceleration forces were experienced as the aircraft continued on its underside for approximately 150 metres before coming to a stop. The two pilots were wearing full inertia-reel type shoulder harnesses and all seven passengers, two in aft facing seats, two in forward facing seats and three in side facing seats, had their lapstraps fastened. All the occupants experienced severe shaking during the overrrun sequence and although all suffered some degree of shock no one sustained an incapacitating injury and all were able to leave the aircraft safely and quickly, through the main door, when the aircraft came to a stop. The commander suffered injuries to his back but was able to walk away from the aircraft; he was later taken by ambulance to hospital where he was detained for treatment.

1.16 Test and research

Nil.

1.17 Additional information

1.17.1 Bird control measures at Dunsfold

At the time of the accident, and in conformity with experimental results which indicate that long grass (of the order of 15 to 23 cm) tends to discourage birds from resting or feeding on aerodromes, the grass for 90 metres on either side of Runway 07/25 was grown long except for a 5 metre gang-mown (ie cut short) strip immediately alongside the runway edges, obstructions, etc. In the central triangle, an area of some 15.5 hectares (38 acres) lying to the south of the main runway, the grass was also grown long but was used for hay production and at the time of the accident had been cut short. All other grass areas were gang-mown and kept short so that approximately 38 hectares (94 acres) ie 40 per cent of the total grass area of the aerodrome conformed to the long grass policy. Long grass, despite its effectiveness in reducing bird numbers, was not, in itself, expected to solve the aerodrome bird problem and Dunsfold also used recorded distress calls and shellcrackers. Unfortunately, the broadcasting playback equipment had not been operating correctly and the Lapwing tape, which was suspect, had been taken to the Pest Infestation Control Laboratory (PICL) of the Ministry of Agriculture, Fisheries and Food for examination the day before the accident occurred.

The decision to take action to scare birds off the aerodrome at Dunsfold rested with Air Traffic Control (ATC) and if the birds were on the ground and clear of the runway, the policy was to leave them alone. When birds were seen to be on the main runway or flying around in significant numbers a request for bird scaring action was initiated by ATC and carried out by the aerodrome fire service. The scaring procedure employed was to try to drive the birds off the aerodrome or at least down to the south side where they were considered to be out of harm's way.

After the accident PICL officers were asked to inspect Dunsfold Aerodrome and report on the bird situation there; visits were made on 25, 26 November and 3 December 1975. In their report the officers noted that the bird numbers appeared to be fairly consistent at about 500 (Lapwings) throughout the periods of inspection; however, because the visits were limited and because conditions can change in short periods of time, it did not necessarily follow that this number of birds would have been present on the day of the accident. The officers had little opportunity to survey the surrounding terrain and were of the opinion that local movements and weather might be expected drastically to influence this number one way or the other; it was their opinion that Lapwings would certainly be less numerous in the summer. They also commented that virtually all the birds seen on the aerodrome appeared to be confined to the short grass areas. Although generally approving the efforts already made at Dunsfold to deal with their bird problems the PICL report made a number of suggestions including an

increase in the surface area to be made subject to long grass and that more responsibility for bird scaring action should be given to the people tasked with carrying out the job. These suggestions have been implemented at Dunsfold, together with the acquisition of staff to be trained in, and wholly concerned with, bird control activities.

1.17.2 Viper 601 engines – surge control

To ensure optimum acceleration at the lower rpm range the Viper 601 engines installed in the HS 125 have a compressor control system which automatically bleeds air from the 4th stage of the compressor. At low rpm 4th stage air exhausts through the open blow-off valve and as the engine accelerates high pressure air from the 7th stage closes the valve.

In the event of ingestion damage occurring to the compressor, manual control of each blow-off valve to its open position may be carried out by the use of a guarded rocker type switch, one for each engine, situated in the cockpit on the left forward top surface of the central control pedestal. According to the manufacturer manually switching the relevant blow-off valve from 'auto' to its 'open' position may reduce the tendency of the compressor to surge.

The HS 125 Flight Manual gives the following drills and related notes:

ENGINE MALFUNCTION

Ingestion

Ingestion of birds and other foreign objects into the engine can cause compressor damage which could lead to compressor surge. This tendency to surge is most likely at intermediate throttle settings but may be reduced by opening the blow-off valve (BOV) (see Note 1).

If ingestion is known or suspected, the throttles should not be moved unless absolutely necessary (see Note 2) until the appropriate action has been taken as follows:

A Ingestion at take-off (above V_1)

As soon as circumstances permit

1. Select the BLOW-OFF VALVE switch OPEN and slowly throttle the relevant engine to idle and back to maximum rpm to confirm satisfactory handling.
2. Repeat 1 above for the other engine if necessary.
3. Land as soon as practicable.

B Ingestion in flight other than at take-off

1. Select both BLOW-OFF VALVE switches to OPEN and, in turn, carry out the engine handling check in A.1 above when practicable.
2. Land as soon as practicable.

NOTES

1. If a large bird or object is ingested, the engine may surge immediately. In this case open the relevant BLOW-OFF VALVE immediately.

2 If indications show a need for immediate shut-down of an engine its throttle may be closed immediately and the normal shut-down procedure completed.

The procedure in 'A.1' is obviously time consuming and the commander did not adhere to it when attempting to overcome the engine surge difficulties during take-off. Post-accident functional tests of the blow-off valve switches showed that some difficulty could be encountered when attempting quick operation of them from the left-hand seat; operation is very much more difficult from the right-hand seat position. Relevant comment on these matters is at paragraphs 2.1 and 2.2.

1.17.3 Small jet engines – bird strike vulnerability

It is a fact that no small engine, eg circa 3,000 lb thrust, has yet fulfilled the bird ingestion test requirements of British Civil Airworthiness Requirements (BCAR's) in an unqualified way. The Viper 600 series engine complies with BCAR's for small (113g) and large (1.8kg) bird ingestion. During the related certification tests there was no unacceptable immediate or ultimate loss of engine performance in the small bird case, whilst in the large bird case, although power was lost, no external hazard would have been created to the rest of the aircraft. At the time concerned the 601 engine was not legally bound to comply with the Requirements relating to medium size birds (0.7kg), but tests were carried out and it was considered that, although not complying literally with the future requirements, the testing gave considerable assurance of the ability of the Viper 601 to withstand medium bird ingestion provided that the special drill noted in paragraph 1.17.2 was followed.

Following the accident to G-BCUX the Civil Aviation Authority (CAA) carried out an examination of 60 executive jet bird strikes that had been reported on a world wide basis in an attempt to assess whether the engines of small executive jet aircraft were more vulnerable to bird damage than the average for jet engined transport aircraft. This showed that although the reported bird strike rate was about the same for small executive and large public transport aircraft, damage was reported from 23 out of 30 engine strikes in the former case, ie a ratio of about 2 to 3 whereas the average for the latter case showed a ratio closer to 1 to 3. It would seem therefore that while the statistics are somewhat limited, the apparent increase in the vulnerability of executive jet aircraft engines to bird strikes is simply because, for a given size of bird, a small engine will be inherently more likely to lose significant power following a strike than a large engine.

Although the great majority of bird strikes result in only minor damage this accident to G-BCUX is the eighth in the period 1968 to 1976 in which a twin-engined turbo-jet executive type aircraft has been compelled to make an immediate forced landing because of significant damage to both engines following bird strikes during the take-off phase. In two of these cases, one being G-BCUX, there were fatalities. It is difficult to obtain an exact figure but it is believed that the eight year period covering the eight accidents represents about five million aircraft hours for the class of aircraft concerned. On this basis the fatal accident rate would be about 0.4 per million hours and the 'write-off' rate about 1.6 per million.

In the opinion of the CAA these figures are high and indicate a rate of significant double engine damage greater than would be anticipated from the normality of the executive turbo-jet aircraft overall bird strike rate. The only apparent explanation for this would seem to lie in the high vulnerability of the engines concerned so that many small or medium bird strikes (which might otherwise have been expected to go unnoticed or at least unreported) become incidents.

1.17.4 Public safety

The take-off and approach funnels which extend in upward sloping planes outside aerodrome boundaries and the margins for overrun and undershoot precautions which are applied within the boundaries have been designed primarily with the safety of aircraft and passengers in mind. It has been assumed that a consequence would also be the safety of people on the ground. In the light of this accident, and of the evidence of small turbo-jet engine vulnerability given in paragraph 1.17.3, the validity of this assumption may be questioned; indeed in a rider to their verdict of 'Accidental Death' the Coroner's Jury at the Inquest into the fatalities in this accident stated:

> 'We recommended that the safety of people on the ground in the vicinity of airfields be the subject of closer scrutiny'.

An example of the type of additional protection which may be thought appropriate, and may have wider application, is that which is under consideration at Dunsfold where the easterly take-off direction is crossed by a busy main road (A281) which is only some 285 metres from the end of the runway. This 285 metres of separation, although it may well be adequate for a safe emergency overrun by an aircraft after a landing on Runway 07, was certainly insufficient to prevent the tragedy which occurred in the course of the accident to G-BCUX. Shortly after the accident the Chief Inspector of Accidents wrote to the CAA, and recommended that consultations should take place with the relevant authorities with a view to installing traffic lights on the A281 road on either side of the extended centre line of the runway to stop road traffic on every occasion that turbo-jet aircraft took-off on Runway 07. The CAA indicated that Dunsfold Aerodrome was outside their field of responsibility but they brought the recommendation to the attention of the aerodrome operator, the local police authority and the local highway authorities concerned.

The Environmental Health and General Purposes Committee of Waverley District Council (the local council) subsequently recommended that such traffic signals should be installed on the A281 road to be operated by the Air Traffic Control at Dunsfold Aerodrome. Waverley Council referred its recommendation to Surrey County Council but it is not known what final conclusions were reached in this matter. The decision whether or not to comply with the recommendation is entirely a matter for the parties involved; the Chief Inspector of Accidents cannot compel compliance with any of his recommendations.

1.18 New investigation techniques

No new techniques were employed in the investigation of this accident.

2. Analysis

2.1 General

The evidence clearly indicates that immediately after take-off when the aircraft was between about 50 and 100 feet it sustained multiple bird strikes and both engines suffered a significant loss of power. After an unsuccessful attempt to restore power the commander elected to make a forced landing with the consequences detailed in paragraph 1.12.1 of this report. Although he did not follow the prescribed drills in attempting to restore power after the bird strike it should be noted that the drills are necessarily time consuming and also that success in their application presupposes that the damage to the engines is indeed within the defined limits. This is something any pilot is unlikely to know until after the event. In a case where only one engine is affected, even at a flight stage as critical as in this accident, the performance of the aircraft with full power on the other engine would enable it to continue to climb. Eventually there would be time for the pilot to assess the situation, apply the drill and, even if it should prove ineffective, there would be no increased hazard to the aircraft.

A two-engine ingestion case occurring just after lift-off, is obviously much more critical. The pilot is faced with the same uncertainty both as to the degree of damage and the success potential of the remedial drills whilst, additionally, his primary concern is to guard against a dangerous erosion of flying speed during the time required for the drills. He knows that unless he is successful in restoring power to both engines he may well find himself with insufficient speed to continue safe flight whilst having placed himself in a more difficult position for a forced landing. It is therefore considered that in this accident to G-BCUX the commander's decision to land straight ahead was correct.

2.2 The engines

Post-accident examination and test running of the engines confirmed that notwithstanding the damage they had sustained from the bird ingestion both engines were capable of surge-free running, albeit at reduced power, provided the blow-off valves were open. No evidence is available regarding the time that would have been required to clear the compressor surging during the accident itself if the remedial drills had been fully implemented. Although not necessarily of direct significance in this accident a factor which tends to increase the pilot's problem on the HS 125 in the event of ingestion at any critical flight stage is the design and the position of the blow-off valve switches. Their operation is difficult for the pilot in the left-hand seat, who, to some extent, is pre-occupied with the immediate task of flying the aircraft and very much more difficult for the pilot in the right-hand seat, thus effectively preventing him from giving vital aid to the handling pilot during a most critical stage of flight. Re-design of the guards for the emergency blow-off valve switches and their installation in a more prominent and readily accessible position in the HS 125 is considered to be desirable if the full potential of the remedial drills is to be achieved.

2.3 The overrun

The aircraft overran the end of the runway at high speed but this was to be expected and, as seen from the flight-deck, the overrun area was flat and contained no major obstructions; consequently there was a reasonable chance that the aircraft could be brought to stop with minimin risk of damage, or of injury to its occupants.

However, when the aircraft encounted the deep ditch and concrete posts bordering the A281 road it sustained major damage including the destruction of the undercarriage and

serious disruption of the port fuel tank. Even so, after the aircraft had bounced across the road and slid approximately a further 150 metres before coming to rest, the occupants were able to escape without injury apart from the commander who had injured his back. The fire which had already started developed to serious proportions before the fire services arrived and although they quickly extinguished it, the aircraft was largely destroyed.

The associated tragedy which occurred when the aircraft hit the passing motor car was, in the existing circumstances, entirely beyond the control of those involved. The commander was necessarily pre-occupied with efforts to keep the aircraft straight and to slow it down; he was not particularly conscious of his position in relation to the road and even if he had been there was little positive action open to him. The motor car was completely hidden from his view by the hedge bordering the road and it is quite certain that the car driver would also have been completely unaware of the approaching aircraft until the moment it burst through the hedge. Matters arising from this aspect of the accident are discussed in paragraph 2.6 of this report.

2.4 Bird control at Dunsfold

The post-accident examination of Dunsfold showed that although birds were markedly absent from areas where long grass was grown, they were uniformly abundant in the short grass areas which represented 60 per cent of the aerodrome grass area. It is therefore reasonable to assume that an increase in the area made subject to long grass, in concert with the other appropriate efforts already being made by Dunsfold, could well prove to be of considerable value in reducing bird numbers there.

At Dunsfold, as at many other aerodromes, the Air Traffic Control Officer on duty was charged also with the responsibility of initiating bird dispersal. Aerodrome Control Officers may well be fully occupied with the control of aerodrome traffic and if they are also to be made responsible for bird dispersal there will be occasions when they do not have sufficient time for the considerable scanning activity which is necessary for keeping up-to-date with the positions and the quantities of birds on their aerodromes.

Personnel having responsibility for bird scaring should have appropriate training and, on balance, it would seem advisable that responsibility both for maintaining surveillance and for taking the appropriate dispersal action should be given to personnel who have been properly trained and who have no other conflicting duties. Some considerable degree of persistence is often required to disperse birds and the sense of personal involvement which is likely to be felt by those concerned full-time with such duties could well lead to better results than have thus far been achieved and the Dunsfold decision to instigate such a policy is to be commended.

There is one further point which although specific to this case is also of more general relevance. Had the Air Traffic Control Officer at Dunsfold been aware of the concentration of Lapwings near the eastern end of the runway and wished to utilise the Lapwing distress call tape he would have been unable to do so. This tape was unserviceable and to avoid such difficulties two copies of all such tapes should be held at aerodromes using bird distress call recordings.

2.5 Bird control – general

11 years ago an organisation, known as the Bird Strike Committee Europe, was founded by a number of European States, with the object of collecting, analysing and circulating to all concerned, data and information relating to the bird strike problem in the European Region. The Committee have held yearly meetings, working groups have been arranged and information exchanged on numerous aspects of the bird

strike hazard. The United Kingdom Bird Strike Committee has been an active participant in the organisation and in 1976 a number of States from outside Europe also participated as observers at the yearly meeting. At the 1976 meeting the Committee made a recommendation of direct interest to aerodrome operators to the effect that a document summarising means of dealing with the bird strike hazard should be prepared for use by aerodrome managers. Information on this material is obtainable from the Directorate of Aerodrome Standards of the Civil Aviation Authority.

2.6 Public safety

The recommendations made by the Coroner's Jury at the Inquest into this accident 'that the safety of people on the ground in the vicinity of airfields be the subject of closer scrutiny' must be seen as an expression of the concern in many people's minds as to whether this accident should be regarded as an isolated incident or is symptomatic of a wider problem affecting public safety. This investigation has not found any evidence which suggests an unsatisfactory level of attention to public safety in the vicinity of aerodromes except for the question of additional safeguards during small executive jet operations which appears to arise from the material given in paragraph 1.17.3.

Although the evidence is limited in quantity and therefore of limited statistical value it undoubtedly implies that the small executive jet aircraft is more prone to significant double engine damage after bird strikes than had been realised. Resultant power losses may well be only temporary but, in the context of the take-off case, can lead to very serious consequences. Although several devices have been employed experimentally in the hope of reducing the vulnerability of the small turbo-jet engine to the consequences of bird ingestion, to date there is no firm evidence of success. This research should obviously continue but, in the interval, to minimise the danger to the general public the existing safety provisions both inside and outside aerodrome boundaries may well require revision to improve existing safeguarding, particularly at those aerodromes where a road crosses near to the end of a take-off runway used by aircraft fitted with small turbo-jet engines.

3. Conclusions

(a) *Findings*

(i) The aircraft had been properly maintained and its documentation was in order.

(ii) The crew were properly licensed and adequately experienced for the flight.

(iii) Prior to take-off no concentration of birds had been seen near the active runway but a large concentration of Lapwings flew across the aircraft's flight path just as it became airborne.

(iv) Both engines ingested birds and lost power because of serious consequential surging.

(v) The commander, being convinced that insufficient power was available, made a forced landing on the remaining part of the runway. His decision to do so is considered to have been correct.

(vi) Post-accident examination established that both engines were capable of surge-free running at reduced power subsequent to the ingestion of the birds provided the blow-off valves were open but no information is available regarding the time that would have been required to re-establish surge-free running if the drills had been fully implemented during the accident itself.

(vii) Except at the cost of greatly increasing the risk to the occupants, there was insufficient time for the commander to apply the full anti-surge drill.

(viii) The anti-surge blow-off valve switches in HS 125 aircraft are insufficiently accessible for quick and easy operation in emergency.

(ix) The long grass policy appears to be effective in reducing the number of birds roosting on aerodromes.

(x) Responsibility for bird scaring should be allocated to properly trained personnel who have no other conflicting duties.

(xi) Analysis of available evidence indicates that small executive turbo-jet aircraft may well be more prone to significant engine damage following bird ingestion than other turbo-jet aircraft.

(xii) Public safety on the A 281 road near Dunsfold Aerodrome would benefit from a traffic control system to be used when aircraft are taking-off on Runway 07.

(b) *Cause*

The accident was caused by a serious power loss on both engines following multiple bird ingestion just after the aircraft became airborne.

4. Safety Recommendations

It is recommended that:

(1) The blow-off valve switches of HS 125 aircraft be redesigned and relocated to a more accessible position.

(2) Aerodromes which have a persistent bird problem should review their bird dispersal policies in the light of current information available from the Civil Aviation Authority and if bird distress call recordings are employed two copies of all such tapes should be held.

(3) Because of the apparent high rate of significant power loss occurring to small turbo-jet engines (such as are typically used on executive jets) following bird strikes, the Civil Aviation Authority should review existing measures to minimise the hazards to this type of aircraft from this cause, particularly during the take-off phase.

(4) The existing safety provisions both inside and outside aerodrome boundaries should be reviewed to ensure adequate safeguarding of the general public at those aerodromes used by small executive jet aircraft, particularly where a road crosses near to the end of any runway used for take-off.

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February 1977

Produced in England by Her Majesty's Stationery Office, Reprographic Centre, Basildon

Bas 31674/R92 K6 3/77 TC