Department of Trade
ACCIDENTS INVESTIGATION BRANCH

Handley Page Dart Herald 203 G-BBXJ
Report on the accident at Jersey Airport, Jersey, Channel Islands on 24 December 1974

Including the Review before
Gerald A Draycott,
Captain J H Montgomery *Pilot Assessor*
and
Mr R F Franklin *Engineer Assessor*

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List of Aircraft Accident Reports issued by AIB in 1976

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Part A

Department of Trade

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Report on the accident at Jersey Airport, Jersey, Channel Islands on 24 December 1974

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

1 March 1976

The Rt Honourable Peter Shore MP
Secretary of State for Trade

Sir

I have the honour to submit the report by Mr G C Wilkinson, an Inspector of Accidents, on the circumstances of the accident to Handley Page Dart Herald 203 G-BBXJ which occurred at Jersey Airport, Jersey, Channel Islands, on 24 December 1974.

I have the honour to be
Sir
Your obedient Servant

W H Tench
Chief Inspector of Accidents

Accidents Investigation Branch
Accident Report No. 4/76
(EW/C507)

Aircraft:	Handley Page Dart Herald 203 G-BBXJ
Engines:	Two Rolls Royce Dart 527
Owner and Operator:	British Island Airways Limited
Flight Crew:	2 – Uninjured
Cabin Crew:	2 – Uninjured
Passengers:	49 – Uninjured
Place of Accident:	Jersey Airport, Jersey, Channel Islands 49° 12'N 002° 11'W
Date and Time:	24 December 1974 at 1918 hrs All times in this report are GMT

Summary

The aircraft was on a scheduled night passenger flight when, shortly after starting the descent to Guernsey Airport, the starboard engine was shut down as a precaution because of anomalous power indications. The aircraft diverted to Jersey Airport where it carried out an Instrument Landing System (ILS) approach in visual conditions in the course of which the commander requested full power on the port engine at a low height and airspeed. The right wing tip struck the ground and the aircraft finally came to rest astride a road on the northern perimeter of the aerodrome having turned through approximately 180° to the right. None of the 53 occupants of the aircraft was injured and there was no fire.

The report concludes that the cause of the accident was the application of asymmetric full power when there was insufficient airspeed to maintain directional control and when the aircraft was too close to the ground to allow recovery from the uncontrollable yaw and roll which developed.

1. Investigation

1.1 History of the flight

The aircraft was operating British Island Airways flight UK 185, a scheduled night passenger service from Southampton to Guernsey. It taxied out initially at 1749 hrs but during the take-off run it was noticed that the starboard engine's rpm gauge indicated 14,550 rpm instead of 15,000 and that the torque reading on the same engine was below the datum appropriate to the use of water methanol injection. The commander, who was handling the aircraft, therefore decided to abandon the take-off when the speed had reached about 60 knots and he returned the aircraft to the apron. A ground run carried out on the starboard engine produced normal full power indications and so the passengers were re-embarked and the flight departed for the second time at 1821 hrs. The power output from the engines during this take-off was satisfactory but when the aircraft had reached about 200 feet a rise in the torque indication of the starboard engine was observed. Climb power was set and the flight climbed to flight level (FL) 80 and continued on track to Guernsey.

The descent into Guernsey was started when the aircraft was about 35 nautical miles (nm) from the airport. Power was reduced on both engines but when the fuel flow was being trimmed back the starboard engine's turbine gas temperature (TGT), torque and fuel flow gauges showed an increase in their readings and because they continued to rise the engine was shut down and the propeller feathered. Guernsey Approach Control was informed of the situation and asked to have the emergency services standing by for the landing.

The aircraft continued the descent but when it was about 5 nm from the runway it was advised by Air Traffic Control (ATC) that the airline had requested that it should land at Jersey airport instead of Guernsey. It was therefore decided to divert to Jersey and clearance was received from ATC to proceed on course at 1,500 feet above mean sea level (amsl).

The aircraft changed to the Jersey Approach Control frequency and after ensuring that ATC was aware of the emergency the commander requested permission to make an ILS approach to Runway 27 although the weather at the time was clear. The commander did not consider that it was necessary to brief the co-pilot about the approach and landing to Jersey as this had already been covered during a previous approach to the airport earlier in the day and he made no special reference to the single engine approach condition. Jersey radar positioned the aircraft on the ILS localiser and it became established at a range of about 5½ nm from the runway and commenced its descent shortly afterwards. In the vicinity of the outer marker the undercarriage was lowered followed by take-off flap (5°). ATC cleared the aircraft to land and reported the wind as 270° at 10 knots.

The aircraft continued its descent flying slightly above the ILS glide path with the airspeed increasing from about 120 knots to 137 knots. Power was reduced on the port engine to a very low value and the IAS began to decay at a rate of about one knot per second. When the aircraft was between 400 and 300 feet above the runway full landing flap (30°) was selected and both pilots considered that at this stage they were correctly positioned for the approach. The co-pilot noticed that the airspeed was about 105-110 knots when he selected full flap. (The recommended speed for the final approach was 99½ knots, ie 10 knots above VATI).

The aircraft became displaced to the right of the runway centre line as it approached the threshold and the commander tried to realign it with the runway by making a sidestep manoeuvre to the left. The flight data recorder (FDR) readout shows that the IAS had continued to decrease at a steady rate during the final stage of the descent and that at this point it was about 89 knots. When the commander realised that he was not going to be successful in his attempt to realign the aircraft with the runway centre line he called for full power. The aircraft was now alongside the runway threshold lights. The co-pilot advanced the throttle on the port engine and believing that the commander had also called 'overshooting' he selected the undercarriage to retract. The aircraft began to yaw and roll rapidly to the right resulting in the starboard wing tip and starboard main wheels almost simultaneously striking the ground well to the right of the runway edge. The aircraft subsided on to the grass as the undercarriage retracted, spun round to the right through approximately 180° and then slid backwards until it came to rest astride a small road on the northern perimeter of the airfield.

About 10 minutes before the aircraft was due to land Jersey ATC, having learned of the emergency from their colleagues in Guernsey, alerted the fire service who positioned four of the six airport fire tenders in readiness close to the runway in use. When it was realised that the aircraft was in difficulties these vehicles set off immediately and as a result arrived at the scene of the accident very shortly after the aircraft came to rest.

When the aircraft had stopped the two stewardesses with the help from some passengers tried to open the emergency exits. The starboard forward emergency exit was released after a slight delay and the evacuation of the cabin began. The handle on the starboard rear emergency exit, however, jammed about one-third of the way along its travel and could not be released. A fireman tried to assist from the outside of the aircraft but the strain on the release handle broke the spindle rendering it useless. Neither the main passenger door nor the crew door on the port side of the aircraft could be opened from the inside as the normal operating handles could not be turned. However, the firemen were able to force open the passenger door (port rear) from the outside and some passengers from the rear of the cabin were able to leave by this exit. The evacuation was completed and there were no injuries to either the crew or the passengers.

There was no fire.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Others*
Fatal	–	–	–
Non-fatal	–	–	–
None	4	49	

1.3 Damage to aircraft

The aircraft was damaged beyond economic repair.

1.4 Other damage

A short length of a wooden post and rail fence was broken.

1.5 Crew information

(a) *Commander*

Age:	35 years
Licence:	Airline Transport Pilot's Licence, valid until 25 October 1977.
Aircraft ratings:	Handley Page Herald, Douglas C47, Piper PA23
Instrument rating:	Valid until 30 June 1975
Medical certificate:	Valid until 31 May 1975
Last competency check:	19 November 1974
Last route check:	12 June 1974
Flying experience:	
Total pilot hours:	3,515
Total flying hours on Handley Page Herald aircraft:	504
Total flying hours in last 28 days:	49

The commander completed a Captain's training course on the Dart Herald on 30 May 1974 having previously served as a co-pilot on the type. His training included single engine landings and overshoots and he completed four single engine landings and five single engine overshoots during the course. He successfully completed on 19 November 1974 a routine competency check on the aircraft which included demonstrating his proficiency in carrying out a single engine approach and overshoot followed by a single engine landing.

(b) *Co-pilot*

Age:	36 years
Licence:	Commercial Pilot's Licence, valid until 22 March 1978 Subsequent to the accident: Airline Transport Pilot's Licence, valid until 26 March 1980.
Aircraft ratings:	Part I PA30 Part II Douglas C47, Handley Page Herald
Instrument rating:	Valid until 16 December 1975
Medical certificate:	Valid until 31 July 1975
Last competency check:	16 November 1974
Last route check:	16 November 1974

Flying experience:

Total pilot hours:	7,052
Total flying hours as co-pilot on Handley Page Herald aircraft:	680
Total flying hours in last 28 days:	54

(c) *Duty period*

The crew had been on duty since 1050 hrs on 24 December 1974. Prior to the accident flight they had already completed four sectors in what was planned to be a six sector duty period.

1.6 Aircraft information

1.6.1 *Details of aircraft*

Handley Page Dart Herald 203:	G-BBXJ
Manufacturer:	Handley Page Limited
Year of manufacture:	1968
Owner:	British Island Airways Limited
Certificate of airworthiness (C of A):	Renewed 31 May 1974 and current at the time of the accident.
Certificate of maintenance:	Issued on 24 October 1974 at 11,517 airframe hours and valid for 84 days or 500 flying hours, whichever was the sooner.
Total airframe hours:	11,781
Maximum permissible landing weight:	17,916 kilogrammes
Estimate landing weight:	17,700 kilogrammes
Centre of Gravity:	Within the limits as shown on the Company's load sheet. The limits at an aircraft weight of 17,700 kilogrammes are: forward 2.64 feet and rear 3.65 feet aft of the leading edge datum.

1.6.2 *Details of the two Rolls Royce Dart 527 engines:*

	Left	*Right*
Hours since last overhaul:	264	1,726
Hours since installation:	264	44
Hours since last inspection:	44	44

The Dart 527 engine, which is a propeller turbine engine, incorporates a fuel trimming device which is manually controlled from the flight deck. The fuel trimmer provides a means of controlling engine TGT by variation of the fuel flow for a given rpm. Before take-off and landing the fuel trimmer is set to a datum appropriate to the ambient air temperature and pressure altitude at the aerodrome so that the correct power is available when the engines are opened up to maximum power and that no further trimming action is necessary to prevent the TGT from exceeding the maximum value. During the climb, cruise and descent the fuel trimmer is used to control the fuel flow and the TGT at the required figure.

1.6.3 *Fuel*

The fuel on board the aircraft was JET – A1 (Kerosene)

1.7 Meteorological information

The approach to Jersey Airport was made in visual contact with the ground and the natural light conditions were moonlight with the moon 11 days old. ATC informed the aircraft as it turned on to the localiser that the surface wind was westerly at 12 knots.

The following observation at Jersey Airport was made at 1923 hrs.

Surface wind	250° (T)/12 knots
Visibility	35 kilometres
Weather	Recent shower
Cloud	2 oktas at 2,000 feet
Temperature	+8° centigrade
Dew point	+5° centigrade
QFE	1007 millibars
QNH	1018 millibars

1.8 Aids to navigation

Jersey Airport was equipped with surveillance radar. An ILS with a 3.1° glide slope was installed on Runway 27 with associated outer and middle fan markers. A non-directional beacon (NDB) was positioned 6 nm from the runway threshold and another NDB half a mile beyond the upwind end of the runway. All relevant navigational services were serviceable and operating at the time of the accident.

1.9 Communications

The aircraft maintained normal VHF radio communications throughout the flight. The relevant ATC authorities were informed when the starboard engine began to malfunction and later that the engine had been shut down.

1.10 Aerodrome and ground facilities

Jersey Airport is on the western side of the Island and has an elevation of 276 feet. The single asphalt runway, 09/27, was 5,300 feet long and 150 feet wide and the landing distance available for Runway 27 was 5,200 feet. The runway surface was damp at the time of the accident following the passing of a slight rain shower.

The approach to Runway 27 was marked by high intensity white and low intensity red approach lights. The runway itself was marked by white high intensity bi-directional and low intensity omni-directional lights with green lights across the threshold. All these lights were switched on during the aircraft's approach with the exception of the high intensity white approach lights.

Visual approach slope indicators (VASIS), set to 3° approach angle, were positioned on either side of the runway. Although these VASIS were switched on neither pilot remembered seeing them during the aircraft's approach.

The airport was equipped with six fire vehicles all of which attended the scene of the accident. In addition two appliances and one ambulance from outside sources assisted in the rescue.

1.11 Flight recorder

The aircraft was equipped with a Sperry Sadas flight data recorder. The wire recorder and signal conditioning unit were mounted on the stepped floor of the rear baggage hold forward of the rear pressure bulkhead. The recorder was undamaged in the accident. The following parameters were recorded against a time base:

Magnetic heading

Indicated airspeed

Pressure height

Normal acceleration

Pitch attitude

These parameters complied with the mandatory requirements in force at the time of the accident. A satisfactory read-out was obtained from the recording and the airline supplied the transducer and system calibration data for use with the read-out.

The resolution of the pressure height in the system is just over 31 feet per count and the resolution of the normal acceleration is 0.008 'g' per count. Both these parameters comply with the FDR specification applicable to older aircraft. However, this specification does not include a requirement for resolution. In the case of the normal acceleration trace, the resolution obtained in the Sadas system is better than that required in the FDR specification for second generation equipment.

The analysis of the recorded data was hampered by this poor resolution. However, a plot was prepared of the calibrated airspeed and pressure height traces for the last 5 minutes of the flight (Appendix 1) together with one for the final 60 seconds prior to impact of the calibrated data for all the parameters except normal acceleration (Appendix 2). A ground plot of the last 30 seconds of flight was constructed also from information derived from the flight data recorder, (Appendix 3) adjusted for a 10 knot headwind component.

An analysis of the data obtained from the recording indicates that the aircraft completed its turn onto the ILS localiser about 3 minutes before the accident happened. Its airspeed at that time was about 120 knots and its height approximately 1,200 feet above aerodrome level (aal). Both the airspeed and the height remained steady for a period of 30 seconds and then the aircraft began a slow drift down and at the same time the airspeed gradually increased. Over a period of approximately one minute the aircraft descended to 900 feet aal and the airspeed increased to a peak of 137 knots. Ninety seconds before the impact with the ground the rate of descent increased to a steady 600 feet per minute.

Shortly afterwards the airspeed began to decrease at a rate of one knot per second and this rate of speed decay remained constant during the last section of the flight. The airspeed fell below the target threshold speed (89½ knots) 15 seconds before the accident by which time the airspeed had further reduced to 78 knots.

The ground plot indicates that the aircraft was displaced slightly to the right of the runway as it approached the threshold. A left turn was initiated 19 seconds before impact but the turn was not sustained for sufficient time to allow the aircraft to realign with the runway. Calculations indicate that some engine power was applied approximately 10 seconds before the aircraft hit the ground resulting in a yaw to the right. This application of power does not appear, however, to have been sustained and the heading trace shows a momentary reversal in the yaw direction. The application of full power called for by the commander at the last moment appears from the calculations to have occurred about 3 seconds before the impact and was followed by a further divergent yaw to the right. The airspeed at this time was just below the minimum control speed air (full flaps) – 79 knots IAS.

1.12 Wreckage

The first impact marks made by the aircraft were on the grass north of Runway 27 in a position approximately 394 feet upwind of the runway threshold and 213 feet to the right of the centre line. The aircraft was then heading approximately 282° (M) and banked about 20° to the right causing the starboard main wheels and the starboard wing tip to strike the ground almost simultaneously. The impact marks indicated that the main undercarriage retracted shortly after the initial impact and that the aircraft then pitched heavily nose-down as the starboard propeller dug into the ground. The aircraft subsided on to the undersurface of the fuselage, spun round through 180° to the right and went into a backwards slide over the grass. It broke through a post and rail fence, slid across a small road and came to a standstill when the tailplane ran into some trees growing on top of a low bank which separated the road from an adjacent wood. When the aircraft came to rest it was upright and substantially intact but lying astride the road in such a manner that the rear part of the fuselage and the forward part just aft of the flight deck were supported on two earth banks and were therefore the only parts in firm contact with the ground. The weight of the aircraft suspended between the two contact points caused a certain amount of additional distortion over and above that sustained in the main impact which, however, mainly disappeared when the wreckage was raised and re-established on its main undercarriage legs.

Examination of the wreckage showed that the main wheels were fully retracted and locked up and that the flaps were in the landing position (30°). The port propeller was in the normal flight pitch range with damage consistent with it having hit the ground whilst still at high rpm with the aircraft travelling backwards. The following cockpit settings were noted:

Rudder trim	⅓ of a division to the left
Aileron trim	¾ of a division to the right
Elevator trim	2 divisions nose-up
Flap selector	take-off setting (5°)

The number one fuel tank (port outer) contained 100 imperial gallons (IG) of JET-A1 and 160 IG of JET-A1 were found in the number 6 tank (starboard outer). No fuel was found in the remaining four tanks.

The aircraft was complete and structurally intact at the time of impact. No evidence of failure or malfunction was found in the flying control systems. An examination of the pitot-static systems and air speed indicators revealed no evidence of a significant pre-impact departure from specifications.

Both engines together with their propeller control units, fuel pumps and fuel control units were given a detailed examination after their removal from the wreckage site and were found to have been capable of normal operation at the time of the accident. The fuel flow, torque pressure and TGT indicating systems were all checked and found satisfactory. The starboard fuel trimmer circuit operated correctly but the port fuel trimmer switch was found to have an intermittent failure in its trim 'decrease' sense although the system itself functioned satisfactorily.

Both engine speed indicating systems were checked and the tacho-generators and tachometers removed and returned to the United Kingdom for calibration checks. It was found that the port tacho-generators over-read by approximately 300 rpm in the 13,000 to 15,000 rpm range and that the starboard tacho-generator and tachometer functioned within specifications. The starboard tacho-generator, however, failed the insulation resistance check and therefore a strip examination was carried out on the generator to find the reason for the low insulation resistance. It was discovered that two of the wires from the connector to the individual generator phases had chafed on an internal ridge in the casting thereby exposing the copper conductors. Tests showed that a short or partial short circuit of the exposed conductors to the generator frame or to each other could produce a reduction of indication of anything between 300 and 3,000 rpm when the tacho-generator was driving the indicator at 14,000 rpm. These effects could have been intermittent under conditions of vibration. Chafing of stator wires on the body casting has occurred in this type of generator in the past and there is an optional modification (Smith's MOD MO 05), introduced in 1970, which provides elastomer sleeving over each stator wire. The airline was not aware of the modification which had not been carried out on this tacho-generator.

1.13 Medical and pathological information

There was no medical evidence which could have had a bearing on the accident.

1.14 Fire

There was no fire. Shortly after the aircraft came to rest smoke and sparks were seen from the port engine. The sparks were caused by the break up of the turbine blades following an overtemperature condition probably brought about by the propeller digging into the ground while the engine was still under power. The commander discharged the port engine extinguisher bottle and the fire services also discharged a 50 kilogramme BCF from one of the crash vehicles into the engine as a precautionary measure.

1.15 Survival aspects

The accident was survivable. All the seats were forward facing with the exception of the front pair of seats on either side of the cabin. The aircraft experienced no excessive vertical or horizontal decelerations during the accident but there was a certain amount of buckling and distortion to the cabin floor which tilted the seats outboard and cracked the frames of two of the seat pairs. All the seats, however, remained attached to the floor and no seat-belt attachment suffered damage.

The commander informed the passengers when the starboard engine had been shut down and later that it had been decided to divert to Jersey. No specific precautions were taken in the cabin. However, the majority of the passengers were aware of the positions of the emergency exits and there was no evidence of any delay in starting the evacuation which was apparently initiated by the two stewardesses and, despite difficulties with the exits, was carried out in an orderly manner.

Normal cabin lighting was on before the accident and it stayed on throughout most of the evacuation. The lights were extinguished when ground personnel disconnected the aircraft's batteries but there was sufficient illumination from the lights of the rescue vehicles to complete the evacuation without any difficulty.

In addition to the normal cabin lighting there were five emergency (Phoenix) lights in the cabin roof. These lights are switched on by the action of inertia switches in an emergency but can also be switched on manually. Because of the relatively low rates of deceleration during the accident the inertia switches did not operate and the lights were not switched on manually.

The fire services were warned by ATC about 10 minutes before the aircraft was due to land that it had shut down one engine. Consequently when the accident happened they were fully prepared and were able to get to the aircraft almost as soon as it came to rest. Their prompt arrival enabled them to give considerable help in the evacuation and the assistance by the emergency services was much praised by the passengers in the aircraft.

The aircraft was fitted with three exits for use only in an emergency. Two of these exits were fitted in the starboard side of the fuselage incorporating numbers 3 and 7 cabin windows respectively. The forward of these escape hatches was a half length unit which extended down the fuselage as far as the seat arm rests and which could be pulled completely into the cabin after the release mechanism had been operated. The rear escape hatch was a full length door extending to the cabin floor which could be pushed outwards after the locking mechanism had been released. The third escape hatch, designed for use in the case of a ditching, was positioned in the cabin roof just aft of the rear escape hatch. In addition to these exits both the crew door situated just behind the flight deck on the port side and the main passenger door located at the rear of the cabin also on the port side were classified as emergency exits. Neither of these doors was equipped with any special opening device other than the normal operating handle and neither door could be jettisoned.

All the exits on the aircraft could be opened from either inside or outside the aircraft.

The airline's maintenance schedule called for ditching hatches to be checked by qualified engineers at intervals not exceeding one year and all other emergency exits at a period not exceeding 500 flying hours. The ditching hatch was last checked on 1 July 1974.

In addition to these emergency exits there were three break-in areas in the fuselage which were marked as such externally. One of these break-in areas was in the cabin roof forward on the starboard side and the other two were positioned at the rear windows on either side of the cabin.

The starboard forward escape hatch was the only emergency exit which opened without difficulty after the aircraft came to rest and was therefore used by about three-quarters of the occupants evacuating the aircraft. The starboard rear escape hatch could not be opened from either inside or outside the aircraft because the release mechanism was jammed. It was found that the internal release handle would not move through its full travel and when firemen tried to rotate the external handle, it only resulted in a broken spindle which rendered the handle and therefore the emergency exit useless. It was also impossible to rotate the operating handle on the crew door from either inside or outside the aircraft because the door locking pins were jammed in the door frame. This door could not therefore be used during the evacuation. Repeated attempts to rotate the internal handle on the passenger door were unsuccessful, however firemen outside the aircraft were able to force the door open and about one quarter of the passengers left through this exit.

No attempt was made to open the ditching escape hatch as it was considered that the evacuation was proceeding satisfactorily. All the passengers and crew left the aircraft safely without any injuries being sustained.

1.16 Tests and research

1.16.1 *The starboard rear emergency exit*

The spindle from the external handle of the starboard rear emergency exit was examined to try and discover the cause of its failure. It was found that the spindle had failed as a result of a torsional overload and that it was in a satisfactory metallurgical condition with no signs of pre-existing cracks.

Calculations indicated that the strength of the spindle was insufficient to withstand the forces that could be exerted upon it by the determined efforts of a person operating the handle in a normal manner but against the resistance caused by jammed door locking pins.

1.16.2 *The ditching escape hatch*

No attempt was made to open the ditching escape hatch during the evacuation but later during the wreckage examination before the removal of the aircraft from the accident site attempts made to turn the opening handle on the inside of the cabin met with substantial resistance. Eventually the hatch was opened after considerable force had been used on the release handle. The cause of the difficulty did not appear to be frame distortion because once released the hatch could be opened and shut with little effort.

1.17 Other information

1.17.1 *Operational procedures for a single engine approach, landing and overshoot*

The following extract appeared in the Flight Manual appropriate to the Dart Herald 203 type of aircraft:

> 'Carry out the necessary initial approach checks at a convenient stage. With the speed below 170 knots IAS the landing gear may be extended to reduce airspeed to below 150 knots IAS when the flaps may be extended to take-off (5°). The initial approach speed should be 110 to 115 knots IAS. The airspeed for the final approach should be reduced to 10 knots above the target threshold speed with one power unit inoperative (VATI).
>
> Landing flap should not be selected until it is reasonably certain that a landing can be made.
>
> *Balked landing with one power unit inoperative*
>
> Landing flap should not be selected until it is reasonably certain that a landing can be made, so that normally the decision to discontinue a single engined landing will be made when the flaps are at the take-off setting and the speed is some 10 knots above the target threshold speed. In this case the landing gear should be retracted as soon as take-off power has been applied and a positive rate of climb identified and the overshoot continued according to the procedure following engine failure during take-off.
>
> Provided the speed has not been reduced below the target threshold speed and the height is at least 200 feet above all obstacles, it is possible to carry out a balk with the flaps at DOWN. The landing gear should be retracted as soon as take-off power has been applied and a positive rate of climb identified but the flap should not be retracted to the take-off setting until the airspeed has been increased to the appropriate take-off safety speed.

Critical Power Unit

Failure of the starboard power unit has the most adverse effect on the handling and performance of the aeroplane during landing.'

The information contained in the company's operations manual was broadly the same as that given in the Flight Manual with the addition of the following paragraph:

'Under certain circumstances, it may be possible safely to discontinue the landing after flap has been selected, so long as the airspeed has not been reduced below VATI. In this case, the landing gear should be selected UP as soon as take-off power is applied, but the flap should not be retracted to TAKE-OFF until the airspeed has been increased to the appropriate take-off safety speed.'

1.17.2 *Relevant speed information*

The following speeds were applicable to the aircraft's landing weight of 17,700 kilogrammes:

Take-off safety speed, flaps at take-off (5°) V_2	97½ knots IAS
Target threshold speed (two engines) VAT_1	89½ knots IAS
Target threshold speed (one engine inoperative) VAT_1	89½ knots IAS
Minimum control speed, flaps up (0°) VMCA	96 knots IAS
Minimum control speed, flaps at take-off (5°) VMCA	87 knots IAS
Minimum control speed, flaps down (30°) VMCL	79 knots IAS
Stalling speed, flaps down (30°) VMS_1	72 knots IAS

The minimum control speeds are based on the failure of the critical power unit, the propeller feathered, and aeroplane banked 5° towards the operative engine.

2. Analysis and Conclusions

2.1 Analysis

2.1.1 *The circumstances of the accident*

The accident occurred while the aircraft was making a single engine approach which was made necessary by the precautionary shut down of the starboard engine. The single engine performance of this type of aircraft is normally adequate to carry out such an approach and examination of the wreckage revealed no evidence of mechanical failure or malfunction which might have caused a deterioration in the aircraft's performance or affected its handling characteristics. The fact that the commander felt able to comply with his company's request to proceed to Jersey indicated that there was no need to expedite the approach. In the event the extra flying required for the diversion from Guernsey gave the crew additional time to prepare themselves for the landing. There was no evidence that the weather presented any particular problem for the night was clear, there was no turbulence and the wind was straight down the runway. The runway itself was well equipped with approach aids having both an ILS and VASIS and was provided with adequate approach and runway lighting. There was therefore no evidence of any factors either external or on board the aircraft which might have created additional problems to those normally encountered in making a single engine approach. It is therefore apparent that the causes of the accident are related to the conduct of the approach and the handling of the aircraft.

The aircraft intercepted the ILS localiser and glide slope in a normal manner and during the descent flew slightly above the ILS glide path. The way in which the airspeed first increased to 137 knots during the initial stages of the descent and then gradually decreased would have made it necessary, in conjunction with the considerable power reduction on the port engine, for the commander to be continuously re-trimming the aircraft and would have made it difficult for him to establish a steady, stabilised approach. Even so the aircraft seems to have been correctly placed for a landing with an IAS of about 113 knots when it was just over 1 nm from the runway threshold. Both pilots were satisfied with the aircraft's position at this time and had the recommended approach speeds been maintained then it is considered most probable that a satisfactory approach would have been accomplished.

The speed, however, continued to decay unchecked at the rate of about one knot per second and it is this continuous speed loss which caused the problems which faced the commander in the final stages of the approach. The falling airspeed would have made it increasingly difficult for him to control the aircraft's heading as the rudder became progressively less effective and it was probably this which was responsible for the aircraft drifting to the right of the runway centre line as it approached the threshold. The commander tried to realign the aircraft with the runway when it was about 1/3 nm from the threshold by banking to the left. The aircraft was not too far misplaced even at this late stage for a 'side-step' manoeuvre to be successful had the speed been adequate. The speed, however, was now about 89 knots and still falling and the turn could not be sustained long enough against the aircraft's natural tendency to yaw to the right for the necessary correction to be made. In a final attempt to retrieve the situation the commander called for full power on the port engine but by then the aircraft had got into an irretrievable position as a landing could not be made on the runway and the aircraft was too low and too slow to carry out a successful overshoot. The only option open to the commander at that stage was to make a landing straight ahead on the grass beside the runway. In calling for full power on the port engine he only aggravated the situation and having lost all directional control could not prevent the aircraft from yawing and rolling until the starboard wing struck the ground.

There was some misunderstanding between the commander and the co-pilot about whether an overshoot was ordered. The commander stated that he called for full power and had not intended to overshoot whereas the co-pilot thought that an overshoot had been called for and consequently selected the undercarriage to retract after applying power on the port engine. In the event the misunderstanding was not a contributory factor to the accident which under the circumstances was inevitable. The effect of retracting the undercarriage was solely related to the way in which the aircraft came to rest after the initial impact. What is of greater concern was the apparent lack of co-operation between the co-pilot and the commander during the approach. The commander did not consider it necessary to give the co-pilot a special briefing for the single engine approach as he considered that the discussion they had had during an approach to the same aerodrome earlier in the day was sufficient. It would have been better if the commander had reviewed the single engine approach procedures in order to ensure the maximum co-operation between the two pilots. His failure to do so, however, did not absolve the co-pilot from carrying out his normal monitoring duties and it is of some concern that he apparently failed to warn the commander in the final stages of the approach that the airspeed was below the minimum approach speed and still reducing.

A single engine approach in this type of aircraft is not a difficult manoeuvre calling for special skills provided that a stabilised approach path is established as early as possible. One of the problems with which the pilot has to contend is lack of practice in the manoeuvre for he rarely has an opportunity of practising it except during his bi-annual checks. The commander had completed one of these checks about one month prior to the accident and had successfully demonstrated his competence in carrying out a single engine approach and overshoot followed by a single engine landing. Even though the airline's training programme complied with the requirements of the legislation this was still the only time in the seven months prior to the accident that the commander had

experienced any single engine handling and it may be that this overall lack of practice was a factor in the reasons for the erratic approach which preceded the accident. The main error was the failure to maintain the correct airspeed at the start of the descent. As a result the commander's workload increased during the later stages of the approach as he tried to cope with the continuous trim changes made necessary by the subsequent large power reduction and the gradual speed decay. Whenever a pilot's workload increases significantly a point is reached when his performance becomes degraded in some way and in this case it seems that the commander's instrument scan was inadequate as he appears to have been unaware of the continuing speed loss that finally made the aircraft uncontrollable.

The recollections of the commander are at variance with the flight recorder data for the latter part of the flight; it has not proved possible to resolve this difference.

2.1.2 *The engine malfunction*

The examination of the starboard engine revealed no evidence of mechanical failure or defect in the engine itself. The fault in the tacho-generator of the rpm indicating system was the only defect found during the investigation which had any significance in the search for a cause of the apparent engine misbehaviour. The nature of the fault was such that the crew could have been misled at any time into thinking that the engine speed was lower than it actually was. This was probably what happened on the initial aborted take-off when the commander noticed low speed engine indications. The intermittent nature of the fault could explain why the subsequent ground run to check the engine failed to reproduce the symptoms. There did not appear, however, to be a direct association between the faulty indicating system and the anomalous indications which occasioned the engine shut down. The cause of the rising TGT, torque and fuel flow indications, therefore, remain undetermined.

2.1.3 *Survival aspects*

Although the main task of the investigation was to determine the cause of the accident there are aspects relating to the evacuation of the aircraft which merit further examination. The difficulty experienced in opening three of the emergency exits could have had serious consequences had fire broken out in the aircraft. The commendable speed with which the fire and rescue service arrived at the aircraft ameliorated the situation to some extent for not only were rescue personnel able to force open the jammed passenger door but they also had the necessary fire fighting equipment standing by in case of a fire outbreak. Their prompt arrival on the scene proved the wisdom of alerting the emergency services and having them stand by on the airfield whenever an aircraft is about to land with an emergency on board.

The reasons why the three emergency exits were impossible to open from the inside was that the locking pins could not be withdrawn because they were jammed in position by the distortion of the surrounding frames. This distortion was part of the general crushing of the fuselage which was the result of the aircraft coming to rest with its undercarriage retracted thereby leaving the fuselage to carry the full weight of the wings and engines attached to its top. The situation was further aggravated by the way the aircraft came to rest with each end of the fuselage supported on an earth bank leaving the main weight suspended between these two points. The problems of door frame distortion are likely to be greater on large doors such as those designed for normal passenger use than on smaller exits and it is perhaps significant that the only exit to open easily after the accident was also the smallest one. On the other hand the larger doors have the advantage of allowing a quicker evacuation rate in an emergency.

It is disturbing that no evacuation could have taken place from the port side of the aircraft without the intervention of the firemen who forced the passenger door open from the outside. This was a potentially dangerous situation for if there had been a fire on the

starboard side of the aircraft and the fire services delayed in reaching the site then the occupants could have been trapped inside the fuselage.

In the case of high wing aircraft, such as the Herald, where it is doubtful whether some degree of fuselage distortion can be avoided, it would seem desirable that each side of the aircraft should have a combination of large and small exits in order to provide the maximum freedom for evacuation.

The cause of the failure of the spindle on the starboard rear escape hatch appears to have originated in its design, for calculations showed that the strength of the spindle was insufficient to withstand the force that could be exerted upon it by determined hand operation of the release handle in circumstances where the mechanism was jammed.

The difficulty in opening the ditching escape hatch when it was checked after the accident appears to have been caused by non-usage rather than fuselage distortion for once it was released it could be opened and shut quite freely. The airline's maintenance schedule called for ditching hatches to be checked by qualified engineers at intervals not exceeding one year and all other emergency exits at a period not exceeding 500 hours. The ditching hatch was last checked on 1 July 1974. Since any delay in opening escape hatches would have serious consequences in an emergency it would seem prudent to include the ditching hatch in the more frequent inspections which are carried out on the other escape hatches.

2.1.4 *Flight recorders*

The analysis of the recorder data was hampered because of the poor resolution of the pressure height and normal acceleration data. As a result double integration of the normal acceleration trace was only possible over relatively short periods. The absence of a requirement for resolution in the specifications which applied to the system installed in the aircraft has since been rectified in the specifications which apply to the second generation equipment. However, the resolution of the aircraft's normal acceleration trace of 0.008 'g' per count was already better than that called for in the new requirement. Difficulties will therefore continue to be encountered in the analysis of recorder data until such time as there is an improvement in the resolution of those data.

2.2 Conclusions

(a) Findings

(i) The crew were properly licensed, qualified and experienced to carry out the flight.

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

(iii) A precautionary shut down of the starboard engine was carried out because of rising TGT, torque and fuel flow indications and this necessitated a single engine approach and landing.

(iv) No evidence was discovered of any mechanical failure or malfunction in the starboard engine although there was a fault in the tacho-generator of the rpm indicating system which could have given erroneous rpm readings.

(v) No reason was found for the starboard engine's rising torque, fuel flow and TGT indications.

(vi) No evidence was found of a failure or malfunction which might have affected the aircraft's single engine performance and handling characteristics.

(vii) The airspeed decayed to below the recommended speeds during the final stages of the approach and the aircraft at the same time drifted to the right of the extended runway centre line.

(viii) The commander called for full power on the port engine at a time when the speed was insufficient to maintain directional control.

(ix) The aircraft went into an uncontrollable roll at a low height causing the starboard wing to hit the ground.

(x) The door locking pins of the three of the emergency exits were jammed in position by the distortion of the fuselage and the exits could not be opened from inside the aircraft.

(xi) The strength of the spindle on the external handle of the starboard rear emergency exit was insufficient to withstand the forces that could be exerted upon it by the determined efforts of a person operating the handle in a normal manner.

(b) Cause

The accident was caused by the application of asymmetric full power when there was insufficient airspeed to maintain directional control and when the aircraft was too close to the ground to allow recovery from the uncontrollable yaw and roll which developed. Other causal factors were:

(i) the requirement to carry out a single engine approach;

(ii) the failure to keep the aircraft correctly aligned with the runway and

(iii) the failure to maintain adequate airspeed during the final stages of the approach.

3. Recommendations

It is recommended that:

(1) All Herald aircraft should have the escape hatch operating mechanism modified to increase strength and ease of operating.

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Inspector of Accidents

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Department of Trade

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