Department of Trade

ACCIDENTS INVESTIGATION BRANCH

Handley Page Herald Series 201 G-APWF Report on the accident at London (Gatwick) Airport, Runway 26 on 20 July 1975

LONDON
HER MAJESTY'S STATIONERY OFFICE

List of Aircraft Accident Reports issued by AIB in 1977

No.	*Short title*	*Date of Publication*
1/77	Hawker Siddeley HS 125 Series 600B G-BCUX at Dunsfold Aerodrome, Surrey November 1975	May 1977
2/77	Cessna 310 G-BCKL at Black Hill, Perthshire, Scotland March 1976	June 1977
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Department of Trade
Accidents Investigation Branch
Shell Mex House
Strand
London WC2R ODP

1 June 1977

The Rt Honourable Edmund Dell MP
Secretary of State for Trade

Sir,

I have the honour to submit my report on the circumstances of the accident to Handley Page Herald, Series 201, G-APWF which occurred at London (Gatwick) Airport, Runway 26 on 20 July 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. 4/77
(EW/C530)

Operator:		British Island Airways (Jersey) Ltd
Aircraft:	*Type*	Handley Page Herald
	Model:	Series 201
	Nationality:	United Kingdom
	Registration:	G-APWF
Place of Accident:		London (Gatwick) Airport, Runway 26
Date of Accident:		20 July 1975

All times in this report are GMT

Synopsis

The accident was notified by the London ATCC to the Department of Trade on 20 July 1975. The Accidents Investigation Branch (AIB) of the Department of Trade carried out an investigation and the following groups were established: Operations, Engineering and Flight Data Recorder.

Immediately following take-off rotation, and whilst the landing gear was retracting at a very low height, the aircraft sank on to the runway where it slid to a stop wheels-up. There was no fire, no one was injured and the passengers de-planed safely through the crew entrance door.

It is concluded that the accident resulted from the landing gear being retracted before the aircraft was properly established in its initial climb. A mistaken wing flap configuration and a consequentially inadequate airspeed at rotation were contributory factors.

The report includes a recommendation that British Civil Airworthiness Requirements should provide a quantified definition of acceptable tangential loadings for the operating handles of emergency exits.

1. Factual Information

1.1 History of flight

G-APWF was making a scheduled passenger flight from Gatwick to Jersey and at 0916 hrs it was cleared to taxi to holding point 'Bravo'. (See paragraph 1.10.2). Whilst the commander was taxying the aircraft the co-pilot completed the taxying checks and commenced the pre-take-off drill. He asked the commander if the take-off was to be made with or without water methanol power (wet or dry) and the commander answered 'dry'. In his evidence the co-pilot said that having been thus informed he therefore selected, and obtained, 5^{O} of flap which is obligatory when water methanol power is not being used. Shortly after the commander had said that the take-off would be 'dry', the take-off drill sequence was interrupted when the co-pilot had to make a change of radio frequency and establish contact with Aerodrome Control. G-APWF was then cleared to line-up on Runway 26 after the departure of a Boeing 707 aircraft which had entered the runway at point Alpha.

Take-off performance vital data appropriate to a 5^{O} flap configuration without water methanol was displayed on an Aircraft Performance Sheet clipped on to the instrument panel; the co-pilot also entered the details in his log and verbally repeated the relevant take-off speeds to the commander; these speeds were:

V1/VR : 94 knots (V1= decision speed, VR= take-off rotation speed)

V2 : 98½ knots (V2= free air safety speed, to be achieved by 35 feet)

Take-off speeds for zero flap with water methanol power were also displayed and were:

V1/VR : 107½ knots

V2 : 111½ knots

No detailed emergency briefing was given by the commander for this take-off since he and the co-pilot had already flown together as a crew earlier that morning and on a number of occasions during the past few weeks; however the commander stipulated that 'standard procedures' would be used. After the Boeing had taken off the commander lined up G-APWF on the left hand side of the runway in order to take advantage of the slight cross-wind from the left which, he considered, should help disperse any residual wake turbulence from the preceding aircraft.

After the Boeing had passed through 2,000 feet and had been cleared from the Gatwick frequency G-APWF was cleared to take-off. This was at 1 minute 44 seconds after the Boeing had called 'rolling' and the commander of G-APWF said he released the brakes and commenced the take-off run within ten seconds of being cleared to do so. Full take-off power was applied and verified by the co-pilot who also made the standard calls of 'speed building, temperatures normal,' then, '80 knots, V1, VR and V2'. During the latter part of this sequence the co-pilot was holding the throttle levers with his right hand and the throttle friction lever with his left hand. In his evidence the commander said that he made a normal rotation to about 7^{O} nose-up at VR and, having observed a positive rate of climb of 70 to 100 feet per minute on the vertical speed indicator (VSI), he ordered the landing gear to be retracted. Seconds later, when the aircraft was about 15 feet above the runway, it descended suddenly and he was unable to arrest the descent. The aircraft struck the runway and slid to a stop, wheels-up. The fuel shut-off levers were moved into the 'feather' position during the ground slide.

According to eye-witnesses the aircraft lifted off after a ground run of about 760 metres and then appeared to be airborne for about a further 125 metres with its landing gear retracting before the rear underside of the fuselage settled back on to the runway.

In his evidence the co-pilot said that on hearing the order to retract the landing gear he had locked the throttle levers and pushed the 'up' selector button with his left thumb but the switch would not depress. He then leaned to the left to obtain more leverage, pressed the 'up' button with his right thumb and the selector switch depressed without difficulty. He also said that he did not observe the reading on the VSI before selecting gear 'up' and that shortly after making the selection he had felt a lurch which he associated with the retracting landing gear. Whilst waiting to confirm that the landing gear was fully retracted, he heard the commander make a remark which suggested that something was amiss and on looking up he saw the aircraft close to the ground and not climbing.

When the aircraft came to rest the commander instructed the cabin staff to evacuate the passengers. After the passengers were safely off the aircraft he noticed that the wing flaps were fully up but he said he had not ordered their retraction. The co-pilot also noticed that the flap selector lever was in the 'up' position but he said he was not conscious of having moved it. When interviewed, both pilots said that take-off (5^{O}) flap was being indicated before the take-off commenced.

The accident occurred in daylight at 0900 hrs in position 510N 0012W at an elevation of 202 feet.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	–	–	–
Non-Fatal	–	–	–
None	4	41	

1.3 Damage to aircraft

Substantial but repairable.

1.4 Personnel information

(a)	*Commander*	Male.
	Age:	50 years.
	Licence:	Airline Transport Pilot, valid until 30 March 1976.
	Aircraft ratings:	Part 1 (Command): Dart Herald and PA23.
	Instrument rating:	Last renewed on 23 June 1975.
	Medical certificate:	Class One, last renewed on 5 March 1975; spectacles to be carried for near vision.
	Last competency check:	23 June 1975, (Base check).
	Last line check:	14 April 1975.
	Flying experience:	Total flying 6,380 hours, 1,766 in command on Heralds.
		Total in last 28 days 51.00 hours.

	Last rest period:	Off duty on 16 and 17 July; stand-by-duty on 18 July.
	Previous day's activity (19 July) :	Total duty time 6 hours 57 minutes with 6 hours 42 minutes flying duty time. Off duty for 10 hours 25 minutes before reporting for duty at Manchester on day of accident.
	Total duty time on day of accident:	2 hours 55 minutes, Manchester to Gatwick.
(b)	*Co-pilot*	Male;
	Age:	58 years.
	Licence :	Commercial Pilot, valid until 25 March 1980.
	Aircraft ratings :	Part 1 (Command): Auster, DH 104 and Canadair C4. Part 2 (Co-pilot): York, HP81, Viking, Dakota, Canadair C4 and Dart Herald.
	Instrument rating :	Last renewed on 16 June 1975.
	Medical certificate:	Class One, last renewed on 10 March 1975 spectacles required to be carried for near vision, prescription renewed during last six months.
	Last competency check :	16 June 1975 (Base Check).
	Last line check :	7 June 1975.
	Flying experience:	Total flying approximately 15,000 hours. Total as co-pilot on Heralds approximately 2,000 hours.
	Last rest period:	Off duty on 16 and 17 July, stand-by on 18 July.
	Previous day's activity (19 July):	Total duty time 6 hours 42 minutes including 2 hours 50 minutes flying time. Off duty for 10 hours before reporting for duty at 0615 hours at Manchester on the day of the accident.
	Total duty time on day of accident:	3 hours 07 minutes.
(c)	*Cabin staff*	Female (two).
	Emergency procedure checks:	The senior air hostess was last checked in emergency procedures on 14 November 1974. The second air hostess, who was last checked in emergency procedures on 10 March was undergoing a line check at the time of the accident.

1.6 Aircraft information

1.6.1 General particulars

Type:	Handley Page Herald 201.
Manufacturer:	Handley Page Ltd.
Date of manufacture:	March 1962, Serial No 154.
Certification:	(a) Certificated in the Transport (Passenger) Category; its certificate of airworthiness was last renewed on 2 May 1975. (b) Certificate of maintenance was issued after a periodic maintenance check on 12 June 1975 and was valid for 84 days or 500 flying hours whichever expired first.
Hours flown:	The airframe had flown 21,495 hours since new and 236 hours since its last periodic check. The engines had been run for 2,174 hours (left) and 1,732 hours (right) since being overhauled.
Maximum authorised take-off weight with 5° flap and without methanol power:	18,144 kg.
Take-off weight on accident flight:	18,022 kg.
Centre of gravity:	Laden index was 22.50. This was forward of the mid-position but well within authorised limits.
Fuel at take-off:	1,900 kg (536 I G) Jet A1.

1.6.2 Documentation and operating procedures

The aircraft was correctly documented for the flight and carried a comprehensive library of operational and technical manuals.

The following extract is from the Operations Manual, Part 1, Volume 1, Section 1, Chapter 1, Page 8:

> 'Gear retraction
>
> A. Both pilots shall cross-check on the vertical speed indicators, or visually (or both) that a positive rate of climb has been established. The Captain will then call 'gear up'. The Co-pilot will respond 'positive climb – gear up' before retracting the gear'.

1.6.3 Flap controls and indications

The flap selector lever is located on the centre pedestal behind the throttle levers and moves in a small gated quadrant which provides three positions: 'up', 'take-off', (5° setting), and 'down' (fully extended). Flap extension is indicated by three sets of warning lights located at the bottom of the co-pilot's instrument panel and these show:

'In transit' (white) when flaps are moving following a selection;
'Take-off' (one green light) when flaps are at 5°;
'Down' (two green lights) when flaps are fully down.

No lights are illuminated when the flaps are 'up'. There is no take-off configuration warning system.

1.6.4 Protection against inadvertent landing gear retraction

An electrically controlled lock on the 'up' push-button is intended to prevent accidental raising of the landing gear whilst the weight of the aircraft is on the main wheels; a micro-switch on the right main landing gear leg controls the lock which is withdrawn when the oleo leg extends as the aircraft becomes airborne. The lock may be overridden, if required, by the application of a pressure exceeding 40 lb to the 'up' push-button switch.

1.7 Meteorological information

At 0919 hours when the Boeing was cleared for take-off, ATC gave a surface wind of 230° 10 knots. When G-APWF was cleared for take-off at 0920.40 hours the surface wind was given as 240° 12 knots. A special observation taken at 0933 hours showed the following conditions:

Surface wind :	230° 10 knots, variable 190° to 260°.
Visibility :	8 km.
Present weather :	Nil.
Cloud:	3/8 at 800 feet, 6/8 at 1,200 feet, 8/8 at 4,500 feet.
Temperatures:	19°C and dewpoint 15°C.
QNH & QFE:	1016 and 1009 millibars.

1.8 Aids to navigation

Not relevant.

1.9 Communications

The aircraft's departure was controlled by:

(a) Ground Movement Planning, which issued start-up clearance departure instructions on 121.95 MHz;

(b) Ground Movements Control, which regulated marshalling and taxying of aircraft on 121.75 MHz;

(c) Aerodrome Control, which took over control of the aircraft on 118.1 MHz prior to its entering the active runway.

Speech recording apparatus with time injection operates continuously at Gatwick and was serviceable at the time of the accident. The accuracy of the time injection was established as 1 second fast; transcripts of radio messages passed on the three frequencies listed above were prepared by the Civil Aviation Authority (CAA) Transcription Unit. Relevant points from these transcripts are:

0909 – 0910	Start-up and departure instructions passed to G-APWF on 121.95 MHz.
0916	G-APWF cleared to taxi to holding point 'Bravo' on 121.75 MHz.
0917+	G-APWF cleared to Aerodrome Control Frequency 118.1 MHz.
0917+	G-APWF established communications on 118.1 MHz.
0919	Boeing G-APFO cleared for take-off (from point 'Alpha').
0919.02	G-APFO called 'rolling'.
0919.03+	G-APWF cleared to line up 'after the departing 707'.
0920	Boeing G-APFO reported passing 2,000 feet.
0920.40	G-APWF cleared for take-off (from point 'Bravo').
0920.46	G-APWF acknowledged.

1.10 Aerodrome and ground facilities

1.10.1 Runway 26

Dimensions:	3098 x 46 metres.
Elevation:	202 feet amsl.
Threshold:	displaced 267 metres from commencement of paving.
Surface:	concrete/asphalt.

The runway surface was dry.

1.10.2 Holding/entrance points

Traffic taking off on Runway 26 enters either from point 'Alpha', which is at the commencement of the runway proper, or from point 'Bravo' which is approximately 250 metres west of 'Alpha'. A plan of the runway may be seen in Appendix 1.

1.10.3 Fire and rescue services

Airport fire service units arrived at the scene within 2 minutes of the occurrence. Other appliances and units of the West Sussex and the Surrey Fire Brigades and Ambulance Service were alerted by the crash alarm and they arrived promptly.

1.11 Flight recorder

1.11.1 The aircraft was equipped with a Sperry SADAS digital flight data recorder (FDR) which was serviceable and recorded the following parameters against time:

Pitch attitude	Pressure altitude
Roll attitude	Airspeed
Magnetic heading	Wing flap position
Normal acceleration ('g')	

A.C. power frequency was also recorded since recorded magnetic heading is frequency dependent. The Penny and Giles wire recorder cassette from which the data was retrieved was shock mounted and positioned on the starboard side of the stepped floor in the rear baggage hold. All FDR units were found to be undamaged although some of the shock mounts supporting the drive unit and cassette had suffered impact damage.

1.11.2 Accuracy

After calibration corrections the accuracy of the data was established as:

Pitch:	± 1.25°	Airspeed: within 2 knots at 80 knots	
Roll:	± 1.25°	Heading:	± 1.0°
		Acceleration:	± 0.02g
Pressure altitude:		The entire flight was made in ground effect, and because the dynamic errors are unknown, no assessment of accuracy can be made for this parameter.	
Flap position:		Discrete digital values indicate 'flap up', take-off', 'down' and 'in transit'. No values differing from the above were recorded.	

The corrected data in graphic form may be seen in Appendix 2.

1.11.3 Interpretation of data

After analysis of the recorded data and correlation with other evidence including previous recordings, eye witnesses, and engineering, it is considered that:

(i) The take-off run was commenced approximately 64 feet (19.5 metres) from the displaced landing threshold on Runway 26 (entry point 'Bravo').

(ii) Throughout the take-off run the flaps were 'UP' (Zero degrees) and there was no loss of or reduction of engine power.

(iii) An airspeed of 94 knots (VI/VR speed used by the crew) was reached 23 seconds after the start of the take-off run and rotation was initiated at that speed; an airspeed of 98 knots (V2) was achieved one second later.

(iv) Rotation was continued at approximately 2° per second and was momentarily arrested at 4.5° nose-up. It was then continued to a maximum of 5.8° nose-up at which time there was a reduction in the rate of increase of airspeed. During these events the aircraft lifted-off although the actual point cannot be precisely defined; the maximum recorded airspeed during this period was 106 knots.

(v) At 27.6 seconds the normal acceleration trace shows an increment of 0.16'g'; this is attributed to the aircraft bouncing on the right main wheel which was already retracting.

(vi) This bounce was immediately followed by the left wing dropping because the left wheel was already more retracted than the right one. (The landing gear retraction sequence was established as left main, right main, nosewheel).

(vii) The left wing continued to drop and at 28.8 seconds the rear of the fuselage contacted the runway. Recorded airspeed was then 104 knots.

(viii) Contact of the rear fuselage with the runway caused the aircraft to pitch down rapidly until the retracting nosewheel contacted the runway.

(ix) The recorder continued to function, though with unknown accuracy, until switched off by the airspeed contactor below 70 knots.

(x) There is no indication of any encounter with wake turbulence from the preceding aircraft throughout the take-off sequence.

1.11.4 Lift-off considerations

Lift-off curves plotted against pitch attitude and equivalent airspeed for 5^{o} and 0^{o} flap settings are given in Appendix 3. On the basis of the recorded data of 5.8^{o} maximum pitch attitude and 106 knots maximum airspeed, and applying the maximum tolerances indicated in paragraph 1.11.2, the aircraft would not have generated sufficient lift forces with 0^{o} flap setting to have permitted sustained flight. Although the information available did not permit the determination of an accurate value, the maximum height achieved is assessed as between 2 and 4 feet above runway level.

1.12 Wreckage

1.12.1 A preliminary examination of the aircraft before its removal from the runway showed that its landing gear and wing flaps were fully retracted and that both propellers were almost fully feathered. The first impact scrape marks on the runway were 890 metres from the western edge of entry point 'Bravo'. From the type and degree of damage to the aircraft it was evident that the main landing gear had been retracting, and the aircraft had been banked slightly to the left and in a nose-up attitude when the rear underside of the fuselage and the tips of the port propeller came into almost simultaneous contact with the runway.

1.12.2 Subsequent examination

Examination of the aircraft structure and propellers showed that all the damage had occurred subsequent to the first point of contact with the runway. Ground tests of the landing gear wing flaps and their respective indicator systems, of the aircraft's hydraulic and electrical systems and of the flight and engine instruments showed that all were serviceable and without fault. No evidence was revealed of incorrect maintenance, pre-crash mechanical defect, malfunction or failure of the aircraft or its engines.

1.13 Medical and pathological information

Not applicable.

1.14 Fire

There was no fire but friction heat generated during the ground slide resulted in smoke entering the passenger cabin from the underfloor area. Foam was laid by the Airport Fire Service who attended the scene promptly with a rescue tender and four appliances.

1.15 Survival aspects

All occupants were correctly strapped in for take-off and when the aircraft subsided gently on to the runway the retardation forces were low and there were no injuries. When the stewardess in the rear cabin found she was unable to open the main rear door the passengers left the aircraft through the front crew entrance without difficulty and in good order. The rear main passenger door, which is outwards opening, was subsequently opened without difficulty from outside the aircraft and it is thought that the stewardess had not applied sufficient force to the internal operating lever. It was company policy that in normal operations the main passenger door should only be operated by ground handling staff in

order to reduce risk of injury to those outside the aircraft and it was established that the stewardess, who was relatively inexperienced, had never operated the main passenger door whilst under training.

1.16 Test and research

Nil.

1.17 Other information

1.17.1 Wing vortices

The effects of residual wing vortices from the preceding aircraft was examined in the light of the circumstances of the accident and existing knowledge of general behaviour of wing vortices. The situation considered most likely to produce a downdraught is one where the wind is light and closely aligned with the runway heading. The worst height for an encounter with such a downdraught would occur just out of ground effect in a case when there had been little or no time for an increase in the separation of the two vortices and hence no diminution in total downdraught. In this case, theoretically, the vortices shed by the departing Boeing 707 near its lift-off point would have had time (at least 1 min 44 seconds) to move apart quite appreciably so that, notwithstanding the slight crosswind from the left, both port and starboard vortices should have been clear of the runway by the time G-APWF arrived in the critical area; thus, any downdraught would have been negligible. However, if the lateral velocity of the vortices had been such that, because of the crosswind, the port one had remained stationary relative to the runway (this implies a vortex movement at less than half the predicted rate) the main effect on G-APWF would have been to disturb it in the rolling plane; any real downdraught effect would have been quite small. It is relevant to note that the FDR data did not contain evidence of the type usually associated with the presence of vortices or downdraught.

1.17.2 Emergency exits – operating loads

Whilst the passengers were leaving the aircraft an Airport fireman tried to get into the passenger cabin through the starboard rear emergency door but its external operating handle broke off. Subsequent examination of the broken spindle revealed no evidence of metal fatigue but all the evidence indicated that the spindle had broken because it was not strong enough to withstand the operating load. Examination of all the exits, their surrounds and door operating mechanisms, revealed no evidence of any marked distortion, fretting or any other deterioration. After all normal and emergency entry doors and hatches had been refitted, measurements were taken to establish the tangential forces necessary to operate the internal operating levers and to achieve complete movement and release of the door or hatch; the approximate measurements were:

Crew main door (port front)	20 lb
Main passenger door (port rear)	30 lb
Forward emergency hatch (starboard)	17 lb
Ditching hatch (top starboard)	75 lb (on external handle only)
Rear emergency door (starboard)	80 lb

The CAA Airworthiness Division were informed of the mechanical failure of the starboard rear emergency door operating spindle on G-APWF and of the operating force measurements which were subsequently taken. A similar mechanical failure of the starboard rear emergency door operating mechanism had occurred following an accident to a Herald aircraft at Jersey in December 1974 and a consequential Service Bulletin (No.52-1530) issued by the CAA Airworthiness Division on 25 April 1975, required:

(a) Visual inspection of the spindle for evidence of cracks and distortion;

(b) The introduction of more frequent function checks from both outside and inside, in turn, of all these emergency hatches.

Maintenance records of G-APWF reveal that the Operator had complied with the requirements of this Service Bulletin.

Following the 1974 accident, as well as introducing the more frequent checks, the CAA Airworthiness Division had proposed a design modification to introduce a strengthened operating spindle to the starboard rear emergency door. When they were notified of the similar failure of the operating spindle in this accident, and in the knowledge of the measured forces found necessary to operate the doors, they reviewed the intended design strength requirements for the operating spindle. With regard to the rather high force (80 lb) needed to operate the starboard rear emergency door handle, Campaign Wire 52-1530 CW dated 5 August 1975 required that the operating loads to open the door from the inside be within the capacity of an average female cabin attendant.

So far as can be established there are no quantitative requirements in British Civil Airworthiness Requirements for the loadings of the operating levers of emergency exit doors or hatches which are based on scientifically determined isometric strength capabilities of female cabin staff. On 1 October 1976, however, the British Civil Airworthiness Requirements were amended to read as follows:

'Means of Opening

(a) The means of opening emergency exits shall be rapid and obvious and shall not require exceptional effort .....

(b) Not relevant.

(c) Each emergency exit shall be capable of being opened, when there is no fuselage deformation:

(i) with the aeroplane in the normal ground attitude and in each of the attitudes corresponding to the collapse of one or more legs of the landing gear; and

(ii) within 10 seconds measured from the time when the opening means is actuated to the time when the exit is fully opened.'

2. Analysis

No defects were found in the aircraft, its engines, flight instruments, flying controls, nor in its warning and indicator systems. There can be no doubt that the events leading to the accident originated in the pilots' mistaken belief that the flaps had been extended to the take-off setting prior to entering the runway, an omission which probably resulted from an interruption in the sequence of the pre-take-off drill. Such interruptions are not unusual but any potential omissions in vital actions should be prevented by proper use of the check list and, if they do occur, should be detected by careful cross-monitoring and attention to detail.

The evidence, particularly that of the FDR, shows that although the take-off was made in a flaps-up configuration the engine power and take-off airspeeds used were those appropriate to a wing flap setting of 5^{O}. The airspeed at the time of rotation was therefore less than was required to sustain a safe initial climb. If the flaps had been extended to 5^{O} for the take-off, the aircraft would have been capable of climbing away safely at the airspeed and rotation angle achieved. The FDR data shows that there was a sudden reduction in pitch attitude shortly after lift-off. The commander said he was unable to counter this and the most probable explanation is that it was caused by the touch down of the underside of the rear fuselage following the brief lift off at too low an airspeed for the zero flap configuration. Unless the handling pilot had been fully aware that the aircraft was prematurely airborne an inadvertent touch down was a probability. The evidence shows that the pilot was not so aware.

If the landing gear had not already been retracting it is unlikely that this touch down would have resulted in anything more than a wheels bounce and continued acceleration to an adequate take-off speed. The premature retraction is therefore identified as the primary causal factor in the accident. The co-pilot's first attempt to raise the landing gear was probably prevented by the weight switch baulk which would inhibit the operation of the selector because the main wheels were still on the ground although the nose-wheel and flight deck had lifted-off. While it is possible that, perhaps in over-anxiety to comply with the commander's instruction, the co-pilot unconsciously exerted sufficient pressure to over-ride the landing gear retraction baulk in his second attempt to raise the gear, a more probable reason for his success is that the selection coincided with the lift-off of the main wheels.

The commander's order to retract the landing gear was undoubtedly premature. In all probability it was based on the knowledge that a positive rotation had been made and on the observation of a small rate of climb, coupled with the confident anticipation of the normal climb which would have resulted from a 5^{O} flap setting. The over-riding factor was probably familiarity with frequent routine activity. Moreover neither the commander nor the co-pilot could have complied fully with the drill specified in their Operations Manual (see paragraph 1.6.2), before taking action to retract the landing gear.

Although the reason why the aircraft failed to sustain a positive climb immediately after lift-off is amply explained by the evidence of flap setting and rotation speed, the possible influence of any residual wing vortices from the Boeing 707 has been considered. Expert opinion suggests that in the prevailing meteorological conditions the wing vortices should have separated and that G-APWF should not have been significantly affected so close to the ground. Although theory gives fairly adequate predictions of the average behaviour of vortex movement, large unpredictable variations do occur in practice. However, on this occasion, the possibility of an encounter with a vortex is not supported by the flight recorder data. After lift-off, which was identified from the recorder data, the aircraft did not achieve a height increase sufficient for it to have been clear of ground effect and into a region where the effects of any residual vortex downdraught might have been pronounced. The recorded data does not contain evidence of an upset in the rolling plane

nor any excursions of pitot-static values which could be identified with the presence of a vortex and it is therefore considered that wing vortices were not a significant factor in the accident.

During the evacuation phase the starboard rear emergency door could not be opened after the operating spindle broke. Had there been a post-crash fire the consequences might well have been very serious. A similar failure occurred during a previous accident to this type of aircraft and on that occasion the failure of the spindle was adjudged to have been due to high forces which had to be exerted on the operating lever to overcome friction and frame distortion. The CAA Airworthiness Division subsequently issued instructions for more rigid periodic inspection standards and functional tests of all emergency doors and hatches; these instructions had been implemented in respect of G-APWF. The design strength of the spindle was also reviewed by CAA but no modification action was taken.

As the result of this second accident the design of the operating spindle to the starboard rear emergency door has been improved and new spindles have been fitted on all Herald aircraft. The operating levers on all the other escape hatches have also been modified to enable higher forces to be exerted. During examination of the effort required to operate the aircraft's door handles it was found that there do not appear to be any defined values for the loadings of operating handles on emergency exits and there is therefore nothing to ensure that the effort required is within the normal physical capabilities of all cabin staff. It is considered that BCAR's should be revised to contain appropriately defined values.

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 to carry out the flight.

(iii) Whilst taxying out for take-off there was an interruption to the check list procedure and the required 5^{o} take-off flap setting was not made.

(iv) Although the pilots believed they had seen the 5^{o} flap setting on the flap indicator before take-off the Flight Recorder shows no such setting had been made.

(v) The engine power and the take-off speeds used leading up to lift off were inadequate for the aircraft weight in the existing zero flap configuration and the aircraft touched down again about 3 seconds after lifting off.

(vi) Landing gear retraction was initiated during the brief airborne period and the gear collapsed when the aircraft touched down again.

(vii) During post-accident examination it was established that, except for damage to the propellers and minor structural damage to the fuselage, the aircraft, its engines, instruments and all ancillary equipment were serviceable and without fault.

(viii) There is no evidence that any effect from residual wing tip vortices from a previous aircraft was a factor in the accident.

(xi) During the otherwise successful passenger and crew evacuation the starboard rear door handle spindle broke because it was not strong enough.

(x) There is no quantitative definition of the effort required to operate emergency door handles and thus nothing to ensure it is within the normal strength capabilities of female cabin attendants.

(b) Cause

The accident was caused by retraction of the landing gear before the aircraft was established in a sustained climb.

4. Safety Recommendations

It is recommended that there should be a British Civil Airworthiness Requirement which stipulates the maximum tangential loads acceptable for the operation of handles or levers on emergency exits and hatches. This Requirement should be properly quantified and related to the isometric strength capabilities of female cabin attendants.

W H TENCH
Chief Inspector of Accidents

Accidents Investigation Branch
Department of Trade

June 1977

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