ACCIDENTS INVESTIGATION BRANCH
Department of Trade and Industry

Hawker Siddeley HS 748 Series 2 aircraft G-ATEK and G-ATEH of Channel Airways

Report on the accidents at Portsmouth Airport, Portsmouth, Hampshire on 15 August 1967

LONDON: HER MAJESTY'S STATIONERY OFFICE
1971

List of Civil Aircraft Accident Reports issued by AIB in 1971

No.	*Short title*	*Date of publication*
1/71	Hawker Siddeley HS 748's G–ATEK and G–ATEH at Portsmouth, August 1967	March 1971

SBN 11 510630 8

Department of Trade and Industry
Accidents Investigation Branch
Shell Mex House
Strand
London WC2
November 1970

The Rt Hon John Davies MP
Secretary of State for Trade and Industry

Sir,

I have the honour to submit the report of Mr R C Warren, an Inspector of Accidents, on the circumstances of the accidents to Hawker Siddeley HS 748 Series 2 aircraft G–ATEK and G–ATEH which occurred at Portsmouth Airport, Portsmouth, Hampshire on 15 August 1967.

I have the honour to be,

Sir,

Your obedient Servant,

V A M HUNT
Chief Inspector of Accidents

Accidents Investigation Branch

Civil Accident Combined Report Nos EW/C/0179 and EW/C/0180

Aircraft:	Hawker Siddeley HS 748, Series 2, G–ATEK and G–ATEH
Engines:	Each aircraft was fitted with two Rolls Royce Dart Type 531 engines.
Owner and Operator:	Channel Airways Limited, Southend Airport, Essex
Crews:	G–ATEK
	Commander
	Captain D P Dogherty – Uninjured
	Co-pilot
	First Officer K F Fenton – Uninjured
	Air Stewardess
	Miss J W Goody – Uninjured
	Air Stewardess
	Miss J Hoare – Uninjured
	G–ATEH
	Commander
	Captain F P Mann – Uninjured
	Co-pilot
	First Officer C Petrides – Uninjured
	Air Stewardess
	Miss G M Smith – Uninjured
	Air Stewardess
	Miss P Crane – Uninjured
Passengers:	G–ATEK – 19 – Uninjured
	G–ATEH – 62 – Uninjured
Other Persons:	Nil
Place of Accident:	Portsmouth Airport, Portsmouth, Hampshire
Date and Times:	15 August 1967 at 1148 hrs (G–ATEK) and 1334 hrs (G–ATEH)
	All times in this report are GMT

The abbreviation MOA/DTI is used in this report to refer to the authority previously exercised by the Ministry of Aviation. The functions of that authority were transferred to the Board of Trade and subsequently to the Department of Trade and Industry. The abbreviation ARB is used in references to the Air Registration Board.

Summary

Both aircraft, operating scheduled passenger services, overran the grass surfaced runways when landing at Portsmouth. G–ATEK struck an earth embankment forming the northern perimeter and G–ATEH broke through the northeast perimeter fencing onto the main road bordering the aerodrome. Each aircraft sustained serious damage but there were no injuries to the passengers or crew or to other persons; there was no fire in either case. Both aircraft were correctly operated by their respective flight crews and there were no technical defects which contributed to the accidents.

Both accidents were caused by inadequate braking which resulted from the extremely low coefficient of friction provided by the very wet grass surface over the hard, dry and almost impermeable sub-soil of the aerodrome. This condition of the grass surface was both unusual and unexpected. It is unlikely that any increments derived from then existingHS 748 grass landing performance data which might reasonably have been applied to the flight manual scheduled landing distance would have proved adequate on this surface.

Quite apart from the particular occasion of these accidents it became apparent during this investigation that the Portsmouth HS 748 operation was unsafe at the permitted maximum landing weight whenever the grass surface of the aerodrome was wet; on such occasions the available landing distances were inadequate. This situation appears to have resulted from a misconception which arose during the planning stage and led to the omission of necessary landing distance increments based on information on HS 748 grass surface performance data existing at the relevant time. When such increments were made mandatory shortly after the accidents the operation was terminated as uneconomic. The fact that no account had been taken of the extra landing distance necessary for HS 748 aircraft on wet grass must be considered as a contributory cause.

ARB and MOA/DTI were inconsistent in that after having recommended a 30 per cent wet grass landing distance increment to the New Zealand authorities they did not call for a similar increment for HS 748 grass surface operations in the United Kingdom. They had no co-ordinated policy on HS 748 grass surface performance requirements and although it is accepted that they fulfilled their statutory obligations this did not suffice to ensure the safety of Channel Airways operation at Portsmouth.

1. Investigation

1.1 History of the flights

The first aircraft, G–ATEK, was operating a scheduled service from Southend to Paris via Portsmouth and after descending below cloud with the assistance of RAF Thorney Island precision approach radar (PAR) proceeded visually to Portsmouth. The pilot contacted Portsmouth Tower at approximately 1142 hrs and was informed that there was slight rain, that the runway in use was 36, and that the surface wind was 010° at 6 knots, this being subsequently amended to 040° at 6 knots. The aircraft flew overhead in a westerly direction, in rain and in and out of low cloud, and joined a left hand circuit but after reporting 'overhead' and confirming that he would land on Runway 36 the pilot made no further contact with Portsmouth Tower. The aircraft was not seen by the controller from the time of passing overhead until it was about 300 feet on short final approach to Runway 36. No information was given to the pilot concerning the aerodrome surface conditions.

The aircraft touched down 500 feet (152 metres) after passing the displaced landing threshold of Runway 36 and 330 feet (100 metres) to the left of the centreline, on a heading of 010° at a speed of about 84 knots. In this manner the pilot had been able to avoid buildings on the approach path and cross the boundary as low as possible so as to make an early touchdown. After the pilot had applied ground-fine-propeller pitch and continuous wheel braking the aircraft decelerated initially but in the later stages of the groundroll it became apparent that the aircraft was not going to stop within the available distance.

Power was applied to the starboard engine in an attempt to induce a ground-loop but after a partial swing to the left the aircraft slid sideways coming to rest on top of the embankment which forms part of the northern boundary of the aerodrome. Under the direction of the two air stewardesses the passengers evacuated the aircraft in an orderly manner through the rear door of the aircraft. The accident occurred at 1148 hrs.

Although the pilot attributed his accident to the poor state of the aerodrome surface the Airport Manager thought it had resulted from a late, fast touch-down; after an inspection he assessed the aerodrome as serviceable. According to Channel Airways operations manual their Operations Centre at Southend was the deciding authority on HS 748 operations. Although also aware of the pilot's opinion they did not question the Airport Manager's assessment, nor did they suspend further HS 748 operations.

The second aircraft, G–ATEH, was operating a scheduled service from Jersey via Guernsey to Portsmouth. After descending to the south of Portsmouth using the Portsmouth very high frequency direction finding station (VDF)

and whilst flying in low cloud and slight drizzle the aircraft made a partial right-hand circuit south of the city to land on Runway 07. The pilot was aware of the poor braking conditions from his experience during a landing made some three hours previously and the tower controller also warned him to expect poor braking. He was completely unaware of the accident to G–ATEK and subsequently stated that had he been informed of this he would not have attempted to land at Portsmouth.

The pilot misjudged the first approach which was too fast and slightly misaligned; after bouncing a number of times during the attempt to land the aircraft took off again for another approach. After a further right-hand circuit the aircraft made a second approach to Runway 07 and during this approach the wind of 10 knots veered from 110° to 180° and by the time of touchdown had backed again to 150°.

The aircraft touched down at a speed of 88 knots, 336 feet (102 metres) after passing the threshold of Runway 07 and exactly on the centreline. The pilot placed the aircraft firmly on the ground and immediately applied ground-fine-propeller pitch and full wheel braking. The aircraft decelerated for approximately the first two-thirds of the landing roll but after this point deceleration was negligible. The pilot then attempted to groundloop the aircraft to the right but abandoned this when he realised that it might lead to collision with cars parked near to the airport buildings. The aircraft slid until it broke through the perimeter fence, coming to rest on the main road having sheared off the nosewheel and mainwheels against a raised banking at the side of the roadway; at that moment there was a break in the usually heavy traffic on this road. Shortly before the impact the pilots shut down the engines and took fire prevention action and, when the aircraft came to rest they assisted the air stewardesses in organising a rapid evacuation of the passengers through the main doors which were at ground level. The accident occurred at 1334 hrs.

1.2 Injuries to persons

Injuries	*Crew*		*Passengers*		*Others*
	G-ATEK	*G-ATEH*	*G-ATEK*	*G-ATEH*	
Fatal	0	0	0	0	0
Non-fatal	0	0	0	0	0
None	4	4	19	62	

1.3 Damage to aircraft

Both aircraft sustained serious damage. The fuselage of G-ATEH was only slightly damaged in the accident itself but extensive damage was inflicted on the rear fuselage by unqualified personnel during efforts to remove it from the road before the arrival of an RAF salvage team with proper equipment.

1.4 Other damage

No other damage was caused in the first accident but during the second, part of the perimeter fencing of steel mesh on concrete posts was broken down and a lamp post was uprooted exposing the electricity supply cabling. Fuel spillage from this accident was hosed off the roadway by the fire services.

1.5 Crew information

1.5.1 *G–ATEK*

Captain Digby Paul Dogherty, aged 34, held a valid airline transport pilot's licence endorsed for command of HS 748 aircraft; his last competency check on this aircraft type was completed on 5 June 1967. At the time of the accident his total flying experience was 6,002 hours, of which approximately 900 had been flown on HS 748 aircraft; during the previous fourteen months he had landed at Portsmouth airport on numerous occasions. He had flown 82 hours in the last 28 consecutive days and had a rest period of 10 hours 10 minutes before reporting for duty at 0620 hrs on the day of the accident.

First Officer Kenneth Francis Fenton, aged 32, held a valid commercial pilot's licence endorsed for co-pilot duties on HS 748 aircraft. His last competency check on the HS 748 aircraft was completed on 1 May 1967. At the time of the accident his total flying experience was about 4,000 hours, of which approximately 300 were on HS 748 aircraft. He had flown 94 hours in the last 28 consecutive days and had a rest period of 10 hours 5 minutes before reporting for duty at 0715 hrs on the day of the accident.

1.5.2 *G–ATEH*

Captain Frank Percy Mann, aged 41, held a valid airline transport pilot's licence endorsed for command on HS 748 aircraft. At the time of the accident he had a total of 5,300 hours flying as a pilot, of which approximately 800 were in command of HS 748 aircraft. His last competency check on this aircraft type was on 22 January 1967.

He had flown 78 hours 30 minutes during the last 28 days and had a rest period of 14 hours before reporting for duty at 0900 hrs on the day of the accident. He had landed at Portsmouth on numerous occasions during the previous fourteen months.

First Officer Costas Petrides, aged 30 years, held a valid commercial pilot's licence endorsed for co-pilot on HS 748 aircraft. At the time of the accident, he had a total flying experience of approximately 1,000 hours of which approximately 590 were as co-pilot of HS 748 aircraft. His last competency check on HS 748 aircraft was on 5 June 1967. He had flown 91 hours 15 minutes during the last 28 days and had the same rest and duty times as Captain Mann during the 24 hours preceding the accident.

1.5.3 *General*

The pilots and the air stewardesses of both aircraft had all received training in HS 748 emergency procedures within the twelve months preceding the accidents.

1.6 Aircraft information

Both were HS 748, Series 2, aircraft manufactured by Hawker Siddeley Aviation in 1966 (G–ATEK) and 1965 (G–ATEH), and both had been owned by Channel Airways since new. The HS 748 aircraft as a type was first issued with a Certificate of Airworthiness in the Transport Category (Passenger) in 1962 and the two aircraft involved in the accidents had current Certificates

of Airworthiness valid until 9 March 1968 (G–ATEK) and 23 September 1967 (G–ATEH); both aircraft had valid Certificates of Maintenance. There were no outstanding entries of relevance in the technical log of either aircraft. At the time of the accident G–ATEK had flown a total of 2,651 hours and G–ATEH a total of 3,037 hours 50 minutes.

Both aircraft were fitted with Dowty Rotol, type R212/4-304/22 propellers having a ground-fine-pitch facility; Maxaret braking control units were fitted to all four mainwheels of each aircraft.

At the time of the accidents the landing weights of the aircraft were, G–ATEK 15,206 kg (33,520 lb) and G–ATEH 17,047 kg (37,580 lb), against the 1967 permitted maximum at Portsmouth of 17,800 kg (39,240 lb). This maximum had been increased from the 1966 permitted value of 16,300 kg (35,935 lb). The centres of gravity were within the prescribed limits. The fuel used was Avtur D Eng R D 2482 (Kerosene).

1.7 Meteorological information

The forecast for Portsmouth for the period 1000 hrs to 1900 hrs was:

Surface wind:	250° 15 knots
Visibility:	10 kilometres
Weather:	rain
Cloud:	6/8 stratus at 1,200 feet 8/8 stratocumulus at 2,000 feet

intermittently 1000 hrs to 1900 hrs:

Visibility:	4 kilometres
Weather:	rain
Cloud:	6/8 stratus at 500 feet 8/8 stratocumulus at 800 feet

The weather at the time of the accident to G–ATEK was:

1148 hrs:	Surface wind:	030° 6 knots
	Visibility:	2.4 kilometres
	Weather:	rain
	Cloud:	2/8 stratus at 450 feet 6/8 stratus at 800 feet 8/8 stratocumulus at 1,500 feet

The weather at the time of the accident to G–ATEH was:

1334 hrs:	Surface wind:	150° 10 knots
	Visibility:	7 kilometres
	Weather:	light rain
	Cloud:	trace at 500 feet 4/8 at 600 feet 8/8 at 2,500 feet

Following a prolonged dry period, which broke two days before the accidents, there was heavy rain at Portsmouth; about 0.5 inches fell there between 0800 hrs and 1500 hrs on the day of the accidents.

1.8 Aids to navigation

The only navigational aid at Portsmouth is VDF which was undergoing maintenance at the time of the accident to G–ATEK. However, it was back in service before G–ATEH began its descent into Portsmouth and was used by this aircraft during both its approaches.

Aircraft approaching Portsmouth may make use of the Instrument Landing System (ILS) and PAR facilities of RAF Thorney Island, which is approximately five nautical miles east of Portsmouth, to break cloud there before proceeding visually to Portsmouth; G–ATEK made use of this procedure. The minimum height authorised for this purpose is 750 feet and because there are no instrument approach and landing aids at Portsmouth, except VDF, all approaches and landings there are necessarily made visually.

1.9 Communications

Normal VHF communications were maintained between the aircraft and the various air traffic control services appropriate to their respective routes. G–ATEK did not make any further contact with Portsmouth Tower after having reported overhead prior to its approach and landing, but G–ATEH maintained radio contact throughout its approach and landing.

1.10 Aerodrome and ground facilities

Portsmouth aerodrome has three grass surfaced runways which provide take-off and landing directions of 36/18, 07/25 and 12/30; there is negligible ground slope on all runways. At the time of the accidents the landing distances available were derived from obstacle approach slopes of 1:20, the steepest permitted by the United Kingdom aerodrome licensing requirements then in force, and were as follows:

Runway	*Landing distance available*
36	2,730 feet (832 metres) (used by G–ATEK)
18	3,179 feet (969 metres)
07	2,949 feet (899 metres) (used by G–ATEH)
25	2,851 feet (869 metres)
12	2,730 feet (832 metres)
30	2,631 feet (802 metres)

Shortly after the accidents the obstacle approach slopes at Portsmouth were revised to 1:30; as a result the available landing distances on four of the six runways (36, 25, 12 and 30) were reduced to the following values:

Runway	*Landing distance available*
36	2,400 feet (732 metres)
25	2,700 feet (823 metres)
12	2,580 feet (786 metres)
30	2,480 feet (756 metres)

There is no runway or obstacle lighting and, except for a white chalk centreline on Runway 36/18, the only runway indications are the white chalk runway designator numerals at each displaced landing threshold. The aerodrome perimeter is severely restricted by obstacles which include buildings, a railway embankment, a raised roadway, earth banking and link mesh fencing on concrete posts. The overruns from the ends of the six landing distances to this perimeter average between 200 and 300 feet. The built up nature of the perimeter and surroundings, combined with the lack of either radio or visual glideslope approach aids and lighting, makes it a very difficult aerodrome during landings in poor weather for bigger aircraft such as the HS 748.

The aerodrome averages 11 feet above mean sea level (amsl), except for the northeast corner which, bordered by tidal creeks, is only some 5 feet amsl. This corner therefore tends to accumulate surface water which runs off from the remainder of the aerodrome.

The aerodrome surface was inspected by the airport manager on the day of the accidents at about 0800 hrs when the surface was found to be firm and wet but free of any standing water. Immediately after the first accident an inspection of the northeast corner showed that although the ground was still firm there were some patches of standing water but these did not appear to be extensive. At that date no equipment for assessing surface braking coefficients was available at Portsmouth, nor was there any requirement for such equipment at grass aerodromes in the United Kingdom. Assessment of surface serviceability was therefore based solely on visual inspection and the experience of the aerodrome staff.

Further information on tests and research made on the aerodrome surface is given in section 1.15.

1.11 Flight recorders

Both aircraft were fitted with Midas CMM/3RA flight data recording systems with the crash protected element located in the tail cone. Each system included primary and secondary tape recorder units. Individual aircraft information is as follows:

G–ATEK

No data relating to the accident flight was recoverable from either tape due to pre-crash defects in both recorders. The primary head was found to be oxide-contaminated so that the resultant high noise-signal ratio made data recovery impossible. The secondary recorder had been badly shock-loaded at some previous time; there was evidence of an impression on the outer spherical protection which was not consistent with anything which could have occurred during the accident. The capstan drive had failed and no data had been recorded since 13 August 1967, i.e. two days before the accident.

G–ATEH

Height and airspeed information was recovered indicating that the aircraft had maintained a height of 280 feet for approximately three quarters of a minute until 10 seconds before the touchdown which was made at a speed of 88 knots. The relatively rough aerodrome surface prevented any useful speed recording after touchdown. The heading recording had been inoperative during the entire approach and landing sequence; the reason for this failure has not been established.

1.12 Wreckage

Both aircraft sustained major damage to their nose wheels and main undercarriages, to the underside of the fuselages and to the flaps, engine nacelles and propellers. Both aircraft were examined in detail and the wheel braking systems and propeller hub units of both were found to be still operable to full specification standard; there was no damage other than that which was directly attributable to the accident impacts. The airspeed static and pressure systems were also checked and their integrity confirmed.

One of the main wheel tyres of G–ATEK was extremely worn, although still serviceable, only very little tread remaining; the other three tyres were in good condition. On G–ATEH the right-hand tyre of each main wheel pair showed evidence of blistering; the tyre manufacturers considered this had occurred during side-skidding in the course of the swing which developed in the final stages of the groundroll.

There was no evidence of any pre-crash failure or malfunction of either of the aircraft or of their engines or ancillary equipment other than the flight recorders.

1.13 Fire

There was no fire.

1.14 Survival aspects

Evacuation of the passengers from both aircraft was easy because the fuselages were at ground level and only slightly damaged. No escape chute or other rescue equipment was therefore necessary. In each accident the air stewardesses organised a rapid and orderly evacuation and also in each case the fire and rescue services were almost immediately on hand to provide all necessary assistance.

1.15 Tests and research

1.15.1 *Surface friction trials at Portsmouth*

Although preparation of the aerodrome surface had included the sowing of special types of grass and the laying of a surface drainage system, there was no detailed technical examination of the sub-soil. After these accidents such an examination was made in the northeast corner covering the area of the final portions of the two runways used by the accident aircraft. This area was found to consist of about two inches of turf over an underlying clay soil which was in a hard, dry and compacted state and was almost

completely impermeable. Natural drainage was therefore completely lacking in this area and the artificial drainage was not sufficiently effective in that it did not prevent an accumulation of surface water.

Friction trials were carried out in this same area but the roughness of the surface limited the test vehicle speeds to about 20 mph. The surface was flooded to simulate the accident conditions and the results of the trials indicated an average braking coefficient of the order of 0.2 mu within the limited speed range examined, with a clearly defined tendency to decrease as speed increased.

An accurate and practical method of determining the braking coefficient to be expected from a grass surface is still the subject of research and for a number of reasons devices such as Tapley meters do not appear to offer the simple solution which was at one time thought to be the case. The braking coefficient itself would appear to be a function both of the hardness of the underlying sub-soil and of the degree of 'wetness' of the grass surface; this latter value is something which is exceedingly difficult to measure or even to define.

Where a grass aerodrome has a relatively permeable sub-soil it will usually be soft enough when wet for the wheels of an aircraft to sink into it during the groundroll; a number of HS 748 pilots suggested this tended to assist the aircraft's deceleration. It was noteworthy that after these accidents the wheel tracks of both aircraft showed as scarcely more than tyre markings on the grass, with no rutting, but only slight impressions on the turf where the grass had been 'scuffed'. This indicated the very hard nature of the Portsmouth sub-soil as a whole at the time of the accidents; consequently the very poor braking would not have been related only to the areas of standing water in the northeast corner of the aerodrome.

1.15.2 *HS 748 grass surface landing performance*

The information on this subject made available to the investigation was obtained from tests made on the grass surface of Lympne aerodrome in 1961 and further trials, subsequent to the accidents, made at Boscombe Down in 1968. Until April 1970 there had been no agreed interpretation of the two sets of results and there is some apparent disparity. Nevertheless, correlation of the results of the trials at Boscombe Down with the evidence obtained from the second of these accidents suggests that at Portsmouth, the wet turf layer over its underlying hard, dry sub-soil would have been equivalent to an icy runway and probably offered a braking coefficient of about 0.1 mu; a hard dry surface such as concrete provides a value of about 0.8 mu.

For the purposes of this investigation the results of the Lympne trials are adequately described in the first three paragraphs of the manufacturer's letter given at Appendix I. (The agreement which is mentioned as having been made between Skyways and the Ministry of Aviation is not relevant at this point.) A re-examination of the trials results made during this investigation shows that more accurate values for the increases in the landing distance on the three types of grass surface described would have been 9 per cent, 19 per cent and 37 per cent respectively for the Series 2 HS 748 for which the

manufacturer was providing the information.

The manufacturer's Notice to Operators of February 1970 which is given at Appendix IV is based on the trials at Boscombe Down in 1968. In the opinion of the Ministry of Public Works Soils Research Laboratory, the Portsmouth surface, under normal circumstances, would have a probable Californian Bearing Ratio (CBR), (see Appendix IV), of from 30 per cent to 50 per cent. Therefore, using this basis, it would seem that an increment of something over 40 per cent on to the flight manual (destination) landing distances would have been appropriate for the HS 748 aircraft whenever the grass surface was wet. (See 1.16.4.)

1.16 Other information

No increments on to the flight manual landing distances were used in the Channel Airways HS 748 operation at Portsmouth, nor, until after these two accidents, was there any formal requirement for such increments in HS 748 grass surface operations by any operator in the United Kingdom. A requirement to this effect was then made as a revision to the terms of Channel Airways Air Operator's Certificate shortly after the accidents, but was applicable only to the Portsmouth operation; the operation was terminated shortly after this revision.

Subsequently there have been two letters to operators recommending the application of certain increments, from the Director of Flight Safety, in December 1967 and in June 1970, as well as the manufacturer's Notice to Operators of February 1970 on the same subject. There is no mandatory requirement for the application of such increments in HS 748 grass surface operations in the United Kingdom.

Because of the unusual state of Portsmouth aerodrome at the time of these accidents it is apparent that increments of the order indicated by either the Lympne trials or those at Boscombe Down would have been inadequate (see 2.1.1). However, if appropriate increments derived from the Lympne trials had been applied, then there would not have been an HS 748 operation at Portsmouth, and to this extent the omission of such increments is pertinent to these accidents. This section of the report reviews the relevant evidence obtained during the course of this investigation.

1.16.1 *Grass surface performance information used by Channel Airways*

At all relevant times the information on HS 748 grass surface performance which was made available to Channel Airways was derived from the trials at Lympne. These trials had been conducted in 1961 by Skyways in co-operation with the manufacturer and some of the latter's pilots had participated in them. Although limited in extent and by the difficulties of defining the precise degree of 'wetness', the results had provided information which ARB in 1966 still assessed as being the best available. (See Appendix II.)

In their HS 748 operation at Lympne, Skyways were using take-off increments of the same value as those shown in the manufacturer's letter at Appendix I; these were subsequently used by Channel Airways in their HS 748 grass surface operations, including Portsmouth. However the landing distance available at Lympne were not limiting for the landing weights involved in the Skyways operation there, and consequently landing distance increments were not appropriate. The manufacturer was mistaken in his belief that there had been an agreement between Skyways and MOA/DTI as to the non-use of landing distance increments in the Lympne operations. (See Appendix I). In the actual circumstances of that operation there was no necessity for any such agreement and none was made, nor would it be MOA/DTI policy to make such an agreement.

When the HS 748 operation at Portsmouth was in the planning stage MOA/DTI informed Channel Airways that their operations manual should contain any necessary information on grass surface performance but did not specify any particular values or whether it was to relate to the take-off case or the landing case, or to both cases. Channel Airways sought advice from the manufacturer, who referred to ARB; the nature and form of the advice eventually received by Channel Airways is apparent from the manufacturer's letter (Appendix I), with particular reference to the penultimate paragraph.

ARB have stated that in April 1965, when they gave agreement for the use of the same correction factors as had been agreed for use at Lympne, they were not aware that Skyways, the only HS 748 operator at Lympne, were not in fact using landing distance increments. In June 1965, ARB did become aware of this and verified it by reference to Skyways operations manual. This contained the information that such increments were not necessary, in a form similar to that shown in Channel Airways operations manual. However, ARB did not revise or withdraw the agreement they had given and Channel Airways continued to plan their Portsmouth operation in the belief that landing distance increments would not be necessary.

1.16.2 *Grass surface performance advice given to New Zealand*

In the latter part of March 1966, shortly before the start of the Portsmouth operation, the New Zealand airworthiness authorities made an urgent request to MOA/DTI for information on HS 748 wet grass performance. They sought confirmation of the same take-off increments which were being used in such operations in the United Kingdom and asked also whether any factor had been approved for landing distances. On the advice of ARB, MOA/DTI informed New Zealand that they agreed with the values for the take-off increments and, in addition, that ARB were taking steps to introduce an amendment to the HS 748 flight manual covering grass factors. It was suggested that, pending this amendment, the New Zealand authorities should apply a landing distance increment of 30 per cent as an interim measure.

1.16.3 *The situation following the advice to New Zealand*

Directly after having given this advice ARB wrote to the manufacturer on the subject of an appendix to the HS 748 flight manual covering grass surface performance. They indicated that the results of the trials at Lympne should form the basis for the information to be incorporated in the proposed appendix. A copy of the ARB letter is given at Appendix II.

The Portsmouth operation began in late March 1966 and on 29 March, when he became aware of the 30 per cent wet grass landing distance increment which MOA/DTI had advised New Zealand to apply, the Flight Operations Inspector concerned with Channel Airways HS 748 operations informed them of this advice. Channel Airways made calculations which showed that such an increment on to the flight manual landing distances would make their Portsmouth operation completely uneconomic and immediately attempted to clarify the contradiction between this new information and that which they had previously received. A 30 per cent increment would have reduced the landing weight at Portsmouth to about 12,000 kg (26,455 lb) (see 2.1.5).

The manufacturer gave them the reassurance contained in the letter given at Appendix III the reference to 'the only official indication in this matter' being to the ARB letter which is given at Appendix II. Thus, by 31 March 1966, ARB, MOA/DTI, the manufacturer and Channel Airways were all aware that:

(a) The Lympne trials had shown considerable increases in the HS 748 landing distances on wet grass surfaces as compared to the equivalent dry concrete landing distances.

(b) The manufacturer did not consider that there was any necessity for increments on to the flight manual landing distances when landing on grass surfaces, whether wet or dry.

(c) No landing distance increments were being used in the Portsmouth operation nor indeed in any other HS 748 grass surface operations in the United Kingdom.

(d) On the advice of ARB, and based on the Lympne trials results, MOA/DTI had advised New Zealand to apply a 30 per cent increment on to the flight manual landing distances when landing on wet grass surfaces.

The foregoing anomalous situation was not known to Channel Airways pilots, the information available to them being limited to that contained in the HS 748 flight manual and in their operations manual. The former contained no grass surface performance information and no indication of any need for take-off or landing distance increments whilst the latter stated that no landing distance increments were required.

1.16.4 *Landing distance requirements*

For each weight in the HS 748 operating range the flight manual gives two landing distances. These are the results of adding margins of 67 per cent (destination) and 43 per cent (alternate) to the landing distance on dry concrete established for that particular weight during the certification trials. The two margins are intended to cover some degree of variation, during normal airline operations, in piloting technique, aircraft performance (i.e. mechanical efficiency such as brakes) and landing surface, in comparison with the idealised standards applied when computing the results of the certification trials. It had not been possible to establish what finite proportions of each of these two margins applies to each of the individual variations they are intended to cover. This is presumably because they stem from the arbitrary requirements of the legislation relating to landing distances and are themselves, therefore, arbitrary values. An assessment by ARB indicates that for the 67 per cent (destination) case the allowance intended for surface variation is probably about 25 per cent. No similar assessment was provided for the 43 per cent (alternate) case but the allowance for surface variation may reasonably be considered as proportionately smaller than for the 67 per cent case.

1.16.5 *HS 748 landing weights at Portsmouth*

During the first season of operations in 1966 the maximum permitted landing weight was 16,300 kg (35,935 lb). In the period between the end of the 1966 operations in October and the start of the 1967 operations in April the manufacturers had reassessed their HS 748 flight data and as a result ARB approved an increase of 1,500 kg in the landing weights for previously

required landing distances. The increase did not entail any modifications to the aircraft and a new maximum landing weight of 17,800 kg (39,240 lb) became permissible at Portsmouth without any increase in the landing distances previously required. The flight manual and operations manual were revised accordingly and Channel Airways pilots were instructed to make use of the additional weight by increasing the amount of fuel uplifted at Jersey when operating with full passenger loads on the short stretches Jersey-Portsmouth-Jersey; this eliminated a previous need to refuel at Portsmouth.

1.16.6 *Post-accidents advice to HS 748 operators*

Very shortly after the accidents, the Director of Aviation Safety (MOA/DTI), in accordance with his powers under Article 4(4) of the Air Navigation Order 1966, SI 1184, varied the terms of Channel Airways Air Operator's Certificate to require provisional increments of 10 per cent (dry) and 30 per cent (wet) on to the flight manual landing distances to be applied at the time of making a landing at Portsmouth. As a consequence, Channel Airways terminated the operation as uneconomic.

In December 1967 MOA/DTI (Director of Flight Safety) sent an advisory letter to UK operators using aircraft such as the HS 748 on grass surfaced aerodromes. The letter discussed the uncertainties in the existing performance data and methods of presentation and, inter alia, drew attention to the circumstances in which the braking characteristics of a grass surface might occasionally become equivalent to an icy hard runway.

The letter stated that, except in this unusual condition, ARB were of the opinion that the increased landing distances known to be required on grass surfaces could be contained by the normal factor applied to allow for unmeasured variables. This presumably referred to the 67 per cent (destination) case, although this was not specified.

The letter noted that ARB intended to amend flight manuals to incorporate grass performance information and that they had suggested certain take-off and landing distance increments as an interim measure pending the production and distribution of the appropriate material. The take-off increments were the same as those already being used by HS 748 operators in the United Kingdom whilst for the landing case it was suggested that 10 per cent be applied for all grass field landings except those made on a very wet surface for which a 30 per cent increment was suggested.

In June 1968 ARB sent an advisory letter to Channel Airways, which included a suggestion that when operating on very slippery surfaces the best information available indicated that an increase of as much as 70 per cent on to the flight manual 67 per cent (destination) landing distance would be appropriate for HS 748 aircraft. A factor in this considerable increase is that at speeds below about 20 knots the propeller ground-fine-pitch setting on this aircraft results in thrust rather than braking drag.

There was no further information sent to HS 748 operators on the subject of grass surface performance until February 1970, when the manufacturer issued the Notice to Operators given in Appendix IV to this report. In September 1970 MOA/DTI (Director of Flight Safety) issued a letter to operators which was essentially similar to that issued in December 1967.

The letter advocated the same take-off and landing increments as the previous letter and stated that these were considered to be consistent with the manufacturer's Notice to Pilots. As in the first letter it was again stated that ARB concurred in these increments.

1.16.7 *Responsibility for particular operational performance requirements*

ARB responsibility. At the time of the HS 748 certification it was normal practice to confine the flight manual take-off and landing performance information to that appropriate to dry concrete unless a manufacturer had requested the inclusion of additional information. ARB state that they have no statutory duty in relation to overseeing operators as to the performance information to be used for particular operations, and consider that their duty is confined to approving the accuracy of the performance information which is contained in the flight manual.

As may be seen from Appendix II, after having been involved in giving the HS 748 grass surface performance advice to New Zealand, ARB brought the attention of the manufacturer to the fact that it appeared desirable to include this type of information in the HS 748 flight manual. It is obvious from Appendix III that the manufacturer did not feel there was any need to modify the factors which had been given to Channel Airways in July 1965 and there has been no addition of such data to the flight manual up to the date of this report, nor has there been any further formal action by ARB to promote the inclusion of such additional data in the flight manual.

MOA/DTI responsibility. MOA/DTI state that they have no statutory obligation to provide guidance to operators in relation to their particular operations and have never regarded it as one of their functions. However, when a new operation is being planned, it is customary for MOA/DTI officers to satisfy themselves that the operator is aware of the need to obtain, from authoritative sources, such information as will be needed to conduct the operation in safety. In relation to HS 748 grass surface performance it is apparent from the various references which MOA/DTI made to ARB that the latter were considered to be such an authoritative source.

MOA/DTI also state that they have no responsibility for initiating or for preparing amendments to flight manuals. They accept that they have a duty to confirm that material which ARB propose for flight manuals is consistent with the Air Navigation (General) Regulations 1966 and, in particular, with the weight and performance regulations contained therein. As a matter of good administration MOA/DTI will also bring to the attention of interested parties any operational matter which appears to have, or could have, a significant effect upon safety.

Operator's responsibility. The onus for deciding whether or not to apply any additional performance limitation over and above those contained in the flight manual appears to lie completely with the operator, subject to the examination of his operations manual by MOA/DTI before the grant of an Air Operator's Certificate and the further monitoring of the operation by the Flight Operations Inspectorate of MOA/DTI. While MOA/DTI do not formally approve the content of the operations manual they may require

revisions to its content if they feel these to be necessary. They did not do so in this case although the Channel Airways manual clearly indicated that no landing distance increments were considered necessary when operating on grass surfaces, whether these were dry or wet.

The information which Channel Airways received had come directly from the manufacturer but, as may be seen from the Appendices to this report, it had apparently received ARB or MOA/DTI approval at one time or another and was unlikely to be revised. Consequently Channel Airways considered that the information was of the requisite standard with which to plan their Portsmouth operation and did not themselves examine or evaluate the Lympne trials results which formed the basis of the grass surface performance information for the HS 748.

2. Analysis and Conclusions

2.1 Analysis

2.1.1 *The circumstances of the accidents*

Aircraft serviceability. Detailed examination of both aircraft confirmed that there had been no pre-crash failure or malfunction in either case, except in respect of the two flight recorders. The recorder in the first aircraft had been inoperative for two days, whilst in the second aircraft the heading parameter was not recording during the approach and landing sequence.

Aerodrome inspection. There was no equipment at Portsmouth for measuring surface friction coefficients or for otherwise assessing the serviceability of the aerodrome surface. No such equipment was in general use at grass aerodromes in the United Kingdom, nor was there any formal requirement for it; at the majority of such aerodromes assessments were based on visual inspection and personal experience. At Portsmouth the only previous difficulties had been related to the usual winter conditions leading to heavy rutting and the consequent danger of aircraft becoming bogged down; no such conditions existed on the day of these accidents.

When the aerodrome was inspected at 0800 hrs, prior to the start of the day's operations, the surface was reported to be wet but firm and consequently it was assessed as serviceable for normal operations; no standing water was reported at that time. Immediately after the first accident a limited amount of water was observed in the northeast corner and had obviously been present at the time of the accident itself. At the time of the second accident there was appreciably more water present, and in the early stages of the investigation it was believed that the very poor braking, which appeared to be the primary cause of the accidents, was a direct consequence of this area of standing water in the northeast corner. However, calculations made during the investigation indicate that the second aircraft must still have been moving at about 40 knots after a groundroll of some 1,800 feet (549 metres) before it reached this area of standing water. It is therefore apparent that the braking inadequacy was not confined to the northeast corner but applied to the aerodrome as a whole.

Aerodrome surface condition. From tests and research it was eventually established that the very poor braking over the whole surface had resulted from the effect of a thin layer of very wet turf over the still dry, hard and compacted sub-soil. This situation had not previously been observed at Portsmouth and passed unsuspected at the time of the accidents because it was masked by some resemblance of the surface to winter conditions, albeit without any rutting. The critical factor was that, instead of softening, as in the more general rainy conditions of winter, the sub-soil had remained dry, hard and compacted and was therefore almost completely impermeable.

The condition of the Portsmouth surface at the time of these two accidents was quite unusual and, because it was not realised that the sub-soil had become so impermeable, it was not appreciated that the comparatively heavy rain would so quickly lead to serious braking difficulties. Indeed, although the aerodrome was closed after the second accident this was primarily because of the obstructed runways; the true state of the aerodrome surface was not realised at that time. There can be no doubt that the surface provided a braking coefficient of only about 0.1 mu and it appears probable that this condition had existed for some time prior to the first accident. Nevertheless, until equipment is available which is capable of providing a quick and accurate measurement of the braking coefficient of a grass surface, it is virtually inevitable that there will be mistaken assessments of aerodrome serviceability, such as took place on this occasion.

Pilot technique. Neither the flight manual nor the operations manual contained information on the increased landing groundroll distances on wet grass surfaces which had been shown to be necessary for HS 748 aircraft during the trials at Lympne in 1961, nor had Channel Airways pilots been informed of the content of the manufacturer's letter to the operator given at Appendix 1 and the subsequent exchanges after Channel Airways became aware of the advice given to New Zealand.

Both landings were made to runways with a length which offered landing distance margins of about 43 per cent. As was frequently the case during Channel Airways HS 748 landings at Portsmouth, both aircraft made early touchdowns; this increased their available groundroll distances and resulted in effective margins of over 67 per cent. Both pilots used their wheel brakes and their ground-fine-pitch braking systems correctly and no defects were found in these systems in either aircraft. Except for the comparatively minor discrepancies that both aircraft touched down at speeds about 5 knots above their optimum values, there was no other apparent divergence from certification standards of pilot technique or aircraft performance during their groundrolls after touchdown. Only surface deficiency is therefore relevant.

Whenever the grass surface at Portsmouth was wet, it was a normal precautionary procedure for the tower controller to include a 'poor braking' warning in the information given to an incoming pilot. The controller stated that, because the pilot of the first aircraft did not follow the correct R/T procedure and make the usual exchange of contacts throughout his circuit of the aerodrome, this warning was not given. The lack of such a warning is however considered to have been relatively unimportant since, from his previous experience of Portsmouth and his knowledge that it was raining at the time of his landing, the pilot was undoubtedly prepared for poor braking conditions. It is considered, however, that it would be unreasonable to expect that either of the two pilots involved in these accidents could have been prepared for the extremely poor braking conditions which are now known to have existed.

Groundroll distances after touchdown. After detailed examination of the airfield, partly from a helicopter, the touchdown points of the two aircraft were established and it was therefore apparent that the total groundroll distances available to each of them had been 2,230 feet (680 metres) for the first aircraft (G–ATEK) and 2,613 feet (797 metres) for the second (G–ATEH).

According to the information available to the pilots from the flight manual and the operations manual the groundroll distances nominally required would have been about 1,460 feet (445 metres) and 1,530 feet (466 metres) respectively. These distances supposedly applied even in the prevailing wet grass surface conditions and, by definition, incorporated allowances for as much as 15 knots of excess touchdown speed and some degree of possible deficiency in the aircraft braking systems. In fact, the only element apart from the wet airfield surface was the minor one of the extra 5 knots touchdown speed, but nevertheless the much larger distances actually available proved to be quite inadequate.

A proper appreciation of the groundroll distances which these aircraft would have required on the Portsmouth surface at the time of the accidents has now become possible as the result of the 1968 trials at Boscombe Down and the subsequent Notice to Operators issued by the manufacturer in 1970. (See Appendix IV.)

Contrary to the information given on page 2 of that notice, and based on information provided by the Soils Research Laboratory, it appears probable that at the time of these accidents the appropriate CBR value for the Portsmouth surface would have been at least 50 per cent. With this value and a braking coefficient of about 0.1 mu the additional factor to be applied to the flight manual 67 per cent (destination) landing distance becomes about 60 per cent.

Using this as the basis for the calculation, and accounting only for the airfield surface, but not for any excess touchdown speed or deficiency of aircraft performance, the groundroll distances appropriate to the accident cases become 2,668 feet (813 metres) and 2,880 feet (878 metres) respectively. As noted above, the distances available were 2,230 feet (680 metres) and 2,613 feet (797 metres); the pilots' inability to stop their aircraft in these distances is therefore understandable.

2.1.2 *Assessment of aerodrome surface condition after the first accident*

After the first accident had occurred, the aerodrome surface was inspected and some standing water was reported in the northeast corner. However, this was not extensive and there was no tendency to rutting and consequently no danger of aircraft becoming bogged down or damaged as a result of this.

Having no equipment with which to make an accurate measurement of the surface friction coefficient, the Airport Manager had only his previous experience on which to base his evaluation of the aerodrome surface. In making his assessment, he was also influenced by his impressions of the first aircraft's touchdown, which he considered to have been late and fast.

Like other tower controllers at Portsmouth, the Airport Manager had been conditioned in his assessment of HS 748 touchdowns by what he had seen of those made by Channel Airways aircraft landing there. Post-accident examination of the aerodrome surface established that the touchdown had in fact been early with respect to the optimum touchdown point. However, as seen by the Airport Manager it appeared to be late and it undoubtedly was late in comparison with many other Channel Airways HS 748 touchdowns he

had seen at Portsmouth. It is therefore understandable, although nonetheless unfortunate, that because of this, the Airport Manager discounted the pilot's expressed opinion that this first accident had been the result of the state of the aerodrome surface.

In the light of what has subsequently been established as the actual state of the Portsmouth aerodrome surface at the time of these accidents, there is no doubt that the Airport Manager was mistaken in his assessment that it was still fully serviceable. That it was to some extent serviceable, however, is apparent from the fact that a Dove aircraft of Channel Airways landed without incident shortly after the second accident had occurred. After due allowance for the considerable hindsight which was involved in reaching a true appreciation of the state of the Portsmouth aerodrome surface at the time of these accidents, it is considered that it would be unreasonable to conclude that the aerodrome should have been closed, following the first accident.

2.1.3 *Responsibility for continuing HS 748 operations*

Except in order to protect the aerodrome surface from possible damage because of the greater landing weight of a particular type of aircraft or, alternatively, when in possession of information of hazardous circumstances which are unknown to an operator and his pilots, there does not appear to be any valid reason for an Airport Manager to intervene in any decision to continue or discontinue the operation of a particular type of aircraft at his aerodrome. Such decisions must lie with the operator and those of his employees who are familiar with the operating characteristics of the aircraft type and have been charged with this responsibility. In this particular instance Channel Airways Operations Centre at Southend was the deciding authority for continuing their HS 748 operation at Portsmouth.

Southend Operations Centre had been informed both of the Airport Manager's assessment that the aerodrome was serviceable and of the conflicting opinion of the pilot of G–ATEK; this information had been given to them by their Portsmouth Station Manager who himself had no operational responsibilities. They did not take any action to consult directly with the Airport Manager, the tower controller or their pilot, whose opinion they apparently disregarded.

Very soon after the first accident had been reported, Channel Airways Chief Pilot and other senior staff had left Southend for Portsmouth, in order to inspect the damage to G–ATEK. Knowing this it would have been logical for Southend Operations Centre to suspend HS 748 operations at Portsmouth until this party had arrived there and provided further information. Had this been done, it appears likely that HS 748 operations would have been further suspended as the result of the conclusions reached by the Chief Pilot after he inspected the Portsmouth aerodrome surface; as it was the second accident had already occurred shortly before he arrived.

2.1.4 *Deficiencies in the information given to the pilot of G–ATEH*

The failure to advise the pilot that there was some standing water at the upwind end of the runway being used, and the further failure to inform him of the criticism of the aerodrome surface made by the pilot involved in the first accident, calls into question the actions of the tower controller.

It must be remembered that an accumulation of standing water in the north-east corner of Portsmouth aerodrome was a usual occurrence after any heavy or continuous rainfall, and was therefore something which the pilot could be expected to know, as a regular user of the airport. In relation to the criticism made by the pilot of G–ATEK, it is relevant that the controller had also seen the touchdown of that aircraft and had formed the same impression of it as the Airport Manager. Furthermore, the aerodrome had subsequently been inspected and assessed as being serviceable and, as a consequence, the controller did not place very much weight on the pilot's opinion of the aerodrome surface.

It is questionable whether either of these items of information would have sufficed to cause the pilot of G–ATEH to decide not to land at Portsmouth rather than to continue with his landing, whilst exercising extreme caution in the process. This in fact is what he did but, as noted earlier in this report, the actual surface state was such that no action on his part could have prevented the subsequent accident.

Of more relevance than either of these possible deficiencies in the information he received is the fact that he was left in complete ignorance of the first accident and there is no reason to doubt, that had he been aware of it he would certainly not have landed at Portsmouth and the second accident would therefore not have occurred.

G–ATEK, damaged in the first accident, was not a hazard for landing on Runway 07 and consequently the tower controller decided not to comment on it. The controller also contended that it would have been unwise to distract the incoming pilot's attention during the later stages of a difficult approach. This is irrelevant since there was no reason why such information could not have been passed during the earlier and less critical stage of the approach. No representative of Channel Airways had asked him to pass any information to the pilot of G–ATEH, but it seems probable that in similar circumstances the majority of controllers would have informed the incoming pilot of the previous accident.

Channel Airways Operations Centre was the appropriate organisation for ensuring that information of operational importance reached their pilots down the line, but they took no action to ensure that the pilot of G–ATEH was made aware of either the accident to G–ATEK or its pilot's opinion of the Portsmouth aerodrome surface. There was ample time for such information to have been passed since G–ATEH did not leave Guernsey until more than one hour after the accident to G–ATEK whilst nearly two hours elapsed before the second accident occurred. Furthermore, if they had considered the matter important, Channel Airways could have asked the tower controller to pass information on the first accident to the incoming pilot; they did not do so.

2.1.5 *The unsafe nature of the HS 748 operation at Portsmouth*

The unusual state of the aerodrome surface which led to these two accidents is dealt with earlier in this report. Apart from this unusual situation however, this operation was unsafe because the extra landing distance required by HS 748 aircraft on wet grass surfaces, albeit somewhat imprecise, had been disregarded.

For a landing weight of 17,800 kg (39,240 lb), the Lympne trials had shown there would be a need for a landing distance of 2,612 feet (829 metres) on a very wet soft grass surface, before making any allowance for variations in piloting technique or in aircraft performance. ARB had assessed the grass surface of Portsmouth aerodrome as being similar to that of Lympne and therefore, logically, the extra distance shown to have been necessary on the Lympne surface was equally applicable at Portsmouth. If this basic distance of 2,612 feet (829 metres) at Lympne is increased to allow only for reasonable variations in piloting technique and aircraft performance, to the extent which is implicit in the scheduled landing distances in the flight manual, then the resultant landing distances required become 3,400 feet (1,036 metres) for the 67 per cent (destination) case, and 3,100 feet (945 metres) for the 43 per cent (alternate) case. In assessing these two distances reasonable allowance has been made for the arbitrary nature of the overall landing distance margins and the imprecise values of their individual components.

The actual landing distances available at Portsmouth are noted in section 1.10. For these distances, and taking account of the results of the Lympne trials, whenever the grass surface was wet an appropriate maximum landing weight would have been about 14,300 kg (31,525lb); alternatively, applying the 30 per cent increment which had been advised to New Zealand, the appropriate weight would have been about 12,000 kg (26,455 lb). These two alternatives are based on information which was available, but not applied, at the time the operation was planned. If increments based on the post-accident trials at Boscombe Down are used, taken from the manufacturer's Notice to Operators of February 1970, an even lower maximum landing weight becomes appropriate.

Channel Airways, as permitted by the relevant legislation, had made use of both the 67 per cent (destination) margin and the 43 per cent (alternate) margin when calculating their permissible maximum HS 748 landing weight at Portsmouth. In the operation there were undoubtedly occasions when there was a combination of a landing weight and available landing distance which provided only a 43 per cent margin. When this situation coincided with a very wet grass surface then 37 per cent out of the available 43 per cent was already committed to absorbing the extra landing distance which the Lympne trials had shown to be necessary for HS 748 aircraft. Consequently there was only a residual 6 per cent margin to allow for variations in piloting technique and aircraft performance in comparison with certification standards. Considered in the context of Portsmouth aerodrome, with its difficult approaches and limiting perimeter, it becomes obvious that in these circumstances the operation was appreciably below acceptable standards of safety.

2.1.6 *The circumstances leading to the omission of landing distance increments*

When considering the manner in which this omission occurred, it is necessary to appreciate that the planning stages of the operation were conducted against a background of some uncertainty as to the grass surface performance of larger aircraft such as the HS 748. The trials at Lympne had been limited in scope, and neither the manufacturer nor ARB were convinced that the results merited total acceptance. It was not until 1968 that further trials at

Boscombe Down were made under more precisely controlled conditions and resulted in information which has since been presented in the manufacturer's Notice to Operators of 1970. (See Appendix IV.)

Consideration of all the evidence now available indicates that the initial factor in the misunderstanding which led to the omission of landing distance increments in the Portsmouth operation was the agreement which ARB gave for the use of the same correction factors at Portsmouth as had been agreed for use at Lympne. ARB state that at that time they did not realise that landing distance increments were neither necessary for, nor being used in, the Skyways operation at Lympne; they took no action on realising it two months later.

Subsequently, following the advice to New Zealand, this original misunderstanding was perpetuated when ARB informed the manufacturer of their opinion that an amendment to the flight manual was desirable and then appeared to allow this proposal to go by default. The chain of events thus sufficed to give the manufacturer, Channel Airways and the MOA/DTI Flight Operations Inspectorate the mistaken impression that ARB did not consider landing distance increments to be necessary for HS 748 aircraft in United Kingdom grass surface operations, including that at Portsmouth, and did not intend to withdraw or modify this opinion despite the advice given to New Zealand.

Having received information which appeared to them to have ARB approval, Channel Airways justly considered they had fulfilled their obligation to obtain authoritative information and to this extent, it is understandable that they did not pursue the matter further and evaluate the basic information from the Lympne trials for themselves. Nevertheless they were remiss in not providing their pilots with a full background on HS 748 grass surface landing performance, based on the information they had received. This would undoubtedly have given their pilots a better appreciation of the problems which they might encounter during landings made on wet grass surfaces.

Having submitted their operations manual to MOA/DTI and received no comments on their proposed operation without landing distance increments, it was reasonable for Channel Airways to assume that neither of the two regulatory bodies had any objection to the Portsmouth operation, and accordingly the operation proceeded on this basis.

2.1.7 *Ensuring safe standards of performance*

The investigation was quickly able to establish the unsafe character of this HS 748 operation at Portsmouth and appropriate remedial action was therefore also quickly possible. On 18 August 1967 the Chief Inspector of Accidents recommended that MOA/DTI should require a 30 per cent wet grass surface landing distance increment in this operation and the Director of Aviation Safety amended the Air Operator's Certificate to this effect. Shortly after this the operation was terminated by Channel Airways.

However, it proved both difficult and time-consuming to establish exactly how such an unsafe operation had come about and, equally important, how it had been able to continue unnoticed despite the existence of a system designed to ensure safe standards of performance.

The essential outline of the existing system is given in 1.16.7. Under this system, subject to MOA/DTI being satisfied with the overall safety of the operation concerned, neither ARB nor MOA/DTI consider they have any statutory obligation to ensure that an operator applies a particular performance limitation to any individual operation, over and above those which are contained in the flight manual. They consider that the flight manual contents represent the mandatory requirements and that anything additional is a matter for the operator's decision. Consequently, both authorities have disclaimed responsibility for the absence of additional landing distance increments in HS 748 grass surface operations in the United Kingdom, including necessarily the one at Portsmouth. For their part, Channel Airways also consider that they fulfilled their responsibilities under the existing system.

The views of the three interested parties, that they had fulfilled their formal obligations and responsibilities are not disputed. Nevertheless, the agreement which ARB gave in respect of the operation at Portsmouth carried effective authority; consequently it sufficed to give the manufacturer, Channel Airways and the MOA/DTI Flight Operations Inspector the mistaken impression that ARB had agreed that the operation could take place without the use of landing distance increments. The matter was further confused by the obvious inconsistency of ARB and MOA/DTI in recommending a 30 per cent wet grass landing distance increment to the New Zealand authorities without making any similar recommendation or requirement for HS 748 operations in the United Kingdom.

It is evident that, on this occasion, the existing system proved to be inadequate to prevent an unsafe operation originating and then continuing unnoticed. The basic factor in this situation was the absence of a co-ordinated policy between ARB and MOA/DTI in relation to HS 748 grass surface performance requirements.

It is vital that an operator has access to an organisation which can confirm that the information he uses is accurate, and has been correctly evaluated for his particular operation. Some operators may not be able to provide such an organisation for themselves, and will have recourse to information which stems, directly or indirectly, from ARB and MOA/DTI. It is therefore essential that these two bodies co-ordinate their activities so that the information they provide is both accurate and consistent.

It is understood that discussions are taking place between ARB and MOA/DTI to devise a procedure which could lead to a more positive relationship between them. This would certainly help to eliminate the type of confusion which appears to have arisen in respect of HS 748 grass landing performance, particularly in the case of Channel Airways operation at Portsmouth.

2.2 Conclusions

(a) *Findings*

(i) The pilots were properly licensed and sufficiently experienced to carry out the flights.

(ii) There was no pre-crash failure or malfunction of the aircraft, their engines or their ancillary equipment with the exception of the

flight recorder of G–ATEK, the serviceability of which was below desirable standards.

(iii) There was no apparent divergence of pilot or aircraft performance from certification standards in respect of the groundrolls after touchdown except for the 5 knots above the optimum touchdown speed in each case.

(iv) G–ATEK landed at a weight of 15,206 kg (33,520 lb) and struck the aerodrome northern perimeter banking after a groundroll of 2,230 feet (680 metres); G–ATEH landed at a weight of 17,047 kg (37,575 lb) and broke through the perimeter fencing after a groundroll of 2,613 feet (797 metres).

(v) The very wet grass surface over the hard, dry and almost impermeable sub-soil of the aerodrome had resulted in a braking coefficient estimated to be of the order of 0.1 mu.

(vi) Up to the time of these accidents, grass surface landing requirements for HS 748 aircraft in the United Kingdom did not make adequate allowance for the extra landing distance this type of aircraft had been shown to need on wet grass surfaces.

(vii) Because of the unusual state of the aerodrome surface at the time of these accidents it is considered that any increments to the flight manual scheduled landing distances, based on HS 748 grass landing data existing at the relevant time would have proved to be inadequate.

(viii) Neither the Airport Manager nor Channel Airways gave sufficient weight to the opinion of the pilot involved in the first accident when they made their respective decisions as to aerodrome serviceability and the continuation of HS 748 operations.

(ix) G–ATEH would not have landed at Portsmouth if the pilot had been informed of the first accident. The primary responsibility for providing him with this information lay with Channel Airways Operations Centre at Southend.

(x) In planning their Portsmouth operation according to the information they received on HS 748 grass surface performance, Channel Airways fulfilled their responsibilities. They did not contravene the terms of their Air Operator's Certificate by using the flight manual scheduled landing distances without landing distance increments.

(xi) Whenever the grass surface of Portsmouth aerodrome was wet, the available landing distances were inadequate for HS 748 aircraft at the permitted maximum landing weight of 17,800 kg (39,240 lb). In these surface conditions, and using the 30 per cent increment derived from the 1961 trials at Lympne, the appropriate maximum landing weight was of the order of 12,000 kg (26,455 lb).

(xii) ARB unwittingly agreed that the Portsmouth HS 748 operation could take place without the use of landing distance increments. When they became aware that the Lympne operation did not include landing distance increments, they failed to appreciate the significance of this in relation to the agreement they had made for HS 748 operations at Portsmouth and therefore took no corrective action.

(xiii) ARB and MOA/DTI were inconsistent in that having recommended a 30 per cent wet grass landing distance increment to the New Zealand authorities they did not call for a similar increment for HS 748 grass surface operations in the United Kingdom.

(xiv) ARB and MOA/DTI had no co-ordinated policy on HS 748 grass surface performance requirements; it is accepted that they fulfilled their statutory obligations in the matter but this did not suffice to ensure the safety of Channel Airways operation at Portsmouth.

(xv) When they became aware of the contradictory situation following the MOA/DTI advice to New Zealand, Channel Airways would have been well-advised to have made their own examination of the results of the 1961 trials at Lympne. Moreover they were remiss in not passing on to their pilots the information on HS 748 grass surface landing performance which the manufacturer had provided.

(b) *Cause*

The primary cause of both accidents was the inadequate braking which resulted from the extremely low coefficient of friction provided by the very wet grass over the hard, dry and almost impermeable sub-soil of the aerodrome.

The fact that no account had been taken of the extra landing distance necessary for HS 748 aircraft on wet grass must be considered as a contributory cause since had this been applied Channel Airways HS 748 operation at Portsmouth would not have taken place.

3. Compliance with Regulations

In conducting this investigation, the provisions of Regulation 7(5) of the Civil Aviation (Investigation of Accidents) Regulations 1951 have been complied with. Letters were sent to the Air Registration Board, to the Board of Trade (now the Department of Trade and Industry), and to Channel Airways Limited, offering them the opportunity of exercising the rights conferred by the Regulation and informing them of the facilities available for that purpose.

All concerned indicated that they wished to make representations; these were made by correspondence and at a number of meetings, and have been taken into account in preparing this report. The representations made did not result in any alteration to the opinion as to the cause of the accidents.

R C WARREN
Inspector of Accidents

Accidents Investigation Branch
Department of Trade and Industry
November 1970

Appendix I

Copy of a letter from Hawker Siddeley Aviation Limited

Mr Collins,
Deputy Managing Director,
Channel Airways Limited,
Southend Airport,
Essex.

23rd July, 1965

Dear Sir,

H.S.748 Grass Airfield Operation

Further to the recent visit by our Mr. Flannigan, it is understood that background information on H.S.748 grass airfield operations is required.

This subject was first taken up with the A.R.B. with reference to the Skyways Lympne operation, tests done at Lympne resulting in agreement that take-off performance from grass surfaces was definable by increasing the appropriate hard surface distances by the following amounts, as now stated in the Series 2 Performance Manual.

Balanced Field Length	+ 17%
Take-off Run	+ 16%
Emergency Distance	+ 22%
Take-off distance	+ 12%

The measured increases in landing distances from 50 ft. were also found to range from 8% on a dry and hard grass surface to 17% on damp grass with fairly firm sub-soil and to 33% on a very wet and soft surface, but Skyways subsequently obtained the agreement of the Ministry of Aviation that, because of the particular operating circumstances, these distances could be regarded as being part of the normal 67% factor, and no additional factor was required.

When our negotiations concerning the purchase of 748 aircraft were in progress, the question of Portsmouth operation was raised with the A.R.B., who wrote a letter dated April 27th, 1965, the substance of which was made known by our Mr. Edgerton, to, it is believed, Squadron Leader Jones, but which anyway reads as follows:–

> "Following comparative examinations of the surfaces at Lympne and Portsmouth, it is agreed that the correction factors on take-off and landing distances already agreed for use at Lympne may also be used for operations at Portsmouth"

It is hoped that this information is adequate for your purpose but if not, we should be pleased to try to assist you further.

Yours faithfully,
for and on behalf of
Hawker Siddeley Aviation Limited

F.O.Sanders
Technical Sales Manager

Appendix II

Copy of a letter from the Air Registration Board

Reference: ARO 1402 21st March, 1966

Hawker Siddeley Aviation Ltd.,
Avro Whitworth Division,
Greengate,
Middleton,
MANCHESTER. For the attention of Mr. D.C.Wood

Dear Sir,

Performance of the HS 748 when operating from grass airfields

We have received several requests for information on increases to the take-off and landing distances when operating from grass airfields.

You will recall that tests were run at Lympne in November 1961 and your Flight Test Department produced a report on the subject. Some information, apparently based on your report, appears in the Skyways operations manual.

We feel the time has come to incorporate this information in a 748 Flight Manual appendix, and we would like you to prepare a suitable statement. The correction factors should be applicable to the full range of conditions scheduled for take-off and landing.

Because of the difficulties of defining Wet and Dry grass surfaces this information can only be regarded as best information available. However the Hatfield division of your company have recently done similar work on the HS 125, and it would be advantageous if you could establish whether comparable changes in rolling drag and braking mu's resulted from your tests.

Yours faithfully,

D.R. Murrin
for Secretary
Air Registration Board

Appendix III

Copy of a letter from Hawker Siddeley Aviation

SALES/76/18 31st March, 1966

Mr. B.F. Collins,
Channel Airways Ltd.,
Southend Airport,
Southend-on-Sea,
Essex.

Dear Mr. Collins,

Thank you for sending the relevant pages of your Operations Manual referring to grass field operation. We shall use this in the case we are now preparing to put to the Air Registration Board.

For your information I am enclosing a copy of the only official indication we have had on this matter and as you will see the letter contains no inference of any kind that the factors already agreed upon will be increased or altered in any way. Any alteration to these factors, unless it was to improve them, would naturally be contested by ourselves, and you may rest assured that the interests of this company are entirely in keeping with your own interests in trying to obtain the maximum performance from the Hawker Siddeley 748 on grass airfields.

Yours sincerely,

K. Edgerton
Assistant Sales Manager

Appendix IV

NOTICE TO OPERATORS

H.S.748. AIRCRAFT

SERIES 1, 2, 2A

MODELS AFFECTED
All Models.

LANDING ON SLIPPERY SURFACES – ADDITIONAL FACTORS ON LANDING DISTANCE

HS.748 aircraft are operating world wide from all types of runway surfaces. In 1967, two incidents occurred in the U.K. on the same day involving landings on a grass airfield which due to unusual weather conditions had a very slippery top surface on a very hard base. The aircraft were unable to come to a complete stop under these conditions within the runway length available.

As a result of these incidents, the U.K. Board of Trade and the Air Registration Board initiated a series of measurements on an in-service HS.748 to assess the effect of various surfaces on the landing distance. The tests covered concrete and grass surfaces in both a damp and wet condition. Simulation of the very slippery surface condition was made by measuring distances without wheel braking. Part worn brakes and tyres were used throughout the tests which were conducted with both engines operating.

The landing distances required given in the Flight Manual include factors on the measured distances to cover operational variables. These include an allowance for variability of the surface. Most surfaces in typical conditions are covered by the Flight Manual factors. However these recent tests have shown that in certain extreme conditions an additional factor on the landing distance required can be necessary. The magnitude of this factor depends not only on the surface friction between the wheels and the ground, but also on the hardness which determines the degree to which the wheels sink into the surface.

Figure 1 has been constructed on the basis of the tests results to show the additional factor recommended. Surface friction and hardness are expressed in the way they were measured during the tests, i.e., friction coefficient at 30 m.p.h., μ 30, and hardness as California Bearing Ratio (CBR) at a depth of 3 ins. The conditions covered in the tests, and the estimated conditions applying at the time of the two incidents, are listed in the following tables :–

Surface Conditions Tested

Surface	Friction μ 30	Hardness CBR	Additional factor from Fig. 1
Concrete, damp	0.80	Concrete	1.0
Concrete, wet	0.65	Concrete	1.0
Concrete, no braking	0.05	Concrete	1.9
Grass, damp	0.27	2% CBR (Soft)	1.0
Grass, wet	0.11	1.5% CBR (Very Soft)	1.0

Approximate Surface Conditions at Time of Incidents

Surface	Friction μ 30	Hardness	Additional factor from Fig. 1
Grass, wet	0.1	20% CBR	1.46

It will be noted that the only conditions likely to require an additional factor on the landing distance are a combination of a hard surface and a very low friction coefficient, e.g. an ice covered paved runway or an unpaved runway with very hard sub-soil and a thin slippery layer on top. On such surfaces the high drag from the discing propellers and the large flaps rapidly reduces the aircraft speed from touchdown to about 40 knots. By this speed the propeller drag has fallen to a low value and changes to a small thrust as the speed approaches zero. This characteristic, common to all Dart engine/propeller combinations, causes the final part of the ground run to increase considerably on the slippery surface.

It is impossible to quote precise values of CBR for varying surfaces, but as a guide CBR's less than 5% represent soft or very soft surfaces producing marked rutting, surfaces of CBR 15% are firm and would show little or no rutting, and surfaces with CBR's greater than 20% are effectively hard. Operators will in general have good local knowledge of their own particular airfields under varying weather conditions. This experience will be the best guide as to whether hard, very slippery surface conditions are likely to be encountered during their operations, and whether any additional factor will be necessary when making a decision to carry out a particular landing or to divert.

When making landings on runways which may be slippery, care should be taken to touchdown as close to the start of the runway as practicable

without excess speed. The flight fine pitch stops should be withdrawn immediately on touchdown.

REFERENCES: The Crew Manual is being revised in accordance with above information.

R 129361 Dd 500311 K7 3/71 P

NOTICE TO OPERATORS

H.S. 748 AIRCRAFT

EFFECT OF SURFACE FRICTION AND HARDNESS ON LANDING DISTANCE REQUIRED

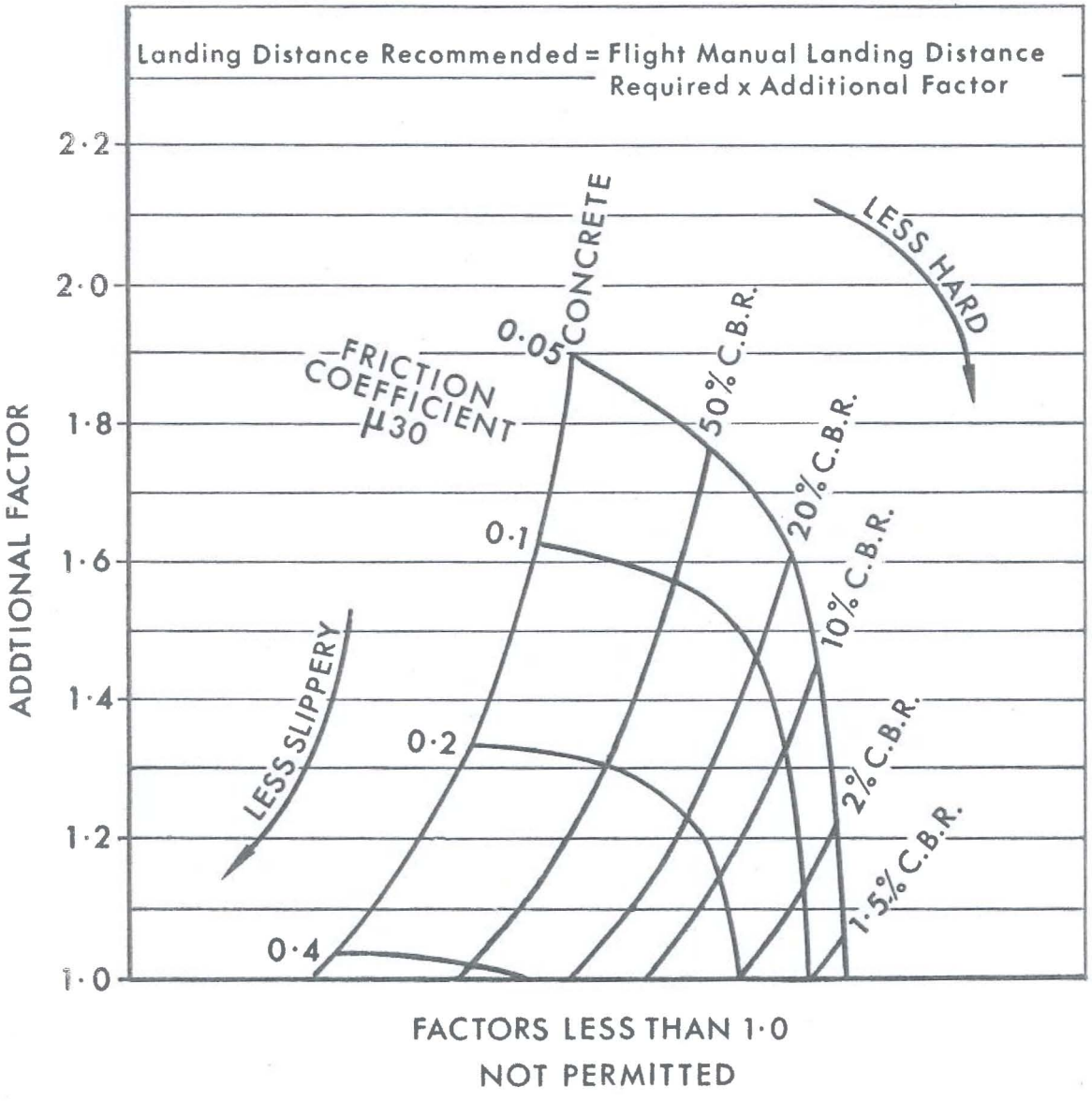

FIGURE 1