AIRCRAFT ACCIDENT REPORT 4/87

Accidents Investigation Branch

Department of Transport

Report on the accident to Twin Otter G-BGPC at Laphroaig, Islay, Scotland on 12 June 1986

LONDON
HER MAJESTY'S STATIONERY OFFICE

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

3 August 1987

The Rt Honourable Paul Channon
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr R C McKinlay, an Inspector of Accidents, on the circumstances of the accident to a Twin Otter G–BGPC, which occurred at Laphroaig, Islay, Scotland on 12 June 1986.

I have the honour to be
Sir
Your obedient Servant

D A Cooper
Chief Inspector of Accidents

Contents

Accidents Investigation Branch

Aircraft Accident Report No. 4/87
(EW/C969)

Registered Owner:		Nordic Oil Services Limited
Operator:		Loganair
Aircraft:	*Type:*	DHC–6 Twin Otter
	Model:	310
	Nationality:	British
	Registration:	G–BGPC
Place of Accident:		1 nautical mile North West of Laphroaig, Islay, Scotland.
		Latitude 55° 37.30′ N
		Longitude 006° 10.05′ W
Date and Time:		12 June 1986 at 1522 hrs
		All times in this report are UTC

Synopsis

The accident was notified to the Accidents Investigation Branch at 1620 hrs on 12 June 1986 and the investigation began the same evening. The aircraft was engaged on a scheduled public transport flight from Glasgow Airport to the Isle of Islay. There were two pilots on board, the handling pilot and a supervisory pilot who was the designated aircraft commander, together with fourteen passengers. Before departure from Glasgow the pilots had obtained a meteorological forecast that indicated generally cloudy conditions over the route and the probability of poor weather conditions at the destination aerodrome.

The departure from Glasgow and the cruise were uneventful, and shortly after starting a descent towards Islay the pilots received the latest Islay/Port Ellen aerodrome weather observation. This reported extensive low cloud, drizzle, and a visibility of 2000 metres. In spite of this information, the aircraft was positioned for a visual approach to the aerodrome from the south of the island. In conditions of low cloud and poor visibility the pilots mis-identified Laphroaig as being Port Ellen and very shortly after turning inland the aircraft struck rising ground approximately 1 nautical mile from the coast at a height of 360 feet above mean sea level.

The report concludes that the cause of the accident was the commander's decision to allow the handling pilot to carry out a visual approach in unsuitable meteorological conditions. An error in visual navigation was a contributory factor.

1. Factual Information

1.1 History of the flight

Loganair Flight LC 423 was a scheduled domestic public transport passenger flight from Glasgow Airport to Islay/Port Ellen aerodrome due to depart from Glasgow at 1440 hrs on 12 June 1986. There were two pilots and fourteen passengers on board. The handling pilot, who occupied the first pilot's position, had recently converted to flying the DHC–6 Twin Otter aircraft, and was completing a series of supervised route flights required by the airline before the award of full command status. A company supervisory captain, the designated commander for this flight, occupied the co-pilot's position. The Twin Otter is certificated for single pilot operation.

The two pilots reported for duty at 1410 hrs. They obtained the latest available weather information from the Glasgow Airport Information Service (AIS). The forecast was for a moist southwesterly airstream affecting the whole area with the sky obscured by stratus cloud. Cloud bases were forecast to be generally 1500 feet above mean sea level (amsl) with tops at 6000 feet. Scattered stratus was also forecast, base 500-800 feet with local patches at 300 feet and associated hill fog. A Terminal Aerodrome Forecast (TAF) is not issued for Islay/Port Ellen aerodrome, however the latest routine Meteorological Aerodrome Report (METAR) was given to the flight crew. This report, timed at 1150 hrs, recorded a surface wind at Islay of 150° at 13 knots, visibility in excess of 10 kilometres, recent rain, and cloud conditions of 3 oktas stratus at 700 feet, 4 oktas at 1200 feet, and 8 oktas at 1700 feet. These weather conditions were above company minima for commencing an approach for landing. The aerodrome approach plates and approved minima are included at Appendix 1.

The aircraft's engines were started at 1438 hrs, and, at 1444 hrs, Glasgow Airport Air Traffic Control (ATC) approved taxy clearance to the holding point of runway 28. The aircraft was operating on a stored Instrument Flight Rules (IFR) flight plan. The requested routeing was a Standard Instrument Departure (SID), to join Airway Blue 2 for the Skipness Very High Frequency Omni-Range (VOR) beacon, and thereafter direct to the Islay/Port Ellen Non-Directional Beacon (NDB). The direct track from the Skipness VOR to the Islay/Port Ellen NDB is the 272° Magnetic (M) radial from Skipness. The planned cruising level was Flight Level (FL) 60 and the estimated flight time was 35 minutes.

At 1446 hrs Glasgow ATC advised LC 423 of their flight clearance. The requirement to fly the SID was cancelled and the aircraft was cleared direct to Skipness, cruising level FL 55, and the secondary surveillance radar code of 5052 was allocated. The clearance was correctly read back by the flight crew, and the aircraft took off from runway 28 at 1448 hrs. Recordings of both the radio telephony frequency (RTF) and of the secondary radar returns show that the flight apparently proceeded normally, and according to flight plan, until the aircraft reported a position overhead the Skipness VOR at 1508 hrs. At this point the controlling authority (Scottish Airways) informed LC 423 that they should clear controlled airspace, contact Port Ellen, and

that there was no known traffic to affect their descent. The radar recording shows that after passing overhead the Skipness VOR the aircraft did not depart that position on the 272° radial, but instead turned 15° left, and descended on the 257° radial towards the south of the island of Islay.

At 1510 hrs, having already started to descend, LC 423 contacted Islay/Port Ellen aerodrome, reported an arrival time of 1523 hrs, and requested details of the latest weather. The Islay/Port Ellen radio operator replied that the weather details were a surface wind of 220°/05 knots, visibility 2000 metres in drizzle, cloud 3 oktas at 400 feet, 5 oktas at 700 feet, and 8 oktas at 1400 feet. The sea level barometric pressure was 1018 millibars. LC 423 acknowledged the information and was asked to advise when overhead the aerodrome at 3600 feet, or when in visual contact. The radar recording shows that the aircraft then continued to descend, on a track of about 260° M towards the south of the island, until it disappeared from radar cover at a height of 1400 feet and at a position 12 nautical miles (nm) from Islay/ Port Ellen aerodrome on the 106° M radial.

From the position that the aircraft descended below radar cover it is estimated that a direct track was flown towards the southern coast of the Isle of Islay. The commander, who suffered concussion and other injuries during the accident, was unable to recall any details of the flight. Evidence from passengers at this time included reports of flying in and out of cloud, and then of first sighting the Eilean a'Chuirn off the south coast of Islay. From there the flight continued at very low level parallel to the south coast. At 1521 hrs the Islay/Port Ellen radio operator transmitted further weather information which recorded that cloud conditions were similar to the previous report but that there was then heavy drizzle. Changes in barometric pressure settings were also reported. LC 423 acknowledged this information and reported "over Port Ellen". From passenger and ground eye-witness evidence it has been established that the aircraft was not, at that time, over Port Ellen, but was in fact turning inland at very low level over Laphroaig. Eye-witnesses estimated the height as between 50 and 100 feet above ground level, and the weather conditions as 'misty'. From overhead Laphroaig the aircraft settled on to a northwesterly heading and very shortly afterwards crashed into rising ground, that was obscured in hill fog, approximately 1 nm from the coast at a height of 360 feet amsl. Shortly before the impact there was a sudden increase in engine noise and the sound of an audio warning from the cockpit. It was later established that this was the sound of the stall warning system. The estimated and intended tracks of the aircraft are shown at Appendix 2.

At 1523 hrs the Islay/Port Ellen radio operator transmitted a call to LC 423, but received no response. After a further call on the stand-by radio also obtained no response, the operator contacted Scottish Airways Centre and advised loss of contact. At 1526 hrs Scottish Centre confirmed that Emergency Procedures and Rescue Action had been initiated. A Royal Air Force Nimrod aircraft and three Search and Rescue helicopters were alerted. The Nimrod aircraft was on task and flying to the accident area at 1538 hrs.

During the impact the handling pilot was killed instantaneously, and the supervising pilot/aircraft commander sustained serious injuries. Some passengers managed to release themselves from the wreckage and went to

summon help. Local residents were quick to arrive at the scene, and the surviving pilot and injured passengers were released from the wreckage and transferred to a local hospital. The more seriously injured were flown in Search and Rescue helicopters to hospitals on the mainland.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	–	–
Serious	11	–	–
Minor/none	–	3	

1.3 Damage to aircraft

Aircraft destroyed.

1.4 Other damage

A small area of open ground, normally used for grazing sheep, was contaminated due to fuel spillage.

1.5 Personnel information

1.5.1

Commander: Male, aged 54 years

Licence: Commercial Pilot's Licence (Aeroplanes) valid until 20 October 1990

Type rating: DHC–6, renewed 13 March 1986

Instrument rating: Renewed 13 March 1986

Medical certificate: Class 1 with the limitation that the holder wear spectacles which correct for near vision. Valid until 24 August 1986

Flying experience:

Total all types:	12,421 hours
Total DHC–6:	867 hours
Total flying last 28 days:	32 hours
Total flying last 24 hours:	2 hours and 30 mins

Duty time: Off duty 0210 hrs 12 June until 1410 hrs 12 June 1986 (12 hours)

On duty 1410 hrs 12 June 1986 (1 hour and 12 minutes up to accident time)

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Report on the Accident to Twin Otter G-BGPC at Laphroaig, Islay, Scotland on 12 June 1986

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CORRECTION

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1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	-	-
Serious	1	11	-
Minor/none	-	3	

Department of Transport
November 1987
LONDON: HER MAJESTY'S STATIONERY OFFICE

The commander completed his initial flying training in the Royal Air Force in 1958, and subsequently qualified as a flying instructor. He left the Royal Air Force in 1970, taking up an appointment as a civil aviation flying instructor. Between 1966 and 1984 he carried out 5700 hours of instructional flying. He joined Loganair as a DHC–6 aircraft commander in October 1985, and was made a supervisory captain in March 1986. Since joining the company he has made 35 approaches and landings at Islay/Port Ellen aerodrome, the most recent being on 23 May 1986.

1.5.2 Handling pilot: Male, aged 30 years

Licence:	Commercial Pilot's Licence (Aeroplanes) valid until 28 July 1992	
Type rating:	DHC–6, issued 27 May 1986	
Instrument rating:	Renewed 26 May 1986	
Medical certificate:	Class 1 with no restrictions. Valid until 11 February 1987	
Flying experience:	Total all types:	2110 hours
	Total DHC–6:	27 hours
	Total flying last 28 days:	30 hours
	Total flying last 24 hours:	nil
Duty time:	Off duty 1030 hrs 11 June 1986 until 1410 hrs 12 June 1986 (27 hours and 40 minutes)	
	On duty 1410 hrs 12 June 1986 (1 hour and 12 minutes up to accident time)	

The handling pilot's initial flying training was on an approved course of instruction for a Private Pilot's Licence. He subsequently became a qualified flying instructor and obtained a Commercial Pilot's Licence in July 1982. He joined Loganair in October 1984 as a co-pilot flying the Shorts 360 aircraft. His Company reports were satisfactory throughout and he was selected for command of the DHC–6, Twin Otter. He had completed the initial conversion and, by 12 June 1986, had flown 29 route flights under supervision. He had carried out only one previous approach and landing at Islay/Port Ellen, which was on 29 May 1986. The weather on that occasion was generally fine with no significant cloud below 3000 feet. His most recent line supervision progress report, dated 10/11 June 1986 included the comment: 'I was certainly quite impressed with his performance. A good professional operator'.

1.6 Aircraft information

1.6.1 General information

G–BGPC was a DHC–6 Twin Otter, a twin turbo-prop high-winged all metal monoplane powered by Pratt and Witney of Canada PT6A engines driving three-bladed Hartzell variable pitch propellers. Provision was made for seating two pilots, side by side, and dual controls and full dual flight instrumentation was fitted. Passenger seats were arranged in 5 rows of 3, with single seats to the left and double seats to the right of a central walkway, plus two further doubles at the rear right side of the cabin opposite the main entry/exit door.

1.6.2 Leading particulars

Manufacturer:	De Havilland Aircraft of Canada Ltd
Aircraft type:	DHC6-310 Twin Otter
Date of manufacture:	July 1979
Constructor's Number:	635
Certificate of Registration:	The registered owners were Nordic Oil Services Ltd, certificate issued on 4 July 1983
Certificate of Airworthiness:	Certificate No 8876-2 renewed on 6 July 1985 and valid to 5 July 1986
Total airframe hours:	9206 hours 11 minutes
Last scheduled maintenance:	3 June 1986 at 9186 total airframe hours. The aircraft had been maintained in accordance with an approved maintenance schedule
Engines (2):	Pratt and Witney of Canada PT6A-27
Total Engine Hours:	Right – 9181 (5990 since overhaul)
	Left – 7545 (5770 since overhaul)
Maximum weight authorised for take-off:	5700 kg
Actual take-off weight:	5257 kg
Maximum weight authorised for landing:	5579 kg
Estimated accident weight:	5117 kg
Estimated fuel remaining at time of accident:	408 kg

Type of fuel:	Jet A–1 (AVTUR)
Centre of Gravity (CG):	The CG limits both at the actual take-off weight and at the estimated weight at the time of the accident were between 20% and 36% mean aerodynamic chord (MAC). The CG remained within the aircraft's safe weight and balance envelope throughout the flight.

1.6.3 *Stall warning*

G–BGPC was fitted with a stall warning system comprising two lift detecting vanes and switches (which were connected in parallel) in the left wing leading edge, and in circuit with a warning light and buzzer in the cockpit. The two vanes are set at slightly different levels in the wing leading edge to ensure the complete effectiveness of the stall warning system at all flap settings and aircraft attitudes. The lower vane is operative over the full flap range of 0° to 37½°, but the upper vane is effective only with flaps extended. In operation, as a stall condition is approached, the stagnation point moves from ahead of the affected vane to behind it and causes it to deflect sufficiently to actuate its switch and complete the warning circuit. The warning light illuminates and the buzzer sounds at 4-9 knots above the stall speed.

At an aircraft weight of 5117 kg, with 10° of flap deployed, the wings level stall speed is 63 knots.

1.7 **Meteorological information**

1.7.1 *Forecast conditions*

Prior to departure from Glasgow the weather forecast information available to the flight crew consisted of the fixed time chart, valid for flights between 1200 hrs and 1900 hrs on 12 June 1986, the United Kingdom Terminal Aerodrome Forecasts (UK TAFS) and the latest routine METAR for Islay/ Port Ellen aerodrome. There is evidence that all the available weather forecast information was collected and signed for by the flight crew.

1.7.1.1 *Fixed time chart (time of origin 1215 hrs)*

Synoptic situation:	A cold front was close to the western coast of Islay, moving east at about 10 knots
Cloud:	Broken stratus between 400 and 1500 feet amsl, 8 oktas stratus 2000 feet amsl
Visibility:	Locally 2000 metres
Weather:	Rain/hill fog

1.7.1.2 UK TAFS

The TAFS for Glasgow Airport and the nearest major diversion aerodrome, Prestwick Airport, were as follows:

Glasgow: Surface wind 200/12 knots, visibility 8000 metres, cloud 3 oktas stratus at 300 feet and 6 oktas strato-cumulus at 1500 feet. Temporarily visibility 2000 metres, light rain, 6 oktas stratus at 500 feet.

Prestwick: Surface wind 200/12 knots, visibility 8000 metres, cloud 3 oktas stratus at 800 feet and 6 oktas strato-cumulus at 1500 feet. Temporarily visibility 4000 metres, light rain, 6 oktas stratus at 500 feet.

1.7.1.3 METAR

The latest METAR for Islay/Port Ellen that was available to the pilots before departing Glasgow, was timed at 1150 hrs and reported:

Surface wind 150°/13 knots, visibility in excess of 10 kilometres, recent rain, cloud 3 oktas stratus at 700 feet, 4 oktas stratus at 1200 feet and 8 oktas strato-cumulus at 1700 feet. Air temperature plus 10° Celsius, sea level barometric pressure 1018 millibars (mb).

1.7.2 Actual conditions

An aftercast of the actual weather conditions in the area around Islay at 1522 hrs on 12 June 1986 was prepared by the Meteorological Office, Bracknell. The observations were:

Synoptic situation:

Pressure was high to the south-east and low to the north-west of the British Isles. A cold front, moving eastwards, was close to the western coast of Islay, with the island and aerodrome lying in a moist south-westerly airstream.

Winds and Temperatures:

Surface – South to south-west 05-10 knots plus 11°C

2,000 feet – 230° (True) at 20 knots

Cloud:

5 to 7 oktas stratus base 500-800 feet, locally 300 feet in patches, covering high ground, with tops at 1200 feet. 8 oktas strato-cumulus base 1500 feet, tops 6000 feet. Further layers above 9000 feet.

Surface visibility:

5 kilometres, falling to 2000 metres in thicker drizzle patches, and to 200 metres or less in hill fog.

Weather:

Rain and/or drizzle with much hill fog.

1450 hrs METAR

Passed by RTF to the aircraft:

Surface wind 220°/5 kt
2000 metres in drizzle
3 oktas at 400 feet
5 oktas at 700 feet
8 oktas at 1400 feet

1.8 Aids to navigation

There are two radio aids to navigation available for use by pilots intending to overfly or land at Islay/Port Ellen aerodrome. They are the Skipness VOR, transmitting on 113.00 Megahertz (MHz), and the Islay NDB transmitting on 395 Kilohertz (KHz). Both these radio beacons were on and transmitting throughout the accident flight and no faults were reported at that time.

On 18 June 1986 both radio beacons were flight checked by a specially equipped aircraft from the Civil Aviation Authority Flying Unit. Relevant sections of the flight check report are:

Skipness VOR (SKP)

A part orbit was flown at a range of 20nm from SKP at a height of 2500 feet in the sector 225° – 315°. Bearings and ranges were within the flight inspection tolerances allowed.

Islay NDB (LAY)

A part orbit was flown at a range of 10nm from LAY at a height of 2500 feet in the sector 100° – 200°. The NDB provided adequate signal coverage with correct coding. These aspects were also satisfactory during the full promulgated procedure to runway 13. In addition a low level flight at 400 to 500 feet was made along the coastline to the south-east of Islay. The NDB indications were normal even at this low level.

1.9 Communications

Very high frequency (VHF) communication was satisfactory and RTF recording was available on all frequencies used during the departure and cruise stages of the flight. During the descent towards Islay/Port Ellen aerodrome two-way VHF communication was satisfactory until the accident time, however, this channel was not recorded nor required to be so.

1.10 Aerodrome information

1.10.1 General description

Islay/Port Ellen aerodrome is situated on a southern coast of the Isle of Islay at a height of 58 feet amsl. It is operated by Highlands and Islands Airports Limited. A diagram of the principal features and facilities is included at Appendix 1. Information to pilots is provided by the Aerodrome Flight Information Service (AFIS), and is confined to advising details of aerodrome traffic to assist pilots in preventing collisions, informing aircraft of essential aerodrome information (ie, the state of the aerodrome, its weather and its facilities), and alerting safety services and initiating overdue action. The radio operators providing this service are qualified meteorological observers.

The main runway is orientated 130°/310° M and measures 1405 metres by 46 metres with a tarmacadam surface. The landing threshold is displaced at either end, giving a Landing Distance Available (LDA) of 1245 metres in both directions. Both runways are equipped with Abbreviated Precision Approach Path Indicators (APAPI's), sited on the left side, and both runways are equipped with threshold and side lighting. At the time of the accident there was no approach lighting to the instrument runway (13), however, this has since been installed. All available lighting was serviceable and selected 'On' at the time of the accident.

1.10.2 Instrument approach procedure

There is an approved and published instrument approach procedure to the aerodrome, based on the Islay/Port Ellen NDB (Appendix 1 refers). Aircraft using this procedure may descend to a Minimum Descent Altitude (MDA) of 472 feet amsl. Aircraft that elect to complete the instrument approach and subsequently circle for landing on a runway that is not suitably located for a straight-in approach are restricted to an MDA of 1108 feet amsl, except that an MDA of 758 feet amsl may be used in the sector 150° clockwise to 050°. On the Jeppesen approach plate, use of which is mandatory for Loganair pilots, these altitudes are rounded up to 760 feet and 1110 feet respectively. The minimum in-flight visibility required to commence the procedure is 1500 metres. The procedure also includes a Missed Approach Point (MAP) which, due to terrain clearance considerations is 1.7 nm (3150 metres) back from the runway threshold.

1.10.3 Visual manoeuvring (circling) obstacle clearance

Visual manoeuvring (circling) area is the area in which obstacle clearance has been considered for aircraft manoeuvring visually before landing, but only after completing the relevant instrument approach procedure. The external limits of the total area applicable to each category of aircraft are defined by a combination of several arcs centred upon the threshold of each useable runway. Aircraft are categorised according to their maximum manoeuvring speeds, and the radii of the arcs determining the extent of the manoeuvring area increases with direct relation to the manoeuvring speeds. The minimum circling heights published for Islay/Port Ellen aerodrome refer to category A and B aircraft only, (the Twin Otter is a category A aircraft,) and the radius

of the arcs defining the external limits of the manoeuvring area is 2.66 nm. Category A and B aircraft manoeuvring within the area and maintaining the MDA's appropriate to the sector (1110 and 760 feet respectively) will have a minimum obstacle clearance of 300 feet.

1.11 Flight recorders

None were required and none were fitted.

1.12 Wreckage and impact information

1.12.1 Impact sequence (see diagram at Appendix 3)

The aircraft had crashed into the upper slopes of the southeast face of a hill 2.2 kilometres (km) northwest of Laphroaig on the south coast of the Isle of Islay. From examination of ground marks and the wreckage it was established that the aircraft had initially contacted a gently rising slope with the main landing gear before striking a steep rocky outcrop with the nose. Its attitude at the time was between 34° and 36° nose up, approximately 10° right bank, and 18° left yaw relative to its ground track of 330° (M); 5° of this yaw may be accounted for by drift.

After initially contacting the soft grass-covered slope, at a height of 360 feet amsl, the aircraft had pitched down, within its own length, to allow the nose landing gear to strike the ground firmly and, very shortly afterwards, to break off. It then continued in an almost level attitude, for a short distance, on the stub of the nose landing gear with the main wheels clear of the sloping ground. The nose then struck the steep rocky outcrop, whereupon the aircraft rapidly pitched nose up. In so doing the left wing rear spar-to-fuselage attachment failed, allowing the wing to pivot forward until failure of the front spar and wing strut attachments occurred. As a consequence of this sequence the left propeller blade tips, with the engine still under power, were able to enter the left rear side of the cockpit and subsequently strike the handling pilot.

The right wing had also contacted the ground, with its outermost section, but had remained attached to the fuselage. The right engine propeller blades had struck the rocky outcrop leaving three distinct slash marks. Calculations based on the measurement between these marks showed that if, at the moment of impact, the propeller had been rotating at its maximum speed of 2112 revolutions per minute, the aircraft would have had a ground speed of 88 knots. The aircraft had finally come to rest close to the top of the outcrop with the fuselage having slid back about 2 metres, and pitched up to 38°. In sliding back, the tail skid had dug into the ground, and worsened a bending/compression failure of the rear fuselage.

1.12.2 On-site wreckage examination

The aircraft had come to rest in three main sections, the cabin complete with the right wing, the left wing and the empennage. The main structure had survived the impact with remarkably little distortion, with the exception of the nose area housing the two pilots. The whole of the under side fuselage structure in this area had been removed or flattened, permitting the relatively undamaged instrument panel and residual upper nose structure to fall forward

and hang inverted from the cockpit floor. The floor itself was grossly distorted back to the first row of cabin seats, but both pilots' seats with their restraining harness had remained in position. The front cell of the under fuselage forward fuel tank group had been ruptured but, because of the fuselage attitude, its content was the only fuel to be spilt. Prior to wreckage recovery approximately 298 kg of fuel was drained from the intact tanks.

The following relevant selections and readings were observed in the cockpit:-

(i)	Altimeters barometric pressure settings:	Left – 1017 mb Right – 1017 mb Centre – 1020 mb
(ii)	Airspeed indicators:	Severely damaged – readings not possible
(iii)	Radio Magnetic Indicators:	Left – Aircraft heading 315° (with yellow needle set to VOR, green needle to ADF) Right – Aircraft heading 315°
(iv)	Horizontal Situation Indicator (Left):	Aircraft heading 315° VOR radial selected – 272°
(v)	VOR/ILS indicator (Right):	Radial selected 268°
(vi)	VHF Radio Comm 1:	123.15 MHz (Islay/Port Ellen aerodrome)
	VHF Radio Comm 2:	130.65 MHz (Loganair company frequency)
(vii)	VHF Radio/Nav 1:	113.30 MHz (Skipness VOR)
	VHF Radio/Nav 2:	113.30 MHz (Skipness)
(viii)	Distance Measuring Equipment:	Set to 'knots' and Nav 1
(ix)	Automatic Direction Finding:	Both set to 395 KHz and ADF (Islay/Port Ellen NDB)
(x)	Transponder:	Code 5052, selected ON
(xi)	Flap lever:	Selected to 12°
(xii)	Flap position indicator:	Showing approximately 11°
(xiii)	Power levers:	Both towards full power position

(xiv)	Propeller levers:	Both towards maximum
(xv)	Fuel quantity indicators:	Aft – 425 lbs Forward – 375 lbs
(xvi)	Fuel selector:	Normal
(xvii)	Standby booster pumps:	Both set to OFF
(xviii)	Emergency fuel shut off switches:	Normal
(xix)	Fire handles:	Both IN (not fired)

1.12.3 Detailed examination of wreckage

Following wreckage recovery to the AIB at RAE Farnborough, a detailed examination was carried out. This examination did not reveal any pre-existing faults in the aircraft's structure or flying control systems. All flying control surfaces were correctly attached to their respective drive systems and their part of the airframe, and it was established from the flap actuation system that the flaps had been at the 11° position at impact. The rudder and elevator trim tab positions agreed with their mechanical indicators in the cockpit, showing that a small amount of right rudder trim (½ needle width) and nose down trim (1 needle width) existed at impact. The electrical aileron trim indicator in the cockpit had returned to zero but the tab on the left aileron was positioned to give a small degree of right roll trim. All three trim actuators are irreversible screw jacks, electrically driven on the aileron and the others are mechanically driven via cables from the cockpit. None of these cables had failed or been stretched and thus the tab positions were considered to reliably indicate the trim state of the aircraft at impact. The flap/elevator inter-connect trim tab on the right elevator had been pulled beyond its normal up position. This was as a result of disruption to its drive system in the fuselage roof as the left wing detached during the impact.

Of the primary flight instruments, only the left and right altimeters were in a condition to be calibrated. This revealed the left altimeter to be accurate within 30 feet, the right within 60 feet when tested on sub-scale settings of 1013 mb and 1017 mb over the height range of 0 to 7000 feet.

Both airspeed indicators had suffered case failures and could not be checked for accuracy. However, their working parts were intact, exhibited no signs of distress and could be functioned over their normal full range. Likewise, the pitot/static system could not be checked for leaks but all damage observed was consistent with being caused by the impact. The aircraft's stall warning system was tested and, whilst it could not be calibrated its component parts operated satisfactorily.

Both engines and propeller assemblies were strip examined at a UK overhaul agency. This revealed that each engine had been rotating at a high speed at impact. Visual assessment of the damage to each propeller blade, distortion of the engine cases, damage to the fuselage and ground marks all confirmed that both engines were delivering power, although the exact power output

of either engine could not be determined with any accuracy. When initially examined, the power levers and propeller control levers were all towards the forward end of their travels, ie, high power and high RPM. However, the left wing had broken free from the fuselage, the right engine from its mountings and in doing so they had either broken or pulled on the control cables. It was not possible, therefore, to directly equate these lever positions with the power at impact, although they would be consistent with witness reports of a marked power increase just before impact.

A strip examination of each propeller unit was conducted which revealed no pre-impact abnormalities in either unit. An attempt was made to assess propeller blade angles, and hence power levels, at impact but with little success. The left propeller blades only struck the fuselage and ground after the wing had detached from the fuselage and consequently yielded no useful information. One blade from the right engine had struck the ground with sufficient force to break off, this alone indicating a high engine power output.

The propeller governor, overspeed units and engine fuel control units (FCU's) were all either rig tested or strip examined and, with one exception, found to be fully serviceable. The left engine fuel control unit was found on test to be governing the gas generator (Ng) speed at 98% instead of a possible maximum of 101.5%. A strip examination revealed some internal contamination of various bleed orifices, although none were blocked, and wear was present on the throttle cam, eccentric lever and governor spring. These defects are not unusual in used FCU's, according to the overhaul agency, and may cause the unit to alter its governing characteristics as described above.

Use of the maximum continuous/take-off power of the PT6A-27 engine of 680 SHP is restricted in the Twin Otter installation to 620 SHP. Also, the maximum propeller speed is limited to 2112 RPM (96% Np) and maximum indicated torque value of 50 psi.

In normal operation, particularly at the ambient temperatures experienced in the Loganair operation, a torque value of 50 psi will produce a gas generator speed (Ng) of 94% to 96% with the propeller speed (Np) governed at 96%. It is possible in the Twin Otter to exceed this rated power by advancing the power levers fully forward to their stops where maximum engine power may be expected to be developed in less than 1 second. It is therefore probable that this defect would only produce an effect when normal maximum power is exceeded on both engines and this could well have contributed to the large left yaw angle of the aircraft. It could not be determined if any sudden rudder deflection had been applied prior to the impact.

The avionic systems computers had survived the impact in good condition and were subsequently tested at their manufacturers' service facility in the UK. This revealed both VOR computers to be accurate within ½° of a selected radial and both automatic direction finding (ADF) computers to be within 3° of the correct relative bearing. The ADF units incorporate a visual indicator, for test purposes, which freezes when power is removed and which indicate the relative bearing of the selected NDB. ADF No 1 was showing 7° right of aircraft nose, No 2 showed 5° right. (The aircraft heading at impact was determined as 10° to the left of the NDB.) The distance measuring equipment (DME) computer was found to be accurate, but outside the manufacturers specification, in that its transmitter power and sensitivity

were low. This would have the effect of reducing the useable range of the DME system, but at no time on test did the computer produce erroneous readings. According to the manufacturer such a defect is consistent with mechanical shock to the output valve in the unit.

The aircraft's master warning panel light bulbs were examined for evidence of illumination at the time of impact. A high proportion showed characteristics of filament failure whilst cold, and none showed evidence of hot failure.

1.13 Medical and pathological information

There was no evidence that any pre-existing medical condition of either pilot contributed to the accident. During the impact the handling pilot died from severe multiple injuries, and the supervisory captain sustained serious injuries. As a result of these injuries the surviving pilot cannot remember anything concerning the flight.

1.14 Fire

There was no fire.

1.15 Survival aspects

1.15.1 The impact

At the moment of the major impact with the rocky outcrop the aircraft appears to have been in a level slightly right wing down attitude, and travelling at a ground speed of between 85 and 90 knots. Both pilots and all the passengers were strapped in and, largely because of this, injuries were kept to a minimum. When examined on site the forward right escape window had been operated and was lying outside the fuselage and the normal passenger exit door, at the rear on the left side, was open. It is believed that all the passengers escaped via this rear door. The other two emergency exits were later operated satisfactorily.

Despite the severe damage to the nose section there was no significant distortion to the fuselage structure over the length of the passenger cabin. All seats had remained securely attached to the cabin floor, and no seat belts had failed due to deceleration forces. The single fatality, to the pilot in the left crew seat, was a direct result of the initial impact forces and the subsequent detachment of the wing which allowed the left engine propeller to penetrate the cockpit.

1.15.2 The injuries

At the time of the impact all the aircraft's occupants were seated with their restraint harnesses fastened. The two pilots were restrained by a full harness, the passengers by lap straps only. All seats were forward facing. The supervisory pilot sustained serious injuries to his head and legs as the front of the aircraft forward of the pilots' seats disintegrated.

In view of the severity of the impact and subsequent deceleration of the aircraft, the injuries sustained by the passengers were remarkably slight. Apart from suffering shock, three passengers escaped without injury. Concerning the

passengers who suffered serious injuries, expert medical advice is of the opinion that most of these resulted from high deceleration forces which caused people to rotate forwards around their lap straps and strike the seat in front with their heads and legs. It is probable that these injuries would have been minimal had the seats been rearward facing.

For the purposes of this report the definition of serious injury is that contained in the International Civil Aviation Organisation Standards and Recommended Practices, Annex 13. This defines serious injury as an injury sustained by a person in an accident which "requires hospitalisation for more than 48 hours, commencing within seven days from the date the injury was received, ...".

1.15.3 Search and rescue

The final radio message from the aircraft was at 1521 hrs when the incorrect position 'over Port Ellen' was reported. When, after two radio calls to the aircraft which failed to obtain a reply, the aerodrome radio operator became worried she immediately contacted Scottish Airways and advised the controller of the situation. Overdue action was commenced at 1526 hrs, and at 1533 hrs a Royal Air Force Nimrod aircraft was en-route to Islay to act as On Scene Commander and co-ordinate the area search and rescue units. Two Royal Air Force search and rescue helicopters and one Royal Navy helicopter were also alerted. In the event the position of the crash site was notified by a passenger who was first from the wreckage and help was directed to the scene. Seven of the seriously injured survivors were transferred to mainland hospitals by helicopters. The remainder were treated in a local hospital.

The total flying hours completed by search and rescue aircraft during the operation were as follows:-

RAF Nimrod	1 hr 43 mins Day
RAF Wessex	2 hr 40 mins Day
RAF Sea King	6 hr 12 mins Day 1 hr 30 mins Night
RN Sea King	3 hr 10 mins Day

1.16 Tests and research

Because it appeared that a significant factor in the accident may have been the decision of the pilots to fly a visual approach in unsuitable weather conditions, during which they mis-identified Laphroaig as being Port Ellen, it was considered necessary to the investigation to mount a trial flight. The purpose of the flight was to assess the difficulty of visual navigation along the south coast of the island, and to compare the differences between a visual approach and the published instrument approach procedure. To this end a fleet aircraft flown by a Company training captain was used to fly a similar flight profile to the accident flight. Both video and still photography were used to record the flight, which was carried out on the morning of 25 June 1986.

The weather on that morning was generally similar to that on 12 June 1986 in that a moist westerly airstream was producing extensive layers of stratus cloud; however, there was no precipitation and no significant cloud below 1000 feet. The aircraft was flown, at 6000 feet to overhead the Skipness VOR when a descent was commenced towards the south of the Isle of Islay. At the top of descent it was noticeable that the centre of the island and the high ground was obscured by cloud, but it was possible to see sufficient landmarks along the south coast through gaps in the cloud cover to enable a visual descent to be carried out. As the aircraft descended, conditions appeared to worsen as it became apparent that the tops of even the smaller hills inland were obscured by stratus (Photograph 1 in Appendix 5 refers).

At the bottom of the descent the aircraft was flown along the south coast at 500 feet above sea level. The flight was continued past Laphroaig until overhead Port Ellen. It was observed that although the two bays are very similar in shape, there is a considerable difference in size and background when viewed from the air. In conditions of good visibility, as were prevelant on the trial flight, it would be difficult to mistake one bay for the other, especially when both are in view. However, in the poor conditions that were prevailing on the accident flight, with an in-flight visibility of 2000 metres or less, identification would probably not be so simple. In these conditions Port Ellen would not have been visible from an aircraft overhead Laphroaig at 500 feet; from less than 100 feet it was considered that very little of the coastline would have been visible at all. Photographs of both bays were taken from the aircraft at a height of 500 feet above sea level and are included at Appendix 5. The prints have been modified to reflect conditions of poor visibility.

As a final part of the trial flight the full NDB instrument approach was flown. The procedure was found to be satisfactory and presented no problems. However, it was observed that, in a flight visibility of 2000 metres, neither the runway threshold nor even the coastline ahead would have been visible from the Missed Approach Point.

1.17 Additional information

1.17.1 The relevant regulations

The general regulations concerning the operation of public transport aircraft registered in the United Kingdom are laid down in Part V of the Air Navigation Order 1985 (ANO). The regulations are expanded in the United Kingdom Air Pilot (AIP), Rules of the Air and Air Traffic Services (RAC). Included in these regulations is the requirement that every operator shall produce an operations manual which must be available to each member of his operating staff. In the company operations manual the operator is required to establish and include operating minima appropriate to every aerodrome of intended departure or landing and every alternate aerodrome. It is also specifically laid down in the ANO Part V, Article 30, paragraph 5(b) that: "an aircraft shall not continue an approach to landing at any aerodrome by flying below the specified Decision Height unless from that height the specified visual reference for landing is established and is maintained."

1.17.2 The company operations manual

The Loganair company operations manual contained the required instructions on operating procedures and aerodrome operating minima. Relevant extracts from the manual are provided in Appendix 4 to this report. Although the conduct of the accident flight touches upon many other regulations and guidelines, only those pertinent to the discussion have been included. A fully amended and up-to-date edition of the company operations manual was on board the aircraft.

1.17.3 "De Havilland, Canada Service Bulletin 6/469"

This service bulletin, revision "A" of which is dated 14 June 1985, provides details of an optional modification, No 6/1752, entitled "Wings – Wing restraint Tension Rod Installation."

In previous impact survivable crashes with the Twin Otter, failure of the wing rear spar to fuselage fitting has allowed, as in the case of G–BGPC, the wing(s) to pivot forward and propeller blades to enter the rear of the cockpit. To enhance the crashworthiness of the aircraft an increased energy absorbtion capability at the rear spar attachment is achieved by the installation of a tension rod attached, at its outboard end, to a special fitting along the rear spar, and at its inboard end to the wing attachment bolt. A pivoted link is also provided at this end such that the rod will not react any tensile load until after the root fitting has failed. To date, no Twin Otter is recorded as having crashed with the modification fitted.

Since the accident, the operators of G–BGPC, have expressed their intention to fit this modification to their fleet of Twin Otters. A recommendation to the CAA to upgrade this modification is made in part 4 of this report.

2. Analysis

2.1 General

Only one defect was found during the engineering examination of the aircraft and its systems. The left engine fuel control unit, when tested, governed the gas generator speed at too low a value when the power levers were selected fully forward, ie, beyond the normal maximum torque position. This defect would not be apparent on a normal take-off when the power levers are progresssively moved to the required maximum torque. However, it readily explains the yaw angle at impact, when the power levers were probably slammed open, and the right engine produced significantly more than the maximum allowable torque whilst the left engine produced only slightly more.

The passengers recall the rapid increase in engine noise followed shortly afterwards by the sound of the stall warning system. This evidence suggests that the pilots probably glimpsed the ridge line in the mists ahead of them in the last few seconds and simultaneously put on the power and pulled up hard, so triggering the stall warning system. It is probable that the stall warning operated because of the rate of nose-up pitch and the "g" loading of the wings rather than a reduction in speed in straight and level flight. The aircraft therefore suffered an accelerated stall and the attitude in which it hit the ground suggests that it "mushed" into the ridge rather than flying directly into it. The lower available power on the left engine is not thought to be a factor in the accident.

It must be concluded that, whilst the pilots were attempting to fly a visual approach for landing at Islay/Port Ellen aerodrome in totally unsuitable weather conditions, the aircraft struck rising ground that was obscured in mist or hill fog. Thus, the main emphasis of the investigation has not been to attempt to establish what happened, for this was self-apparent, but rather to try to determine why the events took place. In this respect the total lack of recall of the aircraft commander and the absence of a cockpit voice recorder have proved to be significant handicaps.

Both pilots were well experienced, properly qualified, and, according to their previous company reports, had performed their flying duties to a satisfactory standard. The handling pilot was close to completing a series of supervised route flights which, if he had completed them successfully, would have resulted in the award of full command status. It was very much in his interests to demonstrate his good airmanship and ability to operate the aircraft safely and in accordance with the regulations. Equally, the supervisory captain was a very experienced pilot and flying instructor who must have been well used to commanding an aircraft in a supervisory capacity. Again it might be expected that, in these circumstances, he would have demanded a high standard of airmanship, and that he would not have permitted an ill-considered and unsafe approach to have been carried out. Yet all the evidence shows that this is precisely what happened. The various factors that may have contributed to this situation are discussed in more detail below.

2.2 The conduct of the flight

The pre-departure and take-off phases of the flight appear to have been normal. The aircraft was declared to be serviceable, it was properly loaded, and there was sufficient fuel on board for the flight to Islay/Port Ellen, an instrument approach followed by a go-around, and then a subsequent diversion either back to Glasgow or to any other nominated aerodrome. Prior to departure the pilots had obtained the latest available weather information. Although the forecast was not good, the conditions generally were not below the minima for commencing an NDB instrument approach at the destination aerodrome. The latest Islay/Port Ellen aerodrome METAR, timed at 1150 hrs, was such that, had these conditions prevailed, then a visual approach to the aerodrome from south of the island would not have been an unreasonable manoeuvre. This type of approach may well have been preferred by pilots to the instrument procedure as it would save time and fuel, and also, by avoiding any turbulence that may have been generated by the high ground in the centre of the island, might be expected to result in a smoother flight. Equally, it must be stressed that there was no evidence of any company pressure on pilots to adopt this procedure, and indeed the company operation manual makes it clear that in all cases the responsibility for the whole conduct of a flight rests exclusively with the aircraft commander. In this case, presumably before departing Glasgow, the pilots had discussed the forecast en-route and terminal weather conditions and agreed that the flight should proceed. In view of the forecast conditions and the availability of an instrument approach aid at the destination aerodrome their departure decision was perfectly reasonable.

2.3 The descent

The RTF and Radar recordings show that the flight proceeded according to flight plan until, at 1508 hrs, the aircraft passed overhead the Skipness VOR and was released from the control of Scottish Airways. From this point, instead of continuing on the flight planned track directly to overhead the aerodrome, the aircraft is shown to have turned about 15° left and commenced an immediate descent towards the south of the island. Some two minutes later, at 1510 hrs, the pilots received the Islay/Port Ellen latest weather and, from the evidence on the in-use flight log, which was recovered from the aircraft wreckage, there is no doubt that they noted it down correctly. In spite of the fact that the pilots were by then aware of the poor weather conditions at the aerodrome, the descent towards the south was continued and the reasons for this apparently extraordinary decision can only be conjectural.

Evidence from the passengers, who variously described the flight as being in and out of cloud, suggest that the stratus layers were probably broken, and it is possible therefore that, at the start of the descent, the pilots may have considered that there were sufficient gaps in the cloud to enable a visual descent to be carried out. What is certain is that they had decided upon a VFR descent towards the south of the island before receiving the actual weather conditions, and that thereafter, in spite of the weather actual, they did not change their minds. From the evidence of the passengers and ground witnesses it is also apparent that the closer the aircraft flew towards the south coast of the island, the worse the weather conditions

became. It is highly probable that, in order to achieve even an intermittent visual contact with the sea or coastline, the aircraft was descended significantly below the 550 feet minimum stated in the company flight manual.

At this stage the only safe option to the pilots would have been to have turned the aircraft onto a southerly heading, climbed over the sea to the Minimum Sector Altitude (MSA) of 3600 feet, and navigated back to overhead the Islay/Port Ellen aerodrome NDB to carry out an instrument approach. This manoeuvre would have added perhaps 15 to 20 minutes to the flight time, and was possibly discarded for that reason. However, despite the weather conditions, the flight was continued along the coast of Islay until it turned inland over Laphroaig. There is reliable evidence from ground witnesses that, at that time, the aircraft's altitude was below 100 feet above ground level, and that visibility was extremely poor in the prevailing mist. The pilots, believing that they had turned inland over Port Ellen, would then have probably been looking for the A846 road which runs directly from the town to the aerodrome. Certainly the heading on which the aircraft left Laphroaig was parallel to and about 1 mile to the east of the road. From the position that the aircraft turned inland over Laphroaig, until the collision with the rising ground, it would have taken less than 45 seconds.

There is evidence from the aircraft's attitude and engine power at impact, that the pilots had seen the ground and attempted to climb the aircraft in the last seconds. However, it must be concluded that from the time that the pilots had misidentified Laphroaig as being Port Ellen, and turned inland at extremely low level, a collision with the ground was a distinct possibility.

2.4 The instrument procedure

As a further part of the investigation the Islay/Port Ellen aerodrome NDB approach procedure was studied in order to determine whether a safe approach and landing would have been possible in the weather conditions reported on the day of the accident. The conclusion must be that an approach and landing in accordance with the current regulations would probably not have been successful.

The minimum visibility for commencing an NDB instrument procedure at Islay/Port Ellen is 1500 metres, and in any conditions of visibility below that limit an approach ban is mandatory. The visibility passed to the pilots on the accident flight was 2000 metres, and so, in accordance with the current regulations, an instrument approach was permissable. However, on the instrument approach procedure the missed approach point is positioned 3150 metres (1.7 nm) back from the runway threshold. At this point if the actual visibility was indeed 2000 metres then the pilots could not possibly have achieved the recommended suitable reference for landing and a go-around would have been mandatory. Although the missed approach point is correctly plotted on all the instrument approach plates examined, the fact that it is a significantly greater distance from the runway threshold than the minimum visibility for commencing an approach, is not highlighted. It is felt that, under conditions of stress or high work load, this factor could well be missed and induce an unwary pilot to commence an approach in flight conditions in which he could not land. A safety recommendation is made accordingly.

2.5 The regulations

The regulations concerning the conduct of public transport flights were examined in detail, in order to determine whether any amendments or additions to the current disciplines might contribute towards preventing similar type accidents in the future. The production of an Operations Manual is the statutory responsibility of an Operating Company and is necessary to the granting, by the CAA, of an Air Operator's Certificate. It is the responsibility of the Operating Company to ensure that the Manual provides clear and explicit regulation of the manner in which the Company's flying operation is to be conducted. The Loganair Company Operations Manual meets all statutory requirements, and is considered to be clear and unambiguous in its description of Company operational procedures. Relative extracts considered pertinent to the accident flight are included at Appendix 4. There is strong evidence that some, if not all of these Company regulations were contravened during the accident flight. It is also apparent that Rule 5 of the Rules of the Air contained in the Air Navigation Order 1985 was contravened. Certainly at the time and position of the impact the aircraft could not be described as "landing in accordance with normal aviation practice", as from that position the pilots could not have possibly been in visual contact with the aerodrome.

Subsequent to the accident the Company has ruled that their aircraft commanders are banned from conducting a visual approach to an airfield which is served by a serviceable approach aid when the reported cloud cover includes more than 4 oktas cloud below circling height, or the reported visibility is less than 2 nm. It is not considered that further changes to current regulations would be appropriate.

3. Conclusions

(a) *Findings*

(i) The commander held a valid Commercial Pilot's Licence with a current medical certificate.

(ii) The handling pilot held a valid Commercial Pilot's Licence with a current medical certificate.

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

(iv) The handling pilot died of injuries sustained during the impact.

(v) The aircraft commander and 11 passengers suffered serious injuries during the impact.

(vi) There was no evidence that any mechanical failure or malfunction had occurred that was relevant to the accident.

(vii) The engines were developing high but asymmetric power at impact.

(viii) Communications throughout the flight were normal.

(ix) The weather forecast was suitable for the flight to be undertaken, but the actual weather on arrival was totally unsuitable for a visual approach.

(x) The final stages of the flight were conducted below the minimum height and minimum visibility conditions stipulated in the Company Operations Manual, and apparently in direct contravention of Rule 5 of the Rules of the Air, Air Navigation Order 1985.

(xi) The published minimum visibility for commencing an NDB instrument approach to Islay/Port Ellen is incompatible with the published Missed Approach Point.

(xii) The Islay/Port Ellen AFIS radio operator initiated overdue action promptly and with initiative.

(xiii) Search and Rescue Services were alerted promptly and responded without delay.

(b) *Cause*

The report concludes that the cause of the accident was the commander's decision to allow the handling pilot to carry out a visual approach in totally unsuitable meteorological conditions. An error in visual navigation was a contributory factor.

4. Safety Recommendations

It is recommended that:

4.1 The CAA should consider upgrading the modification (De Havilland Canada Service Bulletin 6/469) to improve crashworthiness of the Twin Otter by the introduction of a wing restraint tension rod.

4.2 The CAA should require that on those airfield approach plates where the distance from the missed approach point to the minimum visual reference is significantly greater than the published minimum visibility requirement, the difference should be highlighted.

R C McKINLAY
Inspector of Accidents

Accidents Investigation Branch
Department of Transport

Printed in the United Kingdom for Her Majesty's Stationery Office
Dd 239037 C6 9/87

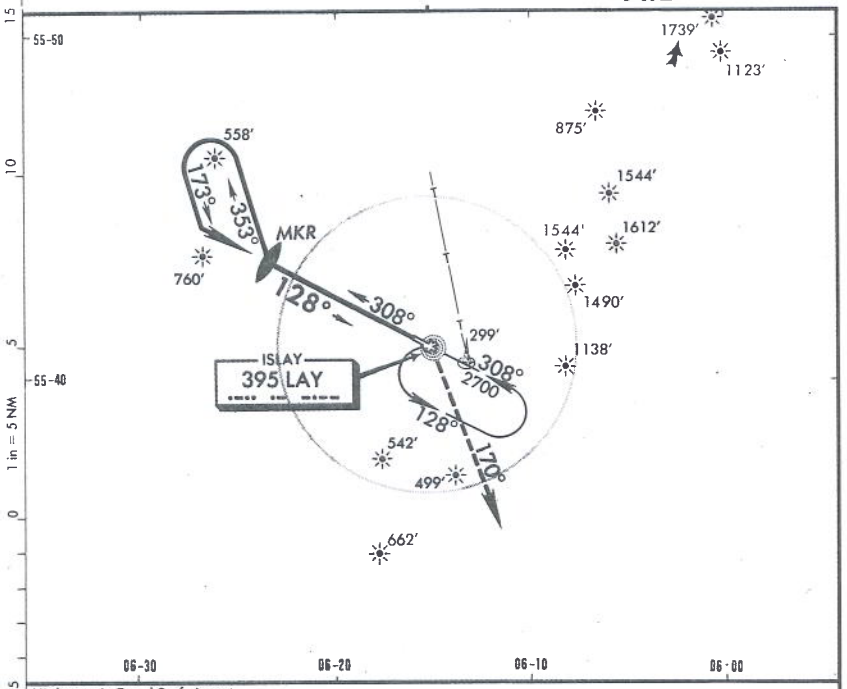
INSTRUMENT APPROACH AND LANDING CHART

ACFT CAT A,B

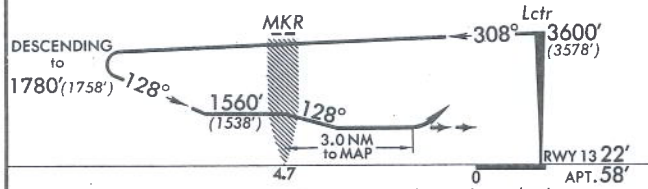
BEARINGS ARE MAGNETIC
ELEVATIONS IN FEET AMSL 299
HEIGHTS IN FEET ABOVE THR ELEV RWY 13 ..... (277)

ELEV 58FT
VAR 9°W

ISLAY/Port Ellen
NDB(L)'LAY' 128°



High terrain E and S of airport.



OCA (H) RWY 13
472'(450')

MISSED APPROACH: Climb AHEAD to 530' *(508')*, then climbing turn RIGHT onto track 170° to 2700' *(2678')*. Turn LEFT to return to Lctr at 2700'*(2678')* or as directed.
Climb to 1000' *(978')* prior to accelerating onto track 170°.

	STRAIGHT-IN LANDING RWY 13	CIRCLE-TO-LAND	
	MDA 480'(458')	Within sector clockwise QDR 150° - 050° from LAY NDB	
		MDA	MDA
A B	1600m	760'(702') 1600m	1110'(1052')1600m
C D	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE

Gnd speed-Kts	70	90	100	120	140	160
MKR to MAP 3.0	2:34	2:00	1:48	1:30	1:17	1:08

UK AUTH 1500m.

CHANGES: See other side.

RADIO		
SERVICE	**FREQUENCY**	**CALL SIGN**
AFIS	123·15	PORT ELLEN INFORMATION

NOTE Call on AFIS frequency 10nm prior to arrival with flight details and intentions.

LIGHTING	
APP 13	APAPI (3°) LHS.
31	APAPI (4°) LHS.
THR 13/31	Green W bars.
RWY 13/31	LI Omni-d. End lights red.
OTHER	Blue taxiway lights from rwy 13/31 via rwy 08/26 to the apron. Obstructions.

MISSED APPROACH POINT	3nm from marker, 1·7nm from threshold

MISSED APPROACH PROCEDURE

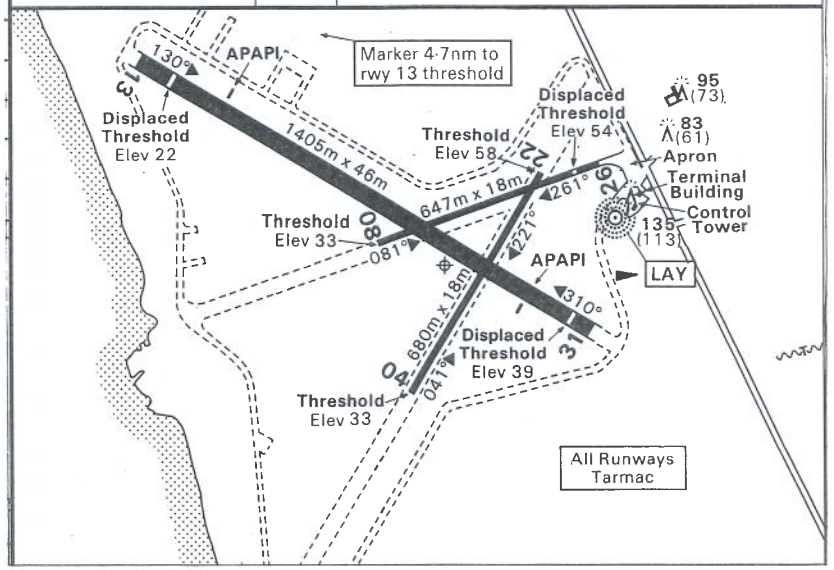
At Missed Approach Point climb straight ahead to **522** (500) then climbing turn right onto 170°. Climb to **1000** (978) prior to accelerating then continue climb to **2700** (2678) before returning to **NDB(L)'LAY'** or climbing to enroute altitude as appropriate.

OBSTACLE CLEARANCE HEIGHTS

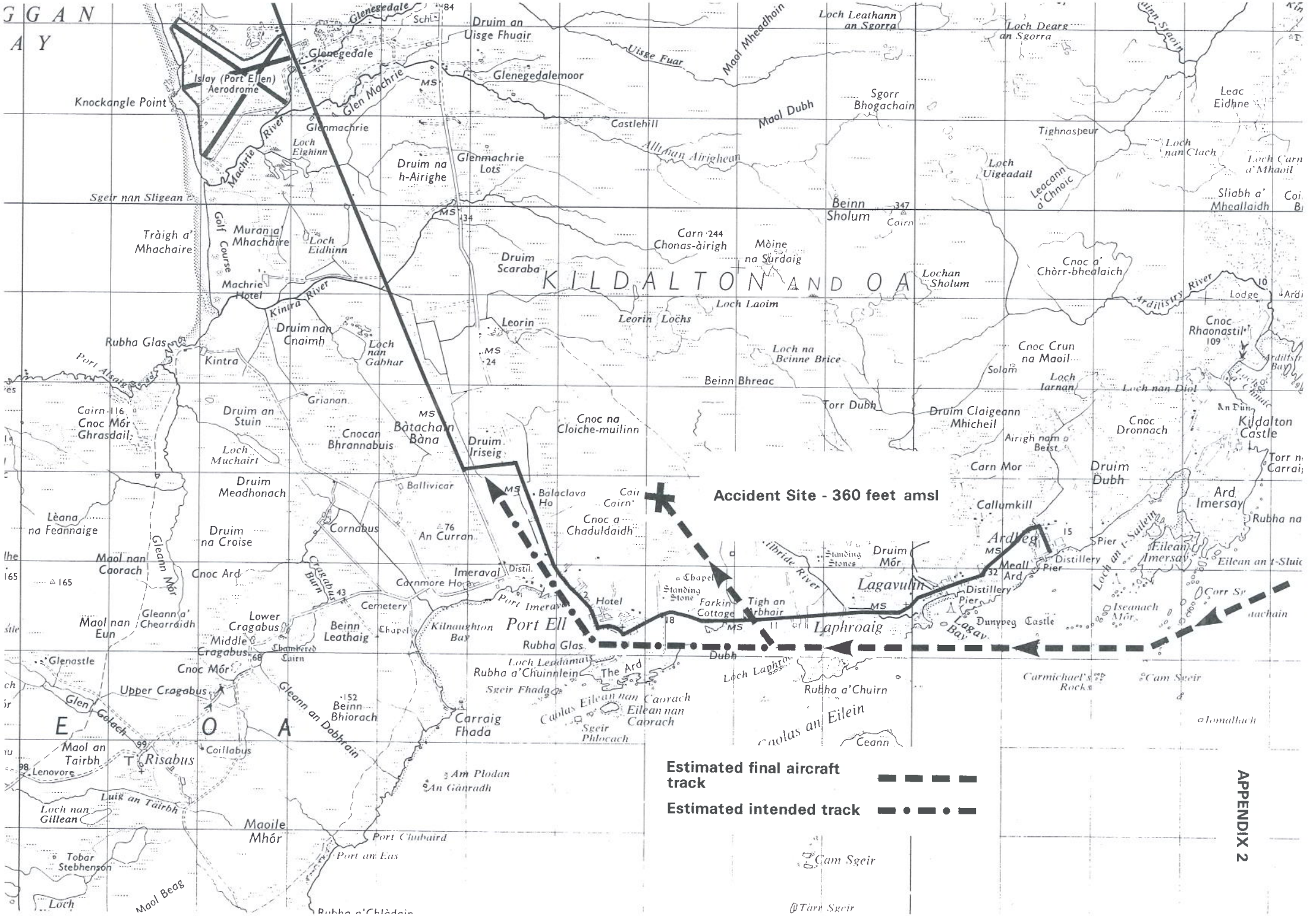
AIRCRAFT CATEGORY	A	B
PROCEDURE	**472**(450)	**472**(450)
VISUAL MANOEUVRING	**1108**(1050)† **758**(700)†	**1108**(1050)† **758**(700)† (150° clockwise to 050°)

LOWEST HOLDING ALTITUDE 2700 † Heights in feet AAL.

	kt	90	120	140	160	180	195
MKR to THR 4·70nm	min:sec	3:08	2:21	2:00	1:46	1:24	1:27



APPENDIX I


Accident Site - 360 feet amsl
Estimated final aircraft track
Estimated intended track
Port Ell
Kildalton and Oa
Laphroaig
Lagavulin
Ardbeg
Port Ellen
Islay (Port Ellen) Aerodrome
Knockangle Point
Glenegedale
Glenegedalemoor
Glenmachrie
Glen Machrie
Machrie River
Machrie Hotel
Golf Course
Sgeir nan Sligean
Tràigh a' Mhachaire
Muran a' Mhachaire
Loch Eidhinn
Loch Eighinn
Druim na h-Airighe
Glenmachrie Lots
Druim an Uisge Fhuair
Uisge Fuar
Maol Mheadhoin
Loch Leathann an Sgorra
Loch Dearg an Sgorra
Maol Dubh
Sgorr Bhogachain
Castlehill
Allt an Airighean
Tighnaspeur
Loch Uigeadail
Leacann a' Chnoic
Loch nan Clach
Leac Eidhne
Loch Carn a' Mhaoil
Sliabh a' Mheallaidh
Beinn Sholum
Carn Chonas-àirigh
Mòine na Surdaig
Lochan Sholum
Cnoc a' Chòrr-bhealaich
Druim Scaraba
Kintra River
Kintra
Druim nan Cnaimh
Loch nan Gabhar
Leorin
Leorin Lochs
Loch Laoim
Loch na Beinne Brice
Beinn Bhreac
Rubha Glas
Port Askaig
Cnoc Rhaonastil
Ardilistry River
Ardilistry Bay
Cnoc Crun na Maoil
Loch Iarnan
Loch nan Dial
Torr Dubh
Druim Claigeann Mhicheil
Cnoc Dronnach
Kildalton Castle
Airigh nam a Beist
Carn Mor
Druim Dubh
Callumkill
Ard Imersay
Eilean Amersay
Rubha na
Cairn Cnoc Mór Ghrasdail
Druim an Stuin
Grianan
Cnocan Bhrannabuis
Bàtachain Bàna
Druim Iriseig
Cnoc na Cloiche-muilinn
Loch Muchairt
Druim Meadhonach
Ballivicar
Balaclava Ho
Cairn
Cnoc a' Chaduldaidh
Lèana na Feannaige
Druim na Croise
Cornabus
An Curran
Gleann Mór
Maol nan Caorach
Cnoc Ard
Craigabus Burn
Imeraval
Carnmore Hos
Distil.
Port Imeraval
Cemetery
Hotel
Chapel
Standing Stones
Farkin Cottage
Tigh an Arbhair
Druim Mór
Meall Ard
Distillery
Pier
Loch an t-Sailein
Eilean an t-Sluic
Iseanach Mór
Corr Sr
Maol nan Eun
Gleann a' Chearraidh
Lower Cragabus
Middle Cragabus
Beinn Leathaig
Kilnaughton Bay
Kilnaughton Chapel
Chambered Cairn
Dunyveg Castle
Lagav Bay
Glenastle
Cnoc Mór
Upper Cragabus
Glen Golach
Loch Leadamais
Rubha a'Chuinnlein
The Ard
Sgeir Fhada
Loch Laphraig
Rubha a'Chuirn
Carmichael's Rocks
Cam Sgeir
Iomallach
Gleann an Dobhrain
Beinn Bhiorach
Carraig Fhada
Cuan Eilean nan Caorach
Eilean nan Caorach
Sgeir Phlocach
Ceann
Maol an Tairbh
Risabus
Coillabus
Lenovore
Luig an Tairbh
Loch nan Gillean
Am Plodan
An Gànradh
Maoile Mhór
Port Chubaird
Port an Eas
Tobar Stebhenson
Maol Beag
Rubha a'Chlàdain
Tarr Sgeir

APPENDIX 2

The Accident Site

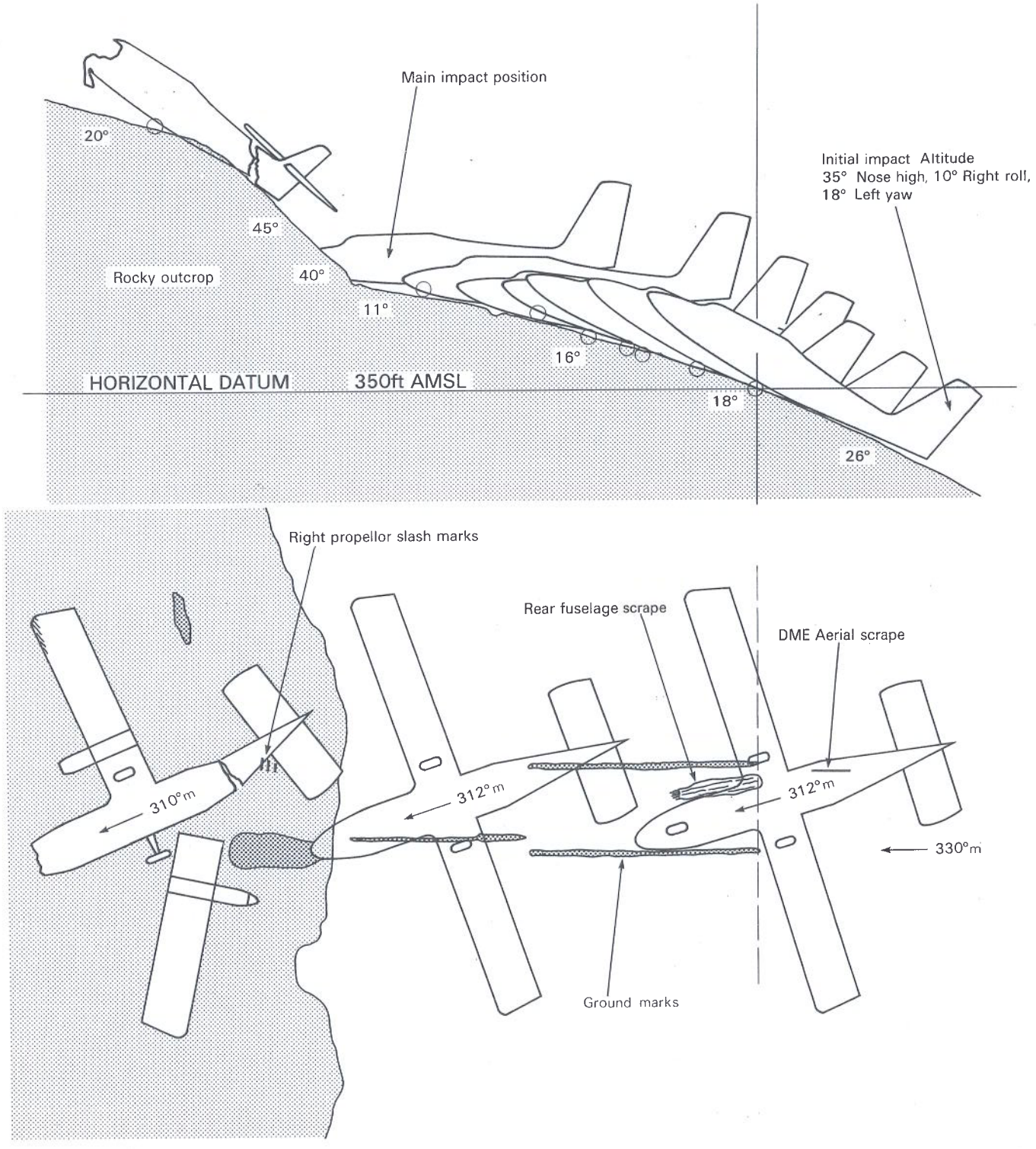


DIAGRAM SHOWING IMPACT SEQUENCE OF G–BGPC

EXTRACTS FROM REGULATIONS RELEVANT TO THE CONDUCT OF THE FLIGHT
(current at the date of the accident)

1. The Air Navigation Order 1985

(a) LOW FLYING

Rules of the Air, Rule 5 (1) (e)

"An aircraft shall not fly closer than 500 feet to any person, vessel, vehicle or structure."

Rules of the Air, Rule 5 (2) (d)

Paragraph (1) (e) of this Rule shall not apply to:
"any aircraft while it is landing or taking off in accordance with normal aviation practice."

(b) VISUAL FLIGHT RULES (outside controlled airspace)

Rules of the Air, Rule 23 (a) (ii)

"An aircraft other than a helicopter flying outside controlled airspace at or below 3000 feet above mean sea level shall remain at least 1 nautical mile horizontally and 1000 feet vertically away from cloud and in a flight visibility of at least 3 nautical miles:

Provided that this sub-paragraph shall be deemed to be complied with if the aircraft is flown at a speed which according to its air speed indicator is 140 knots or less and remains clear of cloud, in sight of the surface and in a flight visibility of at least 1 nautical mile."

(c) AERODROME OPERATING MINIMA

ANO Article 30, para 5 (b)

A public transport aircraft shall not: "continue an approach to landing at any aerodrome by flying below the specified decision height unless from that height the specified visual reference for landing is established and maintained."

For "Specified Visual Reference", the CAA guide to the construction of Operations Manuals, contained in CAP 360 Part One, says: "For a visual circuit of the aerodrome based on visual manoeuvring minima a pilot should have continuous sight of ground features which will enable him to establish the position of the aircraft in relation to the aerodrome and subsequently to remain within the notified visual manoeuvring area."

2. Loganair Operations Manual

(a) CANCELLATION OF IFR FLIGHT PLANS

Part 1, Ch 1, para 6.5 (a)

Conditions when cancellation is acceptable:

1. The flight can be continued to the destination airfield in accordance with Visual Flight Rules . . . . . .

2. Adequate means of safe navigation of the aircraft to the destination aerodrome are available or the aerodrome is in sight at the time of the cancellation . . . . . .

3. Instrument Meteorological Conditions do not prevail over the remainder of the route or at the destination aerodrome.

(b) DESCENT BELOW MSA

Part 1, Ch 1, para 6.6

Prohibition. Descent below MSA is prohibited in the following conditions:

(i) When on an IFR flight plan

(ii) In Instrument Meteorological Conditions

(c) CIRCLING MINIMA

Part 1, Ch 1, para 12.8

Circling Minima represent the lowest conditions in terms of Circling Height and In-flight Visibility, in which a circuit or partial circuit, using visual reference to the airfield surface, may be carried out within a fixed radius or sector of an aerodrome at which landing is intended. If an approach ban is in force circling is not allowed. Circling minima are applicable to:-

(i) an instrument let-down (Cloud break procedure) made for the purpose of landing on a runway other than that (if any) directly served by the approach aid being used, OR

(ii) a visual circuit following overshoot from either an instrument or a purely visual approach.

(d) VFR LIMITS

Part 1, Ch 1, para 12.16 (v)

The Company limits for VFR flights are:-

(i) **DHC6 and BN2A**
An in-flight visibility of 2 mm. A minimum en route altitude of 500 feet over the sea, or 500 feet above ground level.

(e) DEFINITIONS

Part 1, Ch 1, para 12.6

These definitions are included to standardise terminology and to interpret Company Policy on certain requirements:-

(i) **Approach to Landing**, means that part of the flight of the aircraft in which it is descending below a height of 1000 feet above the specified Decision Height.

(ii) **Cloud Ceiling**, in relation to an aerodrome means the vertical distance from the elevation of the aerodrome to the lowest part of any cloud visible from the aerodrome which is sufficient to obscure more than one half of the sky.

3. CAP 360 – Part One

(a) Specification of visual reference

Part 1, Ch 2, para 14.13.3

For approaches using aids other than a full ILS or PAR when approach lighting is not available, the specified visual reference should include the aiming point, ie the desired point of touchdown on the runway of intended landing. If approach lights are available it is not essential that the aiming point should be in view at decision height, but the segment of lighting specified should contain at least seven consecutive lights, which may be approach lights or runway lights, or a combination of both.

The Island of Islay under typical stratus cloud in a westerly airstream

The coast abeam Laphroaig

The coast approaching Port Ellen

NB. In the weather conditions reported at the time of the accident, Port Ellen would not have been visible from an aircraft flying at less than 100 feet overhead Laphroaig.