AIRCRAFT ACCIDENT REPORT 1/85

Accidents Investigation Branch

Department of Transport

Report on the accident to Britten-Norman Islander BN 2A-26 G-BDVW at Sanday Island Airfield, Orkney on 1 June 1984

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

20 May 1985

The Rt Honourable Nicholas Ridley
Secretary of State for Transport

Sir,

I have the honour to submit the report by Mr C C Allen, an Inspector of Accidents, on the circumstances of the accident to Britten-Norman Islander BN 2A-26, G-BDVW, which occurred at Sanday Island Airfield, Orkney on 1 June 1984.

I have the honour to be
Sir
Your obedient Servant

G C WILKINSON
Chief Inspector of Accidents

Contents

Accidents Investigation Branch

Aircraft Accident Report No. 1/85
(EW/C874)

Registered Owner:		Loganair Limited
Aircraft:	*Type:*	Britten–Norman Islander
	Model:	BN 2A–26
	Nationality:	British
	Registration:	G–BDVW
Place of Accident:		Sanday Island airfield, Orkney Latitude 59° 15.2′ N Longitude 002° 35′ W
Date and Time:		1 June 1984 at 0824 hrs All times in this report are GMT

Synopsis

The accident was notified to the Accidents Investigation Branch at 1200 hrs on 1 June 1984 and the investigation began the following morning. The aircraft was engaged on a scheduled public transport flight from Kirkwall Airport, via Stronsay island, to Sanday island. The flight to Stronsay was uneventful and, having disembarked two passengers and picked up another three, it departed for Sanday.

Low cloud and poor visibility persuaded the commander to conduct the flight at 300 feet above mean sea level (amsl) and at an airspeed of 90 knots. The commander made three attempts to establish the aircraft on the final approach to runway 11; on the third, the aircraft was successfully established but at a late stage entered a stalled condition and struck the ground 450 feet (137 metres) before the runway threshold. Following a ground run of 1,065 feet (325 metres) the aircraft came to rest in a severely damaged state. There was no fire and all the occupants evacuated the aircraft without injury.

The report concludes that the accident was caused by the commander's decision to continue a low level flight conducted under Visual Flight Rules in meteorological conditions which were inappropriate. His low experience of the task was a contributory factor.

1. Factual Information

1.1 History of the flight (Appendices 1–5 refer)

Loganair flight LC 621 was scheduled to fly from Kirkwall, on Orkney island, to the islands of Stronsay and Sanday, departing from Kirkwall at 0730 hrs. The commander reported for duty at 0700 hrs and immediately carried out the pre-flight checks on the aircraft, G–BDVW (VW), before attending the meteorological briefing.

The weather at Kirkwall was predominantly misty with low cloud and thus unsuitable for an on-schedule departure; accordingly, the commander decided to delay the flight pending an improvement. Because there are no formal weather reporting facilities at Stronsay or Sanday, crews must rely upon the area forecast and on any informal information passed by the respective aerodrome attendants. At about 0725 hrs, the two airfield attendants telephoned, in turn, to say that the weather at Sanday was suitable for landing and that at Stronsay the visibility was then about 1½ miles.

At 0750 hrs the commander decided that the weather conditions at Kirkwall were now better than the published take-off minima and that the flight could be conducted under the Visual Flight Rules (VFR)*. Accordingly, he took off for Stronsay with six passengers on board. The flight was uneventful and the aircraft landed at Stronsay at 0758 hrs. There two passengers disembarked and three joined for the 6 mile flight to Sanday, which departed at 0803 hrs.

The aircraft commander has subsequently stated that, as they passed the south-west tip of Sanday island, the visibility was 2 miles with very low patchy stratus and with a higher layer of cloud. He therefore flew the route below the upper layer of cloud, at 300 feet amsl and at a reduced airspeed of 90 knots, compared with the normal cruising speed of 130 knots. When the aircraft was about ¾ mile out from Sanday airfield the commander recognised the chequered marker boards near the end of the grass runway 03.

He next saw the windsock, which showed the wind to be about 140°/15–20 knots, and slowly descended to 250 feet amsl (190 feet above the aerodrome) to position the aircraft downwind for runway 11. Whilst doing so, he lost sight of the airfield in deteriorating visibility and, as the cloudbase ahead appeared to be getting lower, he climbed away in a northwesterly direction and levelled off above the layer of cloud, at 600 feet amsl. Whilst establishing the aircraft on the track to Kirkwall, the commander noticed some areas clear of cloud about 3 miles off the northwest coast of Sanday. As, in the opinion of the commander, these provided a safe area for descent over the sea, he used them to descend to 300 feet again and approached the northwest coast at 90 knots with the intention of map-reading his way back to Sanday aerodrome.

Having carried out the descent and the relevant aircraft checks (including the selection of APPROACH flap) the commander saw the headland, which he knew to be Whale Point, some 2-3 miles distant. By reference to his map he was aware that he could follow the road which ran in a southwesterly direction and

* for a definition of Visual Flight Rules see Appendix 1.

then turn southeast to a specific point which would lead him directly onto the final approach to runway 11.

However, having failed to recognise the turning point, he navigated by reference to his map around the south, east and north of the aerodrome in order to intercept the road running southwest and thus relocate the turn-in point to the runway. The commander stated that he was aware that the meteorological conditions were very conducive to the formation of carburettor icing, so he applied the normal period of carburettor heat to each engine just before the final approach. He then turned the aircraft onto the final approach and, not yet seeing the airfield, used the school – which he could see and knew to be almost directly beneath the final approach path – to align the aircraft with the runway. As the aircraft passed abeam of the school the commander was able to identify the runway markers of runway 11. He believes that by this time the aircraft speed had reduced from the 65 knots at which the approach had been flown, but the speed actually achieved is not known.

The commander further stated that, at the latter stage of the final approach, various necessary minor adjustments to track and descent path were made with reference to the visual aspect of the runway and that when, as he believed, he selected LANDING flap, a slight tremor, sometimes associated with that selection, was felt; however, it has been determined subsequently that the flaps had not moved from the APPROACH configuration. Following the tremor, the left wing of the aircraft dropped and the aircraft established a rate of sink. The commander also stated that at some point the stall warning system had activated and that the application of full throttle could not arrest the descent before ground contact.

During this final descent, the aircraft turned through 55° to the left and struck the ground in a manner quoted by some passengers as not very different from a normal landing, although at a point some 450 feet (137 metres) short of the runway threshold. Thinking that the aircraft had merely bounced on the ground, the commander left the power applied and attempted to climb away. With full throttle still applied, the aircraft continued through two barbed wire fences, across a small quarry and a shallow ditch. It finally came to rest, after passing through another barbed wire fence, some 1,065 feet (325 metres) from the initial impact point. The commander then closed the throttles and shut down the engines.

The aircraft had sustained severe structural damage, but there was no fire and none of the occupants was injured. The commander and three passengers evacuated the aircraft via the crew emergency exit and the remaining four passengers left via the emergency exit in the left passenger door. The airfield attendant arrived with the fire appliance and took the aircraft occupants to his house, only a few yards away.

1.2 Injuries to persons

Injuries	Crew	Passengers	Other
Fatal	–	–	–
Serious	–	–	–
Minor/none	1	7	

1.3 Damage to aircraft

Substantial.

1.4 Other damage

One barbed wire fence was flattened. Two others and an electric cattle fence were broken by the passage of the aircraft.

1.5 Personnel information

Commander:	Male, aged 43 years
Licence:	Commercial Pilot's Licence valid until 21 December 1992. Airline Transport Pilot's Licence (Helicopters) valid until 31 March 1991.
Aircraft ratings:	BN 2A and B; PA 23, series 160, –235, –250, E23–250; PA 34 series 200 and 200–2; PA 44 series 180 (except PA23 series 250T and PA34 series 200T); Puma helicopter, SA 330
Instrument rating:	Valid until March 1985
Medical certificate:	Class I, valid until September 1984 with no waivers or restrictions
Recency checks:	Base check: 16 March 1984 Route check: 10 April 1984 Emergency Equipment check: 10 April 1984
Flying Experience:	Total hours: 4,136 Total hours, fixed wing: 3,036 Total hours, rotary: 1,307 Total hours in command: 3,504 Total hours on type: 67 Total hours in preceding 28 days: 9 Total hours in preceding 24 hours: 2 Rest period before duty on day of accident flight: 15 hours 24 minutes

At the time of the accident, it was a Company requirement that, following a conversion onto the aircraft type, each new commander should be given dual training in the form of six landings at each of the island airfields on non-public transport flights. Following this, the commander is screened by the Kirkwall Senior Pilot for his first 100 sectors or 25 hours of operation, whichever is accomplished first.

The commander left the Royal Air Force in November 1982, having spent 7 years on 'low level' operations in Phantom aircraft followed by 4 years on Puma helicopters in the support role. After 13 months flying PA23 Aztecs with an air taxi operator, he joined the Company on 12 March 1984. After his initial ground and base training he completed the 100 sectors under supervision between 29 March and 7 April 1984. During this period the main feature of the weather was the presence of cold, wintry showers, well broken, with excellent visibility outside the showers. Fifteen of the 100 supervised sectors were into Sanday. At the time of the accident his total flying experience on the island routes was 63 hours, including 40 sectors into Sanday, and he had completed 105 sectors without supervision.

Both during his RAF flying and his Company supervised flying the commander is reported to have displayed high aptitude and above average results.

1.6 Aircraft information

1.6.1 General information

G–BDVW was a Britten Norman BN–2A–26 Islander, a high winged eight seat all metal monoplane powered by two Lycoming 0–540–E4C5 carburrated engines, driving Hartzell two bladed constant speed fully feathering propellers.

1.6.2 Weight and balance

Maximum weight authorised:	2994 kg
Regulated take-off weight (landing considerations):	2865 kg
Actual take-off weight:	2799 kg
Accident weight (estimated):	2766 kg
Centre of gravity limits (at accident weight):	19.5–25.6 inches aft of datum
Centre of gravity (at time of accident):	25.6 inches aft of datum

1.6.3 Leading particulars

Date of manufacture:	November 1977
Constructor's number:	522
Registered owner:	Loganair Limited
Certificate of Airworthiness:	Transport Category (Passenger) issued 11 November 1983 valid until 10 November 1984
Certificate of Maintenance:	Issued 13 April 1984 and valid for 60 days or 200 flying hours, at aircraft total hours 4,879:03
Total airframe hours:	5,015:07
Total landings:	13,451
Engine hours since last overhaul:	Left – 1,418:12 Right – 909:20
Total hours since last check:	36 hours 04 minutes (100 hour check)

1.6.4 Fuel

Fuel type was Avgas 100LL. A total of 190 kg of fuel, equally disposed between the two fuel tanks, was decanted from the aircraft after the accident.

1.6.5 Approach and threshold speeds

According to the aircraft Flight Manual the initial approach to the runway should be made at 65 knots, aiming to cross the threshold at 58 knots.

1.6.6 Stall characteristics

At the same aircraft weight as at the time of the accident, and with a zero thrust engine setting, the BN–2A–26 has the following declared stalling speeds (Vs):

(a) TAKE–OFF/APPROACH flap (25°): 37 knots

(b) LANDING flap (56°): 34 knots

These speeds are increased by 4–5 knots with power off. The audio/visual stall warning system is normally set so that it activates at approximately V_S + 10 knots. The experience of operating pilots is that the system can give sporadic, short duration, warnings whilst on short final approach and frequently does so during the flare.

1.7 Meteorological information

1.7.1 Actual weather conditions (provided by an aftercast)

Period 0800–0900 hrs:

Moist southeasterly airstream over area.

Winds:

Surface: East southeasterly 12–16 knots

2,000 feet: 130°/25 knots

Cloud:

5–7 oktas stratus base 300–500 feet, lowering to the surface at times, covering high ground and with tops 800–1,000 feet.

4 oktas stratocumulus, base 2,500 feet. Layers to 5,000 feet

5 oktas altocumulus, probably with embedded castellatus, 8–14,000 feet

Visibility:

200 metres in hill fog, denser fog patches, otherwise 700–1,500 metres in fog/mist. Temporarily 3–5,000 metres

Weather:

Extensive mist/fog, hill fog patches.

1.7.2 Meteorological information issued to the commander

1.7.2.1 Area forecast

Period 0600–1200 hrs:

Southeasterly airstream over area

Winds:

Surface: southeasterly 15 knots, occasionally 20 knots 2,000 feet: 150°/ 30 knots

Cloud:

6–8 oktas stratus, base 200–400 feet covering high ground, temporarily lowering to surface – tops 1,200–1,500 feet. 3–5 oktas stratocumulus, base 2,500 feet layered to 6,000 feet. 4 oktas altocumulus with (probably) embedded altocumulus castellatus layers, 8,000–14,000 feet.

Surface visibility:

200 metres in hill fog, denser fog patches, otherwise 800–1,500 metres.

Temporarily 3,000–5,000 metres.

Weather:

Widespread fog/mist. Probability of outbreaks of rain later.

1.7.2.2 Diversion forecast: Wick

Period 0700–0900 hrs:

Wind:	120°/13 knots
Visibility:	1,500 metres
Cloud:	8 oktas stratus 200 feet

Intermittently:

400 metres in fog, sky obscured and probability of 3,000 metres with 3 oktas at 500 feet.

1.7.2.3 Actual weather conditions

The Kirkwall weather at 0720 hrs was reported as:

Wind:	110°/14 knots
Visibility:	1,900 metres; mist
Cloud:	8 oktas on the surface
Temperatures:	Dry bulb: plus 9°C; wet bulb: plus 9°C

At 0725 hrs, the visibility had improved to 3,000 metres and the cloud lifted to:

4 oktas at 100 feet

8 oktas at 200 feet

The accident took place in daylight.

The commander was aware that the above 'actual' reported the conditions at Kirkwall only, and that those present at the northern islands could be quite different. It is also known to Company pilots that conditions of visibility and cloud base at the islands can change very rapidly.

At about 0725 hrs the airfield attendant of Stronsay reported by telephone that the visibility was now about 1½ miles. The Sanday attendant also telephoned to say that the conditions were now suitable for landing. Neither attendant was a qualified meteorological observer but both had watched many arrivals and departures from their respective airfields.

1.8 Aids to navigation

There are no navigational aids on either Stronsay or Sanday islands. The only aids available to the flight were the VOR at Kirkwall Airport, which operates on 108.6 MHz, and a non directional beacon (NDB), also at Kirkwall, operating on 395 KHz. Both were serviceable throughout the flight. However, as the flight was carried out under Visual Flight Rules (VFR), the serviceability of the radio aids is not considered significant.

1.9 Communications

Kirkwall Airport operates on a single radio frequency of 118.3 MHz. At the times when Air Traffic Control (ATC) is closed down, the meteorological office is able to use this frequency to pass information to the aircraft.

As there is no radio communication available at either Stronsay or Sanday, it is customary for the aircraft landing at the islands to report "Finals at..... to Kirkwall ATC.

At 0803 hrs, the commander of VW reported to Kirkwall that the flight was airborne from Stronsay and, at 0811 hrs, that it had 'overshot' at Sanday. He again called 'finals' at 0823 hrs, shortly before the accident.

1.10 Aerodrome information – Sanday airfield (Appendix 4)

Sanday airfield is positioned 20 nm north northeast of Kirkwall Airport, at an elevation of 66 feel amsl. It has three grass runways, each defined by standard white painted panels set into the turf. The position of the runways is further highlighted by red and white chequered boards on the dry stone walls near the end of each runway.

Runway 11, which the commander selected for landing, is 1,302 feet (397 metres) long and 98 feet (30 metres) wide. The stone wall at the western end is situated 197 feet (60 metres) from the start of the runway and the runway ends 154 feet (47 metres) before the wall at the eastern end.

The centreline of the final approach to runway 11 passes just to the north of a school positioned some 1,800 feet (550 metres) from the airfield boundary.

The sole services provided are a windsock and a wooden hut which serves as a terminal building.

1.11 Flight recorders

Recorders were neither fitted nor required to be fitted.

1.12 Wreckage and impact information

1.12.1 *Impact sequence* (see diagram at Appendix 5)

From examination of the ground marks and the airframe it was established that the aircraft initially contacted the ground in a field covered with grass 6–9 inches high, situated immediately before Sanday airfield, close to the extended centreline and 450 feet (137 metres) from the threshold of runway 11. It touched down firmly on its left main undercarriage whilst travelling on a track of 065°M. The aircraft attitude at this point was determined as nose high (between 5° and 10°), left wing low (between 7° and 15°) and with left yaw of 18°. It then rolled to the right and pitched down to make ground contact with its right main and nose undercarriages as the left main wheels momentarily left the ground. As the aircraft moved forward the heading and track became aligned onto 049°M until, after travelling some 205 feet (60 metres), it ran diagonally across a farm track which was bordered on each side by a three strand barbed wire fence. It collided with both fences, breaking off a total of 3 fence posts and severing several strands of wire.

The aircraft continued on a track of 052°M for a further 120 feet (36 metres) across a second field covered in short grass, leaving only main wheel tracks, whereupon it encountered a large steep sided hole (locally referred to as "the quarry") some 45 feet (14 metres) in diameter and approximately 15 feet (4.5 metres) deep. At this point the wheels simultaneously struck two discarded soft wooden fence posts lying on the ground, 1 foot (0.3 metres) from the quarry edge and separated by a distance equal to the track of the main undercarriage. The aircraft thus passed over the quarry, its wheel tracks starting again approximately 2 feet (0.6 metres) beyond the far edge, and in doing so had struck its lower rear fuselage on a discarded vehicle in the hole. This point of contact was 2 feet (0.6 metres) below the general surface level of the field and had the effect of removing the aircraft's tail bumper and damaging the surrounding fuselage skin.

The aircraft continued, still solely supported by its main wheels, on a track of 052°M for another 160 feet (50 metres) at which point it impinged upon a small ridge lying diagonally across its path. The ridge, rising approximately 6 inches (15 centimetres) over a distance of 2 feet (0.6 metres) was struck first by the right main wheel and then the left, whereafter the ground marks ceased. However, 400 feet (122 metres) from this point, in a direction of 038°M, the aircraft contacted the ground again with the underside of its left wing tip; from there the aileron mass balance weight cut a groove in the turf some 30 feet (9 metres) in length along a direction of 010°M. Thirty feet beyond the end of this groove the outer left wing, left main undercarriage and right engine nacelle, in quick succession, struck an electrified fence and a third barbed wire fence.

This had the effect of slowing the aircraft and slewing it to the left, such that it skated sideways to the right on the underside of its nose, with the remainder of the aircraft clear of the ground. During this part of the accident sequence the nose leg collapsed to the left and the left main undercarriage leg attachment failed in a rearward sense.

As the aircraft came to rest on a heading of 288°M, some 85 feet (26 metres) into a newly cultivated potato field, the fuselage, right wing tip, right tail-plane tip and right main undercarriage contacted the ground heavily. As it did so, the right undercarriage assembly collapsed rearwards.

The aircraft had travelled a total of 1,065 feet (325 metres) from its initial point of ground contact.

1.12.2 On-site examination

Examination of the aircraft showed it to have been complete prior to the accident, all damage being consistent with the sequence of impact referred to in sub-paragraph 1.12.1.

Significant structural deformation had occurred to the fuselage, wings and right tailplane. The passenger cabin floor had moved several inches to the left, with reference to the roof, and this was sufficient to cause the left propeller blades to slice into the fuselage wall just behind the pilot's position. The propeller blades also displayed compacted earth particles on the leading edges. Although the pilot's entry door could be operated, both passenger cabin doors had jammed but their pull-in windows had been operated successfully.

The engine and aircraft control systems were intact with the exception of the rudder trim control circuit. This had failed at a single point where the circuit entered the rudder, but evidence showed that this failure had occurred during the accident sequence. General structural deformation precluded rigging or functional checks of the primary flying controls but no evidence of jams or pre-impact malfunctions was detected. All engine controls functioned satisfactorily and were correctly rigged.

The aircraft had crashed with the flaps set at 25°, the TAKE–OFF/APPROACH position, and it was determined from their sequencing mechanism that the last movement had been from UP to TAKE–OFF/APPROACH. A functional test showed this system to perform correctly over its full range.

All cockpit instrumentation and selectors were undamaged and most had been turned to OFF. The following basic positions/readings were noted:

(i)	Left throttle	½ inch open
(ii)	Right throttle	⅛ inch open
(iii)	RPM levers	Both fully forward (maximum RPM)
(iv)	Carburettor heat levers	Both selected to cold air
(v)	Fuel cocks	Left selected to left engine Right selected to right engine
(vi)	Altimeter sub-scales	Left – 1006 mb Right – 1002 mb

(vii) Rudder trim	Slightly nose left
(viii) Elevator trim	Neutral
(ix) Fuel contents	115 kg per side, wings level
(x) Emergency static source	Closed

A calibration/leak check was carried out on the pitot static system which showed it to be serviceable and accurate.

A functional check of the fuel system, including booster pumps, showed this system also to be serviceable and a total of 190 kg of useable fuel, disposed equally between the two wing tanks, was decanted from the aircraft.

A functional check of the stall warning system was carried out and, although it could not be calibrated, the vane moved freely, the heater element was serviceable and audio and visual warnings functioned correctly.

1.12.3 Subsequent examination

The engines, propellers and associated equipment were examined in detail at the operator's maintenance base at Kirkwall and at their respective overhaul agencies. No sign of mechanical failure, seizure, leakage of oil or fuel, overheating or of birdstrikes was detected. The ignition, fuel and aspiration systems were found to be serviceable, but the spark plugs from the right engine were all covered in sooty deposits. These plugs however, functioned satisfactorily on test, and it was noted that this type of plug is not as efficient in its self-cleaning capability as those fitted to the left engine. The left engine, after appropriate checks, was returned to service.

Compression checks on the cylinders proved satisfactory, except for No. 3 cylinder on the right engine, which recorded a zero value. Removal of this cylinder and its valves revealed the exhaust valve to be in poor condition, with signs of overheating and scoring being exhibited by the stem and valve guide. The seating surfaces, both on cylinder head and valve, were pitted and blackened. Such conditions are unlikely to have markedly affected the power output of the engine.

Samples of fuel and oil from each engine were sent for analysis and no significant abnormalities were detected. The findings of this analysis included a statement that "the oil would appear to be consistent with used Shell W.80 oil exhibiting some oxidation. The starboard engine sample would appear to be the more heavily oxidised of the two."

1.13 Medical and pathological information

On 29 May the commander had returned from 33 days of sick leave. He had been re-examined and passed as fit to fly by a Civil Aviation Authority (CAA) approved doctor on 28 May, and had completed three days flying duties immediately prior to the accident.

1.14 Fire

There was no fire.

1.15 Survival aspects

Despite the severe damage to the fuselage no seat belts failed and the evacuation was carried out without incident.

The commander and three passengers escaped from the emergency window in the left crew door and, although the left cabin door had jammed due to distortion of the fuselage, the remaining four passengers escaped from the 'pull out' window in that door.

1.16 Tests and research

A fleet aircraft was loaded to conditions of weight and centre of gravity similar to those of the accident aircraft. It was then flown by a Company training captain on a typical island flight; he reported that the aircraft handled normally.

1.17 Additional information

1.17.1 The relevant regulations

The production of an Operations Manual is the responsibility of the Operating Company and is necessary to the granting, by the CAA, of an Air Operator's Certificate. The Flight Operations Inspectorate (FOI) of the CAA are responsible for ensuring that this Manual is produced in the proper fashion as laid down by the CAP 360 Part One. However, it remains 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.

Relevant extracts from the Air Navigation Order and Regulations, the CAP 360 Part One (Air Operator's Certificate), the ICAO Document 8168 Pan/Ops and the Company's Operation Manual are provided in Appendix 1 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. The Company has now completely revised its Operations Manual to provide a section specific to the inter-island services, which includes, inter alia, a minimum en-route altitude of 350 feet.

1.17.2 Accident/incident statistics

Prior to this accident there have been two minor accidents during the 17 years of this Company's operation; neither involved injury to any person.

In addition, since April 1978 the Company has suffered some 12 incidents related either to airmanship or to pilot handling in difficult conditions of wind and turbulence. However, this number must be read in the context of the very large number of sectors flown during the period.

1.18 New investigation techniques

None.

2. Analysis

2.1 General

The post-crash examination of the aircraft gave no indication that there was any failure or malfunction which could have contributed to the accident and it must be concluded that the wing drop and high rate of sink which preceded the first ground impact were symptomatic of a stalled condition, from which the pilot was unable to recover in the height available. The various factors which may have contributed to the commander finding himself in this situation are discussed in detail below.

2.2 The en-route phase

In preparation for the flight to Sanday, the commander was provided with a meteorological Area Forecast and the two verbal reports from the airfield attendants. Area Forecasts do not attempt to predict specific local conditions which can be, and indeed often are, quite different from the overall situation. This fact, together with the normal difference in the 'actual' conditions between Kirkwall and the north-eastern islands, is well known to both the Meteorological Office and the local pilots. It was therefore perfectly reasonable that the commander should have decided, with the improving Kirkwall weather, to take off for Stronsay despite the Area Forecast conditions.

The commander's decision to fly the 6 mile sector from Stronsay to Sanday at 300 feet amsl merits careful examination, since the concept of a public transport flight being carried out at this altitude may well give rise to public concern.

The Air Navigation Order states in effect that a flight undertaken at low altitude and outside controlled airspace conforms with the Visual Flight Rules provided the aircraft is flown below 140 knots, remains clear of cloud, in sight of the surface and in a flight visibility of at least 1 nautical mile; provided also that it does not fly closer than 500 feet to any person, vessel or structure, except when taking-off or landing. From the available evidence it would seem that, on the flight from Stronsay to Sanday, the commander conformed with these conditions; the 5 minute sector is flown very largely over the sea and the islands themselves are sparsely inhabited. The question then arises: is a flight in compliance with these rules, as they stand, compatible with safety; or, if not, do the rules require reconsideration in any respect?

The Company's previous safety record in the 17 years of operation on these routes has been generally satisfactory, bearing in mind the type of operation, involving as it often does, 'island hopping' in the vicinity of hilly ground in rapidly fluctuating, and frequently poor, weather conditions. The inclement weather at the time was obviously a pre-condition for this accident; however, it must be appreciated that on these 'highlands and islands' routes, if flights were to be conducted solely in fair weather conditions, many destinations would be without air services for long periods and that, for many islands, these services are essential to the continued existence of the community. It is also clearly impracticable to provide, at the small aerodromes concerned, the sophisticated aids required for operation under Instrument Flight Rules. The record suggests, however, that provided the subject flights are flown in a professional manner by experienced pilots who know the routes well, a standard of safety can be achieved comparable to that obtaining on more orthodox public transport routes.

Nevertheless, the subject accident has highlighted the absence of any requirement for a minimum height limitation on the en-route phase of a flight, be it private or, more importantly, public transport, carried out under these conditions. It is understood that the Company, in agreement with the CAA Flight Operations Inspectorate, has now prescribed a minimum en-route altitude and a new minimum visibility requirement to be satisfied before a descent may be commenced below this altitude.

2.3 The initial approach

The aircraft approached Sanday aerodrome at some 300 feet amsl in what must have been marginal conditions of visibility. Interpretation of the relevant regulations and sections of the Company Operations Manual in the context of this type of approach is no easy matter. However, it must be concluded that, provided the commander conformed to the Visual Flight Rules, that is, remained within sight of the surface and with a forward visibility of at least one nautical mile, there was no reason why he should not have continued, as he did, straight into the downward leg for a low-level circuit and landing on runway 11. His subsequent decision to climb away on losing sight of the airfield was clearly the correct one.

2.4 The subsequent approaches

It is more difficult to justify the commander's later decision to return for another attempt to land at Sanday, having already experienced the poor visual conditions there. No doubt he believed that the breaks in the cloud, which he had not seen during his initial approach to Sanday, signified the same sort of sudden improvement in the weather as he had witnessed at Kirkwall and for which the islands are known. It is also possible that the psychological pressures provided by his desire to accomplish the task, and the knowledge that his recent sick leave had already burdened the Company's three other Kirkwall-based pilots, weighed upon the mind of this relatively inexperienced commercial pilot. His appreciation of the passengers' reliance upon this service and the islanders' special relationship with the Company were factors which could also have affected his judgement.

Bearing these factors in mind, the decision to attempt this, second, approach is perhaps understandable but having failed, again, to recognise his turn-in point, his persistence in making yet another attempt suggests that he was motivated more by the factors detailed above than by the dictates of sound airmanship.

As previously discussed, this type of 'island hopping' operation requires a particular combination of skill and experience. Although the Company requirements for the introduction into line service of pilots joining them would appear adequate in most respects, in this case the commander had only recently joined the Company and, although considered of above average ability, had had no previous experience of this type of operation; furthermore he was relatively inexperienced on the type and had had relatively little exposure during his route checks to the poor weather that can make the role so demanding. It is understood that the Company has now revised its requirements to ensure that new commanders have supervised exposure to poor weather conditions.

2.5 The accident sequence

2.5.1 Events leading to the initial impact

The manner in which the aircraft developed an uncontrolled descent, with one wing dropping, strongly suggests an incipient or established stall condition, as a result of which the aircraft turned through some 55° to the left before contacting the ground.

Although no evidence could be found of any malfunction of the aircraft or its engines, conditions at the time of the accident were strongly conducive to the formation of curburettor icing; therefore it remains a possibility that, despite correct carburettor heat selections, such icing did occur to some extent during the approach. However, the very short interval between heat selection and the application of full throttle suggests that the degree of loss of power due to icing would have had little or no significance as regards the ability to regain the normal glide-path. The same can be said regarding the condition of the one suspect cylinder of the right engine.

In the ambient temperature conditions prevailing, airframe icing could not have been a factor. Similarly, the small variations of estimated wind speed at the time were insufficient either to produce significant turbulence or to promote the onset of a stall.

Although the commander had not, in fact, selected the flaps from the TAKE–OFF/APPROACH position to the LANDING position, this omission should only have increased the stalling speed by some 3 knots, a comparatively insignificant amount in the context of a normal approach speed of 60–65 knots versus a stalling speed in the region of 35–40 knots. The 'tremor' which the commander noticed and which he associated in his mind with the selection of LANDING flap must be presumed to have been pre-stall buffet.

The commander would probably have been able to recover the aircraft from either the low speed condition or the stall had he appreciated its occurrence in time. A pilot is normally made aware of the aircraft's approach to a stall by instrument indications, assisted sometimes by external visual cues or by aerodynamic buffet and, in the case of the Islander, by the aural and visual stall warning device. On this occasion, it seems likely that the difficulty in aligning his aircraft with the runway in poor visibility diverted the commander's attention from the flight instruments, thereby denying him information about either the aircraft's attitude or the rate at which the airspeed was decreasing.

The aural stall warning system should have been calibrated so as to operate at some 10 knots before the onset of the stall. Although the calibration could not be checked after the accident, the system was found to be serviceable and there was no evidence that it was incorrectly set. Therefore, the most likely assumption must be that the airspeed was decreasing rapidly as the aircraft arrived on short final approach and that the time interval between the warning and the stall was consequently very small.

For whatever reason, it is clear that the application of engine power came too late to prevent the aircraft from striking the ground at a speed too low to permit it to become properly airborne again, despite the application of full throttle.

2.5.2 *The ground run*

Following the initial, and not excessively heavy, impact, the aircraft continued along the ground with, as the commander recollects, full throttle selected. However, since the aircraft had crossed the quarry without effectively gaining or losing height, it is clear that it never regained flying speed. Examination of the Islander's take-off performance graphs shows that, under normal circumstances, the aircraft could have achieved flying speed within the distance between the initial and final impacts. It is however impossible to quantify the combined effects on the aircraft of the passage through the wire fences and an uphill, out of wind, ground run, much of it over a rough surface. Therefore it cannot be determined whether the failure to regain flying speed was due to the form of the ground run or because of any reduction of engine power occasioned by carburettor icing, or a combination of both.

It may well be that the commander had suffered some degree of shock as a result of the initial impact with the ground, and that his instinctive desire to get the aircraft airborne again caused him to leave the throttles open during the ground run. However, it seems likely that, had he closed them and applied full braking immediately after the first impact, the aircraft would have stopped before sustaining any serious damage.

2.6 The regulations

In this operation, little meteorological information about the outlying destinations and few, if any, instrument landing aids are available to the commander. Consequently he is frequently required to rely upon his own judgement, based on experience and local knowledge. However, he must also comply with the regulations contained within the ANO and the Company Operations Manual. It is therefore essential that these are explicit and readily intelligible so that the commander is left in no doubt as to the occasions when the regulations allow or require him to use his own judgement, and to what degree. The difficulty in the interpretation of the rules and their applicability or otherwise to this type of approach suggests that some clarification is needed. Although there is no suggestion that this lack of clarity was contributory to the accident, the Company have now revised their Operations Manual. It is understood also that the CAA are considering a revision of Article 29 of the ANO.

2.7 Single pilot operation

The problems of single pilot operation during VMC flight in conditions of poor visibility and low cloudbase are centred mainly on the pilot's ability to divide his attention between navigation or terrain clearance and control of the aircraft. The workload involved in carrying out these tasks is greatly increased when the aircraft is not in stable cruise flight and the requirements of power, descent rate, speed and direction are continually changing. It is evident that, on this occasion, the workload was sufficiently heavy that the required attention to all its facets became degraded. Whilst it is apparent that the greater the pilot's experience in the task and on the specific type, the better he is able to cope with an extended load, there must also be a presumption that, with two pilots to share the tasks and monitor each other's operation, a hazardous situation such as this should be avoided. A recommendation on the subject was made to the CAA in Aircraft Accident Report No. 6/83 on the accident to Bandeirante G–OAIR. Although the regulations on the subject remain unchanged, it is understood that certain revisions are under consideration by the CAA.

3. Conclusions

(a) Findings

(i) The aircraft was correctly loaded and its documentation was in order.

(ii) No evidence was found to suggest that a mechanical malfunction of the aircraft or its engines contributed to the accident.

(iii) The commander was properly licensed and medically fit to conduct the flight.

(iv) The commander had fulfilled the Company training requirements which were, in general, adequate, but his experience of the precise conditions prevailing on the day of the accident was low.

(v) The commander's decision to attempt a third approach, after the failure of two previous attempts due to the weather, was injudicious.

(vi) During the final approach the aircraft entered a stalled or semi-stalled condition with a resultant loss of control at a height which was too low for recovery.

(vii) Had the commander closed the throttles immediately after the first impact it is likely that little or no damage would have occurred to the aircraft.

(viii) The extent of carburettor icing which may have been present would have been insufficient to have contributed to the initial loss of control of the aircraft although it could have affected the aircraft's ability to become airborne again after the first impact.

(b) Cause

The accident was caused by the commander's decision to continue a low level VFR flight in meteorological conditions which were inappropriate. His low experience of the task was a contributory factor.

4. Safety Recommendations

It is recommended that:

4.1 The current regulations concerning crew complement in aircraft engaged on public transport flights, and having a maximum authorised weight not exceeding 5,700 kg, be reviewed.

4.2 Companies operating under an Air Operator's Certificate should be required to prescribe minimum en-route altitudes approved by the Authority.

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