

BN2A-26 Islander, G-BEDZ, 19 May 1996

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Aircraft Type and Registration:	BN2A-26 Islander, G-BEDZ
No & Type of Engines:	2 Lycoming O-540-E4C5 piston engines
Year of Manufacture:	1976
Date & Time (UTC):	19 May 1996 at 2336 hrs
Location:	Griesta, near Lerwick, Shetland
Type of Flight:	Public Transport (Air Ambulance)
Persons on Board:	Crew - 1 - Passengers - 2
Injuries:	Crew - Fatal - Passengers - 1 Serious, 1 Minor
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	3,879 hours (of which 305 hours were on type) Last 90 days - 101 hours (14 hours at night) Last 28 days - 14 hours (3 hours at night)
Information Source:	AAIB Field Investigation

History of the flight

The pilot was one of three based at Tingwall airstrip, Lerwick, operating Britten-Norman Islander aircraft on scheduled and air ambulance flights. He had been resident in the area since September 1995 and had operated the majority of his flights into and out of Tingwall. The accident occurred during a night time recovery to the aircraft's home base following a medical evacuation flight. The aircraft crashed short of the runway whilst attempting to land after a previous discontinued approach in strong gusting cross winds.

The medical evacuation flight

At 0815 hrs on the day of the accident the pilot operated an air ambulance flight from Tingwall to Fetlar. Upon his return to Tingwall at 0853 hrs he went home on standby duty. During the remainder of the morning and that afternoon he was engaged in domestic activities with his family.

Meanwhile, at the local hospital a patient was being made ready to be transferred from Tingwall to Aberdeen by air ambulance. At approximately 1730 hrs the pilot received a call from the hospital advising him that the air ambulance flight would be required. At 1735 hrs, having partaken of tea and supplied with a flask of coffee and sandwiches, he left his house for the airstrip. Two nurses had been assigned to accompany the patient on the flight but because of the patient's condition it was later decided that a doctor should replace one of the nurses. After examination by the doctor it was decided to delay the journey to the airstrip pending the results of an x-ray examination. The pilot was advised of the delay and at 1930 hrs he returned home briefly to collect some forgotten paperwork.

The flight had been originally planned to Aberdeen but, due to adverse weather conditions at Aberdeen the flight was re-planned to Inverness. The aircraft departed Tingwall at 1953 hrs and landed at Inverness at 2134 hrs. The recorded wind conditions for the departure were 070°/15 kt. The doctor, who for this flight occupied the 'nurses seat' adjacent to the stretcher, described the outbound flight as routine with good flying conditions except for moderate turbulence during the initial departure from Tingwall.

Return flight to Tingwall

At Inverness the patient was transferred to a waiting ambulance and the doctor and nurse stowed the medical equipment for the return flight. Having obtained a weather update the pilot advised the doctor that there were no problems for the return flight. A fuel receipt from Inverness timed at 2140 hrs, confirmed that the aircraft uplifted 184 litres of AVGAS 100LL fuel (cruise consumption 109 litres per hour).

The aircraft departed Inverness at 2203 hrs. At 2212 hrs the aircraft was radar identified and two minutes later the pilot reported reaching FL 070. For most of the flight the doctor dozed on the stretcher whilst the nurse slept on the rear bench seat. He only returned to sit down and strap in on the left beside her during the descent into Tingwall.

At 2258 hrs the pilot requested the latest Lerwick weather. After a six minute delay the controller radioed that the Lerwick weather was "SURFACE WIND 100°/24 KT GUSTING 37KT, RECENT RAIN, VISIBILITY 12 KMS, CLOUD 4 OKTAS OF STRATUS AT 400 FEET, SIX OKTAS OF STRATUS AT 700 FEET, EIGHT OKTAS OF STRATUS AT 1,000 FEET, PRESSURE SETTING 1007.8 MB". The pilot replied "THAT'S ALL COPIED THANKS, AND I'LL BE LEAVING FL 70 INITIALLY 2,000 FEET TOWARDS SUMBURGH". At 2323 hrs the pilot radioed that he would probably lose radio contact with Scottish shortly and that he would be changing to Tingwall in a couple of miles.

At 2300 hrs the two Tingwall fire attendants opened the airstrip for the returning flight. The airstrip lights were turned on and the fire appliance made ready. The firemen reported that, sometime later, the pilot radioed Tingwall asking for the wind speed and direction. This was passed as 090° to 120°/20 kt. One of the firemen also reported that at the time there was very fine drizzle but the visibility was good.

Analysis of recorded radar data from the radar head at Sumburgh confirmed that the aircraft routed over Lerwick and then flew north turning west inland over Kebister Ness. The doctor reported that, on approaching Lerwick he could see the lights of the town and the visibility was good enough for him to identify his house. The aircraft then turned southwards to join downwind right hand for Runway 02. The doctor stated that there were not many lights on the ground to the north of the

airstrip but some to the south in the vicinity of Veensgarth. He also stated that the ride at this stage was moderately turbulent.

At the end of the downwind leg the aircraft banked 'sharply' to the right to position on finals. It had, however, been blown through the centreline by the gusty easterly wind and was to the left of the required approach. The doctor confirmed that although the aircraft appeared to be at the correct height for its position he could see that when they were lined up the airfield lights were to the right of the windscreen. The pilot, unable to complete the approach, carried out a go-around to the left of the runway, climbed to 550 feet and turned right to enter the downwind leg again. The doctor reported that the engines sounded normal throughout this manoeuvre and the runway lights were clearly visible again as the aircraft became established on the downwind track.

Several witnesses saw the aircraft fly downwind and turn onto the final approach. One witness, positioned on higher ground to the east of the runway threshold, stated that the aircraft flew downwind along the line of the houses at Veensgarth and 'as it turned it descended all the while'. Radar information shows that for this second attempt the pilot extended the downwind leg by approximately 800 metres before turning towards the airfield. The rapid turn onto finals was described by the doctor as being very steep but without the increase in 'g' that he would have expected for such a steep angle of bank. The nurse described the sensation as 'the aircraft dropped, with my cheeks and whole body being forced upwards'. Throughout the turn the pilot was seen by the passengers to be generally looking to the right, presumably for the airfield. Seconds later the aircraft hit the ground.

After the impact the nurse found herself still in her seat with the aircraft in an upright position. She was relatively uninjured and soon released her seatbelt, released her trapped right foot and struggled clear of the wreckage through the open right rear aircraft window. She ran around the tail section to the doctor and released debris from around his head. Unable to move him because of his injuries, she ran to a nearby house to summon the emergency services. The doctor, although seriously injured, remained conscious throughout and managed to clamber clear of the aircraft to lie on the ground some ten feet from the wreckage. The pilot had received fatal injuries at impact.

Meteorological information

An aftercast obtained from the Meteorological Office, Bracknell reported that the synoptic situation for the area at 0000 hrs UTC on 20 May 1996 showed a complex area of low pressure, 994 mb, centred over south west Scotland that was maintaining a strong to gale force east to south east airstream over the route from Inverness to Tingwall. At midnight there was an occlusion lying northwest/southeast midway between Shetland and Orkney. The weather consisted of occasional rain with a visibility of 8 to 15 km with scattered cloud at 500 feet and broken to overcast cloud conditions at 700 to 1,000 feet. The surface wind was 110°/25 gusting 36 kt, while the wind at 2,000 feet was 130°/40 kt. The sea level pressure was 1007 mb with a temperature of +7°C, dewpoint +6°C. The zero degree isotherm was at 7,000 feet.

The Lerwick observatory (6.8 km south-east of Tingwall and 269 feet amsl) weather observations for the period were: at 2247 hrs; wind 100°/24 kt, visibility 12 km with recent rain, cloud 4 oktas at 400 feet, 6 oktas at 700 feet, 8 oktas at 1,000 feet. and at 2349 hrs; wind 110°/25 kt, visibility 15 km in rain, cloud 2 oktas at 500 feet, 6 oktas at 800 feet and 8 oktas at 1,100 feet.

Pilot experience

The pilot started his flying career in May 1983 and gained his PPL in September 1983 with an IMC rating added on 4 October 1987. He continued to fly light single engine aircraft for pleasure until April 1988 when he converted to twin engine aircraft. He completed an abridged Basic Commercial Pilot's Licence (BCPL) course in November 1988 and one month later gained his Basic Commercial Pilot's Licence. A year later he became an Assistant Flight Instructor. In May 1991 he gained his Commercial Pilot's Licence and joined the operating company flying the DHC-6, Twin Otter. He converted to the Shorts SD 360 as a co-pilot in September 1993 and later, in August 1995, converted to Britten-Norman BN2 as a Captain.

His most recent Line Check, Base Check and Instrument Rating renewal were completed on 7 February 1996. His company airfield clearance certificate, allowing him to operate into the category 'B' airfield of Lerwick (Tingwall) was signed on 22 August 1995.

The pilot had flown a total of 483 hours at night of which 16 flights had been flown at night within the 6 months preceding the accident. This included eight night landings at Tingwall and two when the wind was in excess of 20 kt (140°/20-32kt and 230°/35-50 kt).

Company actions

Since the accident the aircraft operator has amended its Operations Manual, Part 16 'Shetland Inter Island Service Route Guide' by adding under the section 'Weather Minima En-Route', the following:

'Pilots with less than 1 year's experience in theatre will have increased minima applied at night. The en-route minima on direct tracks between aerodromes will be -

- a) Cloud base 1,000 feet QNH.
- b) Inflight visibility 5 km and visual contact with the land or sea surface.
- c) Absolute wind limit of 30 kt.

Pathology and Medical certification

Post mortem examination of the pilot did not reveal any pre-existing medical conditions that could have affected his performance or contributed to the accident.

The pilot held a Class One medical certificate with no restrictions that was issued on 29 April 1995. The medical certificate issued to a Commercial Pilot under 40 years is valid for 12 months plus the remainder of the month of issue. The pilot's medical certificate had therefore expired on 30 April 1996 (19 days before the accident flight). He had however made an appointment to see his Authorised Medical Examiner (AME) during the week of the accident. He had apparently miscalculated the expiry date of his medical, believing it to expire at the end of May 1996. His certificate also specified that an ECG examination needed to be completed on or before the end of April 1996.

The Air Navigation Order 1989 (2) Article 21 Paragraph 8 sub para(a) states: "The holder of a licence, other than a flight radiotelephony operator's licence, granted under this article, shall not be entitled to perform any of the functions to which his licence relates unless it includes a valid medical certificate".

The operator's crew records system, whilst correctly recording the date of a pilot's last medical, did not draw attention to the fact that the pilot had not revalidated his medical category. Since the accident the operator has revised the system of recordkeeping so as to prevent a recurrence of this oversight.

Flight Time Limitations

The Company Flight Times Limitation Scheme, forming part of the Operations Manual and which is approved by the Civil Aviation Authority, details the maximum length of duty that can be undertaken by a pilot.

The pilot started his duty at 0740 hrs (35 minutes before the departure time of 0815 hrs) for the first flight of the day, and went off duty at 0910 hrs (17 minutes after landing at 0853 hrs). He then went home, free from duty, to be available for air ambulance callout.

The company Operations Manual Part 1 para 1.3.11 Table 'C' shows the crew duty time and maximum flight duty period (FDP) allowed for single flight crew. It states:

For a start of duty between 0700 and 1259 hrs, operating up to 4 sectors, the pilot is allowed a FDP of 11 hours (without using discretion). This can be extended under the split duty scheme by half of the intervening rest period.

The pilot was alerted for a further ambulance flight at 1730 hrs for a take off at 1900 hrs. His second duty period therefore started at 1830 hrs (30 minutes before the planned take off). This therefore had resulted in a split duty rest period of 9 hours and 20 minutes allowing an increase in overall duty time by 4 hours and 40 minutes (half the rest period) to a total of 15 hours and 40 minutes. Having started duty at 0740 hrs in the morning the latest permitted finish time was 2320 hrs without the use of discretion. The accident occurred at 2335:50 hrs thus the pilot had exercised his discretion and extended his duty time by 15 minutes.

Aircraft history

The BN-26-2A Islander is a high winged, fixed tri-cycle undercarriage all metal monoplane, powered by two normally aspirated Lycoming O-540 piston engines. These 260 HP engines each drive a two bladed constant speed propeller. In normal operation seating is available for 10 passengers but G-BEDZ was configured in the air ambulance role with two seats at the front (pilot and passenger), two at the rear, one half way along the cabin on the right and a stretcher occupying the centre part of the cabin on the left. G-BEDZ was built in 1976 and had been owned by the operator since new on the Highland and Island routes. During this time the aircraft had flown for some 14,700 hours and conducted some 39,000 flights.

Impact Parameters

The aircraft had crashed onto grass covered gently rising ground at location N60°10'35, W000°1'25, narrowly missing several houses. This position was 1.5 km to the south of, and approximately 0.3 km to the left of, the extended centreline of Runway 02 at Tingwall. The aircraft's track at the time of initial contact with the ground was 335°M, approximately 45° off the runway heading, whilst in a right wing low attitude of some 70° and a nose low attitude of approximately 20°. Its groundspeed at this time was estimated at 125 kt. Contact with the ground by the right outer wing precipitated failure of the outer wing structure, and caused the aircraft to cartwheel onto its nose, approximately

27 metres (90 feet) from the first point of impact. During this sequence the right engine, complete with propeller, detached from the airframe and came to rest some 92 metres (300 feet) along the wreckage trail. As this engine detached, the propeller left several equi-spaced slash marks in the surface. By the time its nose struck the ground, the fuselage was pitched down by some 60° and at this point severe structural disruption occurred in the region of the cockpit. The abrupt deceleration experienced by the forward end of the fuselage allowed its rear section, due to the momentum of the fin and rudder, to fold over the top of the wing centre section until the tip of the rudder made contact with the ground. The disruption to the cockpit area released the pilot and his seat from the surrounding structure. From this point the aircraft tumbled for a further 61 metres (200 feet), passing through two wooden post/wire fences and a substantial wooden power wire support pole from which it received significant further damage, before coming to rest. Despite the disruption of both wing fuel tanks and large areas of fuel soaked grass throughout the wreckage trail, there was no fire. The primary wreckage trail was some 92 metres (300 feet) long, although the right main wheels assembly had been thrown a further 137 metres (450 feet) beyond the main part of the wreckage.

Wreckage Examination

Structure

Despite the apparent severe nature of the damage to the aircraft, almost all of the structural elements were available for inspection, and it was possible to determine that the aircraft had been complete and structurally intact prior to the accident. All damage and failures examined were consistent with having occurred during the impact sequence.

Flight Controls

With the exception of the flaps, the flight controls on the Islander are manually controlled and are relatively simple systems. Examination revealed no evidence of pre-impact failures or disconnection, or evidence of jamming by any foreign objects within these systems. There was consistent evidence throughout the wreckage that, by the time the cockpit struck the ground, the controls were positioned such as to recover the aircraft from its attitude at impact, *ie* up elevator and full left aileron. All trim systems were found set close to their neutral positions and the electrically operated flaps were at the mid, take off/approach, setting.

Instruments

The instrument panels, complete with most of the flight instruments and avionics, had survived the impact in remarkably good condition, with few sustaining serious damage. The Airspeed Indicator, Vertical Speed Indicator, Altimeter (found set at 1007 mb) and both artificial horizons (one vacuum driven, one electric) were taken to an overhaul agency for examination and test. Here it was established that all these items could be functioned and, after applying a makeshift patch to a hole in the case of the VSI, all calibrated within normal test limits and were consistent in their operation. The severity of the damage to the aircraft precluded a full check of the pitot/static system, although all breaks in the piping/tubing were consistent with having occurred during the accident. The components of the stall warning system, *ie* the wing leading edge flow sensor microswitch and stall warning horn were tested and found to operate correctly, although the sensor had been deformed in the accident. Filament analysis of the available instrument illumination light bulbs revealed all to have been ON at the time of the accident. The stall warning light was not recovered, but the 'doors shut' warning light was found to have been OFF at impact.

Engines

Damage and witness marks between the engine control levers in the cockpit and their support structure indicated that the power levers had been set to approximately 50%, the propeller pitch control levers to fine pitch and the mixture controls to rich. These settings are consistent with the approach to land phase of the flight and no disconnections were found between any of these levers, their respective Teleflex cables or control levers at the engines. There was evidence from the general distortion of the blades of the right propeller, and damage to their leading edges, to indicate that this engine had been turning under power at the time of impact.

As the aircraft cartwheeled onto its nose, the engine detached from the airframe leaving several slash marks in the surface. If it is assumed that the propeller was turning at 2500 RPM, as indicated by the control lever in the cockpit, then the aircraft would have been travelling over the ground at approximately 100kt at this time. In addition, several pipes from the exhaust system of the right engine, which became detached and lobbed along the wreckage trail, were found to have scorched the grass where they came to rest. It was evident that the left propeller had also been rotating under power at impact, the damage to the blades being similar to that on the right propeller. Strip examination of the propeller hubs revealed only impact related damage, witness marks and the position of the pitch controlling piston indicating the both propellers had been located towards the fine pitch end of their range of movement. Functional tests carried out on the propeller constant speed control units showed both to perform correctly.

Functional and/or strip examinations were carried out on the engines and their ancillary equipment. Both engines were free to rotate and it was established that no pre-accident mechanical failures had occurred to either their rotating components, gear trains, crankcases or cylinders. All four magnetos, although slightly damaged, and the 24 spark plugs, were functioned and assessed as being serviceable prior to the accident. Both the oil and air filters were free from pre-accident damage and contamination, and a strip inspection of the carburettors, fuel and vacuum pumps revealed only impact damage. Both carburettor air intake boxes were found in the cold air settings, as were their respective operating controls in the cockpit.

Fuel System

The fuel tanks are located in the wing immediately outboard of the engines, and are formed by a sealed section of the wing structure. The nature of this accident was such that both wing tank areas were severely disrupted, all fuel being released along the wreckage trail. It was not possible to determine the exact quantity of fuel contained at the time of impact, but the large extent of fuel stained ground throughout the trail allowed the possibility of fuel exhaustion to be discounted. Examination of the fuel lines to the carburettors, and all other fuel system components failed to reveal any evidence of pre-accident defects, contamination or the presence of water.

Electrical System

There was no evidence of failures/arcing/burning within the electrical system components and wiring looms. The battery, which had survived the accident almost undamaged, was tested and found to be serviceable. This, in conjunction with witness evidence of radio operation, transponder returns, witness and technical evidence of internal and external lights being illuminated, dismissed the possibility of any significant failure in the electrical system having contributed to the accident.

Survivability

The lack of any significant damage to the primary flight instruments suggested relatively low levels of shock loading which the pilot might possibly have survived. However, it was apparent from the impact sequence that the cockpit area was the first part of the fuselage to strike the ground. With a minimal amount of structure forward of the cockpit to deform, and alleviate the shock loading, sufficiently high decelerative forces were generated which severely disrupted the local airframe, failed the pilot's seat attachment to its mounting frame and the left set of legs securing the frame itself to the cockpit floor. Additionally, the pilot's diagonal strap had suffered a tensile failure at the position where it passed through a support loop at the top of the cabin sidewall. Although both halves of the pilot's lap strap were intact and had remained attached to the seat mounting frame, no damage was evident to the buckle mechanism, which was found undone. The two occupants who survived the accident were seated together on the rearmost double seat. This was fitted with lap strap harnesses only, which were reportedly being used, and neither these nor the seat structure/floor attachments, failed in the impact. The occupant of the right seat received only superficial injuries whilst the left seat occupant was more seriously injured. Analysis of the wreckage showed that this section of the fuselage had been deformed by being forced into a roughly curved shape by the action of the momentum of the fin, rudder and rear fuselage nodding forwards and upwards in relation to the wing, as the forward fuselage struck the ground. In doing so, the right sidewall of the rear cabin remained largely intact and relatively undistorted, whilst the left sidewall crumpled. The space immediately forward of this double seat was not penetrated significantly by any wreckage. These factors, and the load attenuating effect of airframe distortion forward of this location during the impact, appear to be the main reasons for the less severe nature of the injuries sustained by the occupants seated at the rear of the aircraft.

Documentation

The aircraft possessed a valid Certificate of Airworthiness, which was due to expire on 26 November 1996, a Certificate of Maintenance Review valid until 2 July 1996. All required maintenance was recorded as having been carried out and there were no defects recorded in the Technical Log or Deferred Defects lists of any significance in the context of this accident.

Airfield circuit environment

The airfield is situated in a sparsely populated 3.4 km wide shallow valley 6.4 km north-west of Lerwick. The valley is orientated approximately north/south and the runway at Tingwall 02/20 is aligned along the valley floor. The line of hills 1.8 km west of the runway, rise to a height of 394 feet, while the hills 1.8 km to the east rise to a height of 485 feet. South-east of the airfield, at a range of 1.2 km, lies the small community of Veensgarth. A small group of houses within the community is spaced along a road aligned directly beneath the track flown by an aircraft carrying out a right hand visual circuit to land on Runway 02 at Tingwall. Recorded radar data shows that this line feature, visible at night because of the lights from the houses, was overflown by the aircraft just prior to the accident. In order to maintain this track the pilot would have allowed for the strong gusting easterly wind (estimated to be 110°/30 kt at 500 feet agl) by heading 20° into wind (*ie* heading 180° at an IAS of 85 kt).

Runway acquisition

The pilot's view from the aircraft's left hand seat of ground features on the right of the aircraft is restricted due to the position of the right wing, engine and landing gear strut. Because of this the runway lights and threshold are not visible to the pilot after passing abeam the threshold when flying downwind, at approximately 500 feet amsl, in a right hand visual circuit in calm conditions.

Furthermore sight of the runway is lost earlier if corrective drift to the left is applied. Pilots current on type suggest that the runway only becomes visible again when the pilot has approximately 30° of his final turn to complete. Earlier acquisition of the runway can be achieved in the turn if the pilot leans forward in his seat when looking to the right.

The pilot of the accident aircraft had applied drift downwind and hence not only had he to turn through 180° at the end of his extended downwind leg but also through twice the drift angle (40°). A resultant turn through 220°. He had already overshot the runway extended centreline to the west on his first approach and hence would have known that he had to increase his bank angle during the final turn if the aircraft was to be correctly aligned with the runway. Visual acquisition of the runway would be further restricted by the high wing during this turn. The final turn was flown towards an area of few ground lights and hence appreciation of height and position was difficult to assess visually until the pilot had acquired the runway lights again. The pilot had to lean forward and look to the right to acquire the runway lights as soon as possible. He also had to maintain a degree of back pressure on the control column in order to maintain height during the high banked final turn. In effect the final turn would have been flown 'blind' until the aircraft was almost in line with and heading towards the runway. The rising ground close to the west and east of the airfield precluded the flying of a wider circuit.

Recommendation 96-68

It is recommended that the Shetland Islands Council, operators of Tingwall airfield, in consultation with the CAA (Safety Regulation Group, Aerodrome Standards), consider installing easily distinguishable lights on the runway extended centreline at a suitable distance from the runway thresholds, in order to assist pilots in visually positioning and correctly monitoring their progress when carrying out visual circuits to either runway in marginal weather conditions by night or day.