BN2A MK.III-2 Trislander, G-BDTO

AAIB Bulletin No: 2/2002	**Ref: EW/C2001/7/1**	**Category: 1.2**
INCIDENT		
Aircraft Type and Registration:	BN2A MK.III-2 Trislander, G-BDTO	
No & Type of Engines:	3 Lycoming O-540-E4C5 piston engines	
Year of Manufacture:	1976	
Date & Time (UTC):	17 July 2001 at 1244 hrs	
Location:	Alderney Airfield, Channel Islands	
Type of Flight:	Public Transport	
Persons on Board:	Crew - 1	Passengers -11
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Aircraft overran runway, single tyre burst	
Commander's Licence:	Airline Transport Pilots Licence	
Commander's Age:	53 years	
Commander's Flying Experience:	11,185 hours (of which 1,235 were on type)	
	Last 90 days - 204 hours	
	Last 28 days - 64 hours	
Information Source:	AAIB Field Investigation	

History of the flight

The commander had been rostered to fly a series of scheduled passenger flights on 17 July 2001. These flights were between various airfields within the Channel Islands and the series began and ended at Alderney. He reported for duty at 0700 hrs having had more than 12 hours rest since his previous duty. The aircraft remained serviceable throughout and the flights were uneventful until the final flight from Guernsey to Alderney. Prior to departure for this flight, the aircraft was refuelled with 88 gallons of fuel; the total fuel state was then approximately two-thirds of the maximum capacity and well in excess of the required fuel for the planned flight. The commander checked the latest meteorological report (METAR) for Alderney. This was timed at 1150 hrs and reported the following conditions:

Surface wind 150°/22 kt, visibility 4,000 metres in heavy rain and mist, scattered cloud at 100 feet and broken cloud at 200 feet, surface temperature +14°C and QNH 996 HPa.

The commander contacted ATC at Alderney by telephone to discuss the meteorological situation and then decided that the conditions were suitable for him to commence the flight to Alderney. The aircraft departed Guernsey at 1220 hrs.

The commander contacted Guernsey Approach shortly after take off and was given radar vectors towards Alderney at 2,000 feet. (Guernsey Approach provides approach services for aircraft bound for Alderney). At 1223 hrs he was informed that the latest update from Alderney reported a visibility of 600 metres in fog. He therefore decided to fly at a reduced speed to Alderney and enter the holding pattern. The aircraft entered the hold at an altitude of 2,000 feet at 1234 hrs. Whilst in the holding pattern the commander received a number of updates to the prevailing conditions at Alderney. At 1236 hrs he was informed that the conditions were:

> "A met visibility of one thousand two hundred metres scattered less than one hundred broken at one hundred but the RVR remains seven hundred metres"

The commander replied that this was below his minima for an approach to Runway 08 using the non- directional beacon (NDB). At 1237 hrs he was informed that the reported meteorological visibility was now 3,000 metres and replied that he required a minimum RVR of 1,200 metres. The commander was then informed that the RVR was now above his limits and he immediately requested an approach. He was given radar vectors to intercept the inbound track for the NDB approach to Runway 08. Whilst being vectored for the approach he was passed an update to the cloud base at Alderney which was now "scattered at one hundred feet and broken at two hundred feet". At 1242 hrs the commander announced that he was stabilised on the approach. Guernsey Approach confirmed that the aircraft was 4 miles from touchdown and cleared the commander to contact the Alderney Tower controller.

On contact with Alderney at 1242 hrs the commander was informed that the meteorological conditions were:

> "Surface wind one six zero at two zero gusting three two occasionally the cloud base is improving all the time now scattered at two hundred and broken at four"

The commander requested the option to circle for Runway 14. This was approved and he was informed that Runway 14 was "still very wet but firm so there is no problem". However, once visual with the airfield the commander informed the Tower controller that he would continue with the landing on Runway 08.

The commander stated that once established on the inbound radial he commenced descent to the minimum height of 390 feet with the flaps at the TAKE OFF setting. He had no difficulty in maintaining the required radial and there were no handling problems in the moderate turbulence. On reaching 390 feet the commander was visual with the terrain below and was satisfied that he was on the correct track by reference to known prominent features. He first saw the runway and its associated lighting at a range of approximately one and a half miles and quickly established the aircraft on the extended runway centre-line and on the required descent path. In the prevailing surface wind the commander expected an increased level of turbulence as he passed steep cliffs on his right side during the latter stages of the approach and deliberately delayed the selection of flap to DOWN. This was selected at a height of approximately 70 feet at which stage he considered that the turbulence was severe. The tower controller provided updates to the surface wind throughout the latter stages of the approach; the final update, given when the aircraft crossed the threshold, was "ONE EIGHT ZERO TWO TWO".

The commander had a target threshold speed of 75 to 80 kt but he was uncertain of the speed at touchdown because of the erratic airspeed indications. All other parameters appeared to be normal and he stated that the aircraft touched down on the runway centre-line just prior to the intersection with the grass runway 14 / 32. He placed the control column fully forward, applied full right aileron and commenced braking whilst maintaining these control inputs. He was soon aware that there was no retardation. The commander considered a go-round but was conscious of a tail wind element combined with insufficient runway available, he therefore continued to apply maximum braking.

The controller in the tower first saw the aircraft when it was approximately 1,000 metres from the runway threshold. He reported that the aircraft touched down just prior to the intersection with the grass runway 14 / 32; he considered that this was the normal touchdown point for the Trislander aircraft. The controller described the runway surface as wet with pools of standing water in the areas where the grass runways crossed Runway 08 / 26. He considered this to be normal following heavy rain. The controller reported that a large plume of water was noticeable as the aircraft crossed the intersection with Runway 03 / 21; the aircraft then ran off the end of the runway. As the aircraft left the runway surface its speed was estimated by the commander to be about 20 miles per hour. It then went through a light fence and crossed a track before coming to a halt in a field after about 70 metres.

A professional pilot, who routinely travelled as a passenger on this route, estimated that touchdown was at the normal position as was the aircraft attitude and speed. He was aware that the brakes had been applied but reported that there was no obvious retardation.

Two workmen, who were in their car close to the threshold of Runway 26, saw the aircraft land. As the aircraft approached the end of Runway 08 the workmen realised that the aircraft would be unable to stop and reported that 'it appeared to be skating on ice'. As the aircraft crossed the track, they estimated its speed to be about 25 mph.

Passenger evacuation

As soon as the aircraft came to a halt, the two workmen ran towards it in order to assist the passengers and crew. As they approached the left side, they noted that the propellers had stopped rotating. They assisted a male passenger to exit via the emergency exit located above the left, forward passenger door. They described this emergency exit as being only half open with the bottom edge fixed into its rubberised seal. Robust attempts to remove the emergency exit panel from this seal failed. One of the workmen went to the front right door to assist the passengers in that area whilst his companion remained at the left door which he attempted to open but without success.

As soon as the aircraft came to a halt, the commander spoke briefly to the passengers in order to reassure them. He recalled that some of the passengers were attempting to exit the aircraft via the emergency exit above the left, forward passenger door at Row 3. This door is protected by an interlock such that it cannot be opened whilst the left magneto is live. The commander selected the magnetos to 'OFF', shut down the aircraft, and then he and the remaining passengers vacated the aircraft. After selecting the magnetos to 'OFF' the left, forward passenger door opened without difficulty.

The airfield Rescue & Fire Fighting Services (RFFS) were on a weather standby and responded immediately. They proceeded to the aircraft via the main runway and arrived as the last of the passengers were vacating the aircraft. Whilst driving along the runway they noticed that the runway surface was very wet and that there were a large number of puddles of water.

Engineering examination

The aircraft was removed from the over-run area, with AAIB permission, prior to the AAIB team's arrival. To achieve this the right outboard tyre, which had burst, had to be replaced and the aircraft was then taxied back to the runway under its own power, after the remains of the wire perimeter fence had been removed from around the nose landing gear.

The aircraft was examined on the ramp outside the terminal building. There was no discernible airframe damage, but there was evidence of very slight 'nicking' of the left propeller blades which may not even have occurred during this incident. The removed wheel was stowed inside the cabin and the tyre bore clear signs of a locked-wheel burst: some of the other tyres had fairly deep cuts which required replacement before the aircraft flew again on revenue service. A team from the airline's maintenance provider attended to perform an inspection of the main landing gear attachments and other structural elements. No damage or deformation was found.

Following the above work, the braking system was inspected for leaks and tested for function: no anomalies were found. The engines were started and a series of high-speed runs along the runway, followed by heavily-braked full-stops were carried-out. The braking system in all cases both functioned and 'felt' normal, but the runway conditions were now dry.

It proved impossible to identify, on the runway, where the aircraft had touched-down. There were also no signs of the characteristic 'scouring' tyre marks traditionally associated with aquaplaning by heavier types of aircraft. A black, somewhat irregular, skid mark, which could have been associated with the locked right wheel could be discerned roughly half-way along the runway and just to the right of the centreline. None of the three intact tyres showed any signs of 'rubber reversion' on the tread - which might be considered a classic indication of aquaplaning. Discussions with the maintenance provider suggested that they were used to seeing such evidence on Trislander tyres when very wet conditions were experienced, particularly at Alderney.

Following the tests and examination, the aircraft was ferried to Guernsey where further detailed examination was carried-out and the remaining wheels replaced before the aircraft was returned to service.

Emergency exit

As examined by AAIB, the emergency exit in Seat Row 3 had been re-sealed to prevent water ingress (apparently by the pilot). The exit is simply a Perspex sheet window, gripped in a rubber or neoprene sealing strip in the door panel. To deploy the exit, a handle attached directly to the window in the upper aft corner is pulled inwards. This action 'peels' the glazing out of the sealing strip and the whole panel is then discarded.

When this was attempted on the exit on G-BDTO, it was found that the initial action of pulling the handle started the process of removing the window, but the lower edge remained in the sealing strip and could not be dislodged. This effectively meant that the Perspex panel hinged inwards and downwards instead of being completely removed and posed a significant obstacle to anyone trying to evacuate by this route.

Examination immediately revealed that the lower edge of the window was stuck in a thick bead of what appeared to be a white silicone rubber sealant which was acting as a flexible adhesive and could not be broken even by using considerable force.

The AAIB immediately alerted both the CAA and the aircraft manufacturer to this situation, pointing-out the potential consequences of an impeded exit, particularly in a ditching case. Sealing the emergency exit, and other, windows with an applied sealant has been found to be necessary to prevent rainwater ingress and this process was reflected in the Maintenance Manual as being applied to the lower half of the sealing strip.

In practice, it was found that two different sealants were applicable, depending-on the material of the sealing strip. Original Islander/Trislander aircraft were supplied with a rubber strip, for which a proprietary 'Plasticised' Sealant was specified. However, in 1986 a new sealing strip made of neoprene was introduced by modification NB/M/902. Operators purchasing this modification were supplied with Supplementary Maintenance Information which gave installation materials details, including a change of sealant to RTV732. It appears that the airline had not purchased the new seals as a manufacturer's modification, but simply as spares and therefore were not in possession of the new maintenance information (the sealing strip on G-BDTO was post-modification standard).

Although the airline had been using a form of RTV sealant on the exit window, it was felt that the application was excessive, with the Perspex effectively 'embedded' in sealant, where the Maintenance Manual specified a small fillet on the exterior side only. The manufacturer asserts that extensive testing shows that, if the correct instructions and materials are used, the sealant presents no obstacle to proper function of the exit.

On 3 August 2001, the Manufacturer issued Mandatory Service Bulletin (SB) 277. This required that all BN2 Islander and Trislander operators should remove the emergency exit windows within 10 Flight hours of the SB's issue and re-install them in accordance with the instructions in the SB. The aircraft Maintenance Manual would be amended 'as necessary by normal revision action at the earliest opportunity'.

Meteorological situation

The synoptic situation at 1200 hrs on 17 July 2001 showed a fresh to strong south-south-westerly flow with a warm sector covering Alderney. It is possible that a cold front crossed the island at about the time of the incident. A special report issued immediately after the incident reported the following conditions:

Surface wind 170°/23 kt gusting 35 kt, visibility 4,000 metres in rain and drizzle, scattered cloud at 200 feet and broken cloud at 400 feet, surface temperature +16°C, QNH 995 HPa.

An aftercast provided by the Meteorological office provided the following wind velocities at various heights as depicted in Table 1.

Table 1: Wind Profile

Height AGL	**Wind velocity**
Surface	170°/ 23 kt, gusts 35 kt

1000 feet	220º / 30 kt, gusts 35 kt
2000 feet	230º / 30 kt, gusts 35 kt

An aircraft flying an approach to Runway 08 in these wind conditions would thus experience a significant tailwind component.

Recorded radar data

The Guernsey radar has the ability to calculate and record the ground speed of aircraft during an instrument approach at Alderney. The recorded ground speed during the approach by G-BDTO prior to the incident are produced at Table 2. For comparison purposes similar data from approaches on 2 July 2001 are also presented. These NDB approaches to Runway 08 were flown in differing surface wind conditions.

Table 2: Radar ground speed comparison (kt)

Date	Surface Wind	speed at 1 nm					last recorded speed before touchdown
17 July	160/21	142	142	136	132	126	121
2 July	160/09	89	87	86	84	82	80
2 July	160/09	101	103	99	95	89	86

The surface wind, in each instance, was recorded at the anemometer sensor located on the roof of the control tower. The ground speeds are those calculated by the radar during each sweep made within the last nautical mile, this represents the final 300 feet of descent. It is entirely possible that the ground speed recordings for the 17 July contained a significant tailwind component, even at these low levels, bearing in mind the prevailing wind conditions. Nevertheless, whatever the cause, it is clear that on 17 July G-BDTO had a higher than normal ground speed prior to touchdown.

Air traffic control

Runway 08 / 26 was the primary runway at Alderney and was intersected by two grass runways: 14 / 32 and 03 / 21. Runway 08 was the runway in use at the time of the incident. It had a published landing distance of 880 metres of which the first 50 metres was grass and the remaining 830 metres was asphalt; the runway was 23 metres wide. There was no stopway associated with this runway.

The runway was equipped with high intensity approach lighting, consisting of a centre line and a single cross bar. Abbreviated precision approach path indicators set to indicate a glide path of 3° were set on the left side of the runway. Low intensity, omni-directional, white, runway edge lights were installed and the end of the runway was indicated by red threshold lighting. All lighting was serviceable at the time of the incident.

The instrument approach aid for Runway 08 was the 'ALD' NDB with an inbound radial of 083°M; this was coincident with the runway centreline. The published minima for this approach were 390 feet and 1,200 metres RVR. The RVR at Alderney was assessed by a human observer counting the number of runway edge lights visible from the nominated runway observation position. The normal maximum value that can be assessed by this method is 1,100 metres. However, in order to satisfy the minimum requirements for aircraft wishing to land at Alderney an RVR of 1,200 metres may be obtained by the use of two extra remote RVR lights, one at each end of the primary runway.

The anemometer readout available to the controller in the tower was derived from a sensor on the roof of the control tower. The present system was installed September 1999 and was calibrated for direction, however, at that time no equipment was available to calibrate the airspeed. The system was re-calibrated on 21 August 2001. The results indicate that measurement of the wind velocity was well within the limits laid down in Civil Aviation Publication (CAP) 670 (speed to ± 1 kt, direction to ± 10°).

The 1120 hrs METAR reported rain and the 1150 hrs METAR reported heavy rain. A special meteorological report, issued at 1235 hrs reported light rain and drizzle. The commander had read the 1150 hrs METAR and was thus aware of the recent heavy rain, but subsequent updates to the Alderney weather passed to him had concentrated on the cloud and visibility. The Alderney Tower controller recognised that the runway was wet and was aware of standing water at the runway intersections, a situation that he described as normal after prolonged or very heavy rain. The presence of water on runways is defined as essential aerodrome information (Manual of Air Traffic Services Part 1) which 'shall be issued to pilots in sufficient time to ensure the safe operation of the aircraft'. The presence or otherwise of water on a runway is reported using the descriptions presented in Table 3:

Table 3: Surface conditions

Reporting term	**Surface conditions**
WET	The surface is soaked but no significant patches of standing water are visible.
	Note: Standing water is considered to exist when water on the runway surface is deeper than 3mm. Patches of standing water covering more than 25% of the assessed area will be reported as WATER PATCHES.
WATER PATCHES	Significant patches of standing water are visible.
	Note: Water patches will be reported when more than 25% of the assessed area is covered by water more than 3mm deep.
FLOODED	Extensive patches of standing water are visible.
	Note: Flooded will be reported when more than 50% of the assessed area is covered by water more than 3mm deep.

When reported the presence of surface water on a runway should be assessed over the most significant portion of the runway (i.e. the most likely area to be used by aircraft taking off or landing). For JAR-OPS performance purposes, runways reported as 'water patches' or 'flooded' should be considered as contaminated. The controller did not inform the pilot that Runway 08 was either wet or contaminated.

Aerodrome inspection

The UK CAA had previously been requested by The States of Guernsey to carry out an inspection of the aerodrome and the RFFS at Alderney Airport, Channel Islands. The inspections were carried out between 3 and 5 April 2000. The inspection team made a number of comments; the following are relevant to this incident.

a 'The runway has an asphalt surface which is in a poor condition and will require re-sealing in the near future. It is beginning to break up leaving a large number of stones that could cause damage to an aircraft fuselage and to the propellers.' It was recommended that the runway should be resealed.

Subsequent action. The runway was swept during the interim period and has now been resurfaced. Resurfacing work commenced on 2 September 2001 and was completed on 13 September 2001. This project was delayed because the preferred tenderer was unable to commence work until this date.

b 'There is no runway friction measurement at present, however, it is the planned to bring over a Griptester in the near future in order to measure the coefficient of friction. This should be done as soon as possible.' It was recommended that the runway friction values should be determined.

Subsequent action. Runway friction testing was carried out on 16 June 2000. The overall friction level for the runway was 0×91 against a design level of 0×8. The runway was noted to have good friction levels but was very uneven and bumpy due to previous repairs.

c 'The actual distances for the grass runways are those declared in the UK AIP. In the case of the main runway 08 / 26, there is no provision for the required Runway End Safety Areas (RESAs). It is strongly recommended that these are implemented in order to provide the 150 metre safety zone (60 metre strip end plus 90 metre RESA) which is now a Standard in Annex 14 and CAP 168. This would give the required level of safety in the event of an aircraft overrunning or undershooting the runway... Since both thresholds need to be moved both sets of APAPIS will also need to be repositioned.' It was recommended that RESAs should be provided.

Subsequent action. The States of Guernsey have been, and are in, protracted negotiations with the owners of the land to the east of the airfield boundary in order to acquire it for the RESA.

Operational issues

a Required landing distance The Trislander flight manual provides information for the required landing distance to be calculated. The resulting factored distance allows for clearance over a 50 ft obstacle and assumes the following conditions:

Engines: Propellers in fine pitch
Wing Flaps: DOWN
Technique: Approach at the appropriate threshold speed. Maximum wheel braking applied immediately after touchdown
Runway: Dry tarmac runway

Utilising the appropriate parameters at the time of landing the factored landing distance required was 630 metres; the available landing distance was 880 metres. However, as noted above the required landing distance is based upon the use of a dry runway. The certification basis for the

Trislander was BCAR, Section K. This required that scheduled take-off and landing data should be provided only for dry, hard concrete or tarmac runway surfaces. Thus, the Trislander aircraft has no published take off or landing performance data for operations on wet runway surfaces.

Operations for this type of aircraft on runways affected by snow, slush or water is addressed in Aeronautical Information Circular (AIC) 61/1999 (Pink 195). In the AIC the following guidance is provided for the landing.

> *"Depths of water or slush, exceeding approximately 3mm, over a considerable portion of the runway can have an adverse affect on landing performance. Under such conditions aquaplaning is likely to occur with its attendant problems of negligible wheel braking and loss of directional control. Moreover, once aquaplaning is established it may, in certain circumstances, be maintained in much lower depths of slush or water. A landing should only be attempted in these conditions if there is an adequate distance margin over and above the normal landing distance required, and when the crosswind component is small. "*

Guidance provided in the operator's flight manual states that " *A landing will not be made unless the landing run available exceeds the landing run required by at least 20% for wet runways*". In this instance the landing run available exceeded the landing run required by 39×7%.

b. **Braking technique.** The commander reported that after the landing he placed the control column fully forward. By maintaining this control input the commander allowed the weight on the main wheels to decrease thus reducing the effectiveness of the brakes. The conventional landing technique for a nose wheel aircraft is to lower the nose wheel, apply braking and then ease the control column back. This ensures that weight is applied to the main wheels thus improving the braking efficiency. In this case the pilot maintained weight on the nose wheel in an attempt to improve the directional stability in the prevailing crosswind.

Summary

The recorded radar data indicates that G-BDTO had a higher than normal ground speed just prior to touchdown. The landing was made in a strong crosswind, and in conditions that the pilot described as severe turbulence. The runway surface was at least 'WET' and may have had 'WATER PATCHES' but the pilot was not made aware of its condition. Three witnesses describe the aircraft touching down at the normal touchdown point and on the runway centre-line. The aircraft then failed to stop in the remaining distance available and ran off the end of the runway.

The runway had been inspected in April 2000 and its asphalt surface had been described as in a poor condition. However, its braking action had been assessed as good although it was noted that the surface was uneven and bumpy due to previous repairs. The aircraft braking system was inspected and no anomalies were found. Functional tests were carried out on the braking system in dry conditions and the brakes behaved normally. There were none of the classic indications of aquaplaning on either the tyres or the runway surface despite the report that the aircraft 'appeared to be skating on ice'. Furthermore, the pilot had no problems in maintaining directional control. Aquaplaning, although possible, is therefore considered to have been unlikely.

It appears that the pilot employed an inappropriate braking technique by maintaining the nose wheel firmly in ground contact in an attempt to improve the directional stability in the prevailing crosswind. In doing so he reduced the effectiveness of the brakes and this, coupled with his increased speed over the threshold, ensured that he would not be able to stop in the prevailing conditions.