BN2A, Mk 111-2 Trislander, G-WEAC

AAIB Bulletin No: 7/2000 Ref: EW/C99/10/3 Category: 1.3

Aircraft Type and Registration:	BN2A, Mk 111-2 Trislander, G-WEAC
No & Type of Engines:	3 Lycoming 0-540-E4C5 piston engines
Year of Manufacture:	1976
Date & Time (UTC):	28 January 2000 at 0100 hrs
Location:	20 nm south west of Edinburgh Airfield
Type of Flight:	Public Transport (Cargo)
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - None - Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	1,430 hours of which 38 were on type Last 90 days - 100 hours Last 28 days - 34 hours
Information Source:	AAIB Field Investigation

The pilot had intended to fly from Edinburgh to Belfast (Aldergrove) and had filed a flight plan requesting a cruising level of 4,500 feet. The actual take off weight of the serviceable aircraft was 4,485 kg. (Maximum take-off weight is 4,536 kg). Whilst conducting the pre-take off checks the pilot checked for correct operation of the pneumatic de-icing boots since moderate icing conditions were forecast.

The aircraft was cleared for departure at 0030 hrs and the aircraft commenced a climb to 4,500 feet. At 0033 hrs the aircraft was handed over to Scottish Area Control Centre (ScACC). The aircraft entered cloud at 2,500 feet and the pilot selected the propeller de-ice and the windshield heat to 'ON'. At approximately 3,500 feet the pilot noted that there was a layer of ice approximately a quarter of an inch thick on the temperature probe, which is externally mounted on the windshield. The pilot checked the wings for icing and saw clearly accumulations of ice on the leading edges. He then operated the pneumatic de-ice boots in manual mode. The rate of climb progressively decreased until, at 4,300 feet, the rate of climb was zero. Full engine power was checked and all engines were indicating 2,500 RPM with a manifold pressure of 25 inches. Shortly afterwards the aircraft began to descend at approximately 100 feet/min on a track of 220°M. At 0045 hrs the pilot requested a cruising level of 4,000 feet and reported having difficulty in maintaining altitude

because of ice. The ScACC controller advised that the minimum level was 4,500 feet; this was the lowest level available for allocation to IFR flights based upon terrain clearance criteria.

In accordance with guidance contained within his company Operations Manual the pilot selected 10° of flap, and this action initially allowed the aircraft to maintain altitude. However, the aircraft eventually recommenced a descent. The pilot continued to operate the pneumatic de-ice boots, initially in the manual setting and subsequently, as his workload increased, in the automatic setting. At no time did the de-ice boots have any noticeable effect in dislodging the accumulated ice. At 0058 hrs, as the aircraft approached 2,000 feet, the pilot requested a diversion to Prestwick, which was approximately 20 nm away. He did not declare an emergency. The aircraft, still in cloud, continued to descend slowly with full power applied. At 0116 hrs the pilot reported that he was at 900 feet at which stage he was handed over to Prestwick which was 4 nm away. The pilot subsequently completed a visual approach to land on Runway 21 at 0122 hrs at which time the weather was reported as: 9,000 metres visibility in light drizzle with a few clouds at 500 feet and broken cloud at 1,000 feet. The surface wind was 240°/19 kt.

Aircraft de-icing systems

The aircraft was cleared for flight into known or forecast icing conditions not more severe than 'moderate'. It was equipped with the following de-icing systems:

a. Pitot heat and stall warning vane heaters

b. Heated windshield panel

c. Ice formation inspection lamp

d. Electrical propeller de-icing system

e. Airframe de-icing system

The airframe de-icing system is pneumatic and operates inflatable 'boots', which are installed on the leading edges of the wings and the tail unit. The system can be operated in manual mode or in automatic mode in which case a timing unit ensures alternate inflation and deflation of the 'boots' to a predetermined cycle. As soon as the airframe de-icing system has cleared the ice accretion the system should be switched OFF until a further build up occurs. If this is not done there is a danger that ice will form over the profile of the inflated 'boots' making the system ineffective. Therefore the system should not be run continuously but should be used intermittently.

The company Operations Manual contains the following advice for icing encounters:

'The first indication of airframe icing is a build up on the probe of the OAT gauge. When the accretion is about half an inch thick then the de-icing boots should be inflated. The wing leading edges should be monitored for further accumulations that should be removed when thick. With an OAT of 0°C to -3°C there is a probability of the ice extending from the leading edges well back along the upper and lower wing and tail surfaces. Since this ice cannot be removed by use of the leading edge boots a change of altitude should be made into air either above 0°C or below -4°C.

A build up of ice on other parts of the airframe will, by extra weight, slow the aircraft. To maintain altitude an increased angle of attack will be required and at lower airspeeds this nose up attitude

will present a larger undersurface profile which will accumulate much more ice, which cannot be removed by the boots. To reduce this possibility restore a level attitude by lowering approximately 10° flap (using the cb).'

Meteorological aspects

The synoptic situation at 0001 hr on 28 January 2000 showed a warm front lying from Newcastle-upon-Tyne to Glasgow to Portree. A moderate southwesterly airstream covered the area. The meteorological forecast, available to the pilot prior to take off, indicated the following conditions for the Edinburgh area:

Generally: 30 km visibility with no significant weather,

3 to 6 octas Cumulus and Stratocumulus, base 2,000 feet, tops 8,000 feet

Occasionally: 7 km visibility with rain and snow showers

7 octas Cumulus, Stratocumulus and Alto cumulus, base 1,500 feet, tops 12,000 feet

There was an associated warning of moderate icing and moderate turbulence in cloud.

An aftercast, obtained from the Meteorological Office, indicated the following cloud structure between Edinburgh and Glasgow at the time of the incident.

4/8 Stratocumulus between 1,200 feet and 1,500 feet

6/8 Stratocumulus between 2,800 feet and 3,200 feet

6/8 Stratocumulus between 4,500 feet and 5,000 feet

8/8 Altocumulus and altostratus above 7,000 feet

The zero degree isotherm in the Prestwick area was determined to be at 3,500 feet.

Local wind profiles, derived from the aftercast, were:

Height	Wind	Temperature
(ft amsl)	(kt)	(°C)
1,000	250°/25	+4
2,000	260°/30	+2
3,000	260°/30	+1
4,000	270°/30	-1
5,000	270°/28	-3

This wind profile is indicative of standing waves. However, at 4,000 feet the conditions were not optimum for the generation of long wavelength, large amplitude waves. Analysis indicated that a maximum downdraft of 400 feet/min would occur at 7,500 feet. At 4,000 feet the vertical motion would have been approximately 200 feet/min and would have included updrafts and downdrafts separated by a distance of up to 10 km along the direction of the airflow. However, uplifted air associated with standing waves does have an increased concentration of water and hence the risk of icing is also increased in this regime. It is therefore unlikely that the standing waves, by themselves, could have prevented the aircraft from climbing to 4,500 feet whilst it was on a track of 220°M. It is more probable that the aircraft's performance was affected adversely by the accumulation of airframe icing as described by the pilot.

Air traffic control

The aircraft was identified by ScACC on departure from Edinburgh and cleared to climb to 4,500 feet. Later the pilot requested descent to 4,000 feet because of icing 4,500 feet was the lowest level available for allocation to IFR flights, based upon terrain clearance criteria, so the pilot was advised that a clearance to 4,000 feet was not available, however, he was informed that there was no conflicting traffic at that altitude. The aircraft was later observed to be descending towards 2,000 feet, as indicated by the transponder mode C data tag. When the controller asked the pilot whether he had the ground in sight, he replied that he was still in cloud. The controller was now in no doubt that the aircraft was in an emergency situation and so he requested assistance from colleagues, including his supervisor, whilst continuing to monitor the aircraft's track and altitude. The pilot then requested a diversion to Prestwick, which was l9 nm away. He was provided with radar vectors. Prestwick radar was not available so the aircraft was retained by ScACC. The Manual of Air Traffic Services (MATS) Part 1 (Section 5 Chapter 1 to 3) requires controllers to ask if a pilot wishes to declare an emergency in such circumstances. However, in this case the controller and his colleagues treated the flight as if an emergency had already been declared.

Whilst the controller monitored the aircraft's progress his colleagues provided details of relevant high ground and obstructions close to track. Position updates were passed to Prestwick who requested that the aircraft be routed overhead the airfield for a visual approach, since the aircraft was already below the altitude required for the instrument approach procedure. The pilot was provided with further information concerning his position, relevant high ground, the Prestwick weather and serviceability state. During the transit to Prestwick the controller observed that the aircraft's track varied between approximately 180° and 280°, whereas the suggested heading had been 260°. When at 3.5 nm from Prestwick, and at a height of 900 feet, the aircraft was transferred to the tower frequency. Although he was still effectively invisible to Prestwick and had not reported the airfield in sight the controller felt that it was prudent, after co-ordination with Prestwick, to transfer the aircraft to the airfield frequency at this time.

One of the tasks required by the MATS Part 1 (Section 5 Chapter 1 to 10) in such circumstances is for the Area Control Centre to alert the Distress and Diversion Cell (D&D); this was not done. Selection of the emergency transponder code of 7700, either initiated by the pilot or in response to instructions by ATC would have had the effect of automatically alerting the D&D Cell. In any event early notification of an incident is essential in order to prepare the relevant emergency services.

Crew composition

The regulations concerning the composition of crew of an aircraft are set out in The Air Navigation (No 2) Order 1995 Part IV, Article 20. This normally requires the use of two pilots in a Trislander aircraft unless a serviceable auto pilot is available. This aircraft was not fitted with an auto pilot. However, the CAA had granted the operator of the aircraft an exemption to Article 20, which permitted single pilot operation without the use of an auto pilot. The exemption contained specified conditions regarding the airfields to be used, maximum sector lengths and the minimum Runway Visual Ranges for the landing aids in use. Furthermore, the operator had defined minimum experience levels for the commander in addition to the requirements laid down by the Authority.

The concern with single pilot operations without the use of an auto pilot is that the pilot workload may become too high during abnormal operations or that routine operations, such as the use of checklists or altimeter cross checks, may be compromised. In the adverse conditions encountered during this flight there were times when the pilot workload was high, although the pilot never felt overloaded. However, whilst flying the aircraft with sole reference to the flight instruments this pilot also had to look behind him in order to monitor the wing leading edges. This would have compromised the accuracy of his instrument flying and led to the heading deviations observed by the ScACC controller.

Analysis

This was a potentially catastrophic incident that was averted by good fortune and the actions of ATC controllers. The pilot reported that the de-icing boots were ineffective in removing ice from the leading edges of the wings and the aircraft performance was severely degraded by the accumulation of ice on the wings and airframe. This resulted in the aircraft being forced to fly in IMC at a height well below the safety altitude, which is inherently unsafe. Although the pilot had the option to return to Edinburgh he chose to divert to Prestwick which lay close to his planned track, was near the coast and lay in a relatively unpopulated area.