Aviation Safety Investigation Report 199601101

Britten Norman Ltd Islander

07 April 1996

NOTE: All air safety occurrences reported to the ATSB are categorised and recorded. For a detailed explanation on Category definitions please refer to the ATSB website at www.atsb.gov.au.

Occurrence Number: 199601101 **Occurrence Type:** Accident
Location: 3km N Coolangatta
State: QLD **Inv Category:** 3
Date: Sunday 07 April 1996
Time: 2138 hours **Time Zone** EST
Highest Injury Level: Serious
Injuries:

	Fatal	Serious	Minor	None	Total
Crew	0	1	0	0	1
Ground	0	0	0	0	0
Passenger	0	1	8	0	9
Total	**0**	**2**	**8**	**0**	**10**

Aircraft Manufacturer: Britten Norman Ltd
Aircraft Model: BN-2A-21
Aircraft Registration: VH-HIA **Serial Number:** 415
Type of Operation: Charter Passenger
Damage to Aircraft: Destroyed
Departure Point: Tangalooma QLD
Departure Time: 2105 EST
Destination: Coolangatta QLD

Crew Details:

Role	**Class of Licence**	**Hours on Type**	**Hours Total**
Pilot-In-Command	Commercial	177.3	881

Approved for Release: Thursday, February 20, 1997

FACTUAL INFORMATION

History of the flight

The aircraft was the third in a stream of five company aircraft departing the Tangalooma Resort airstrip at two-minute intervals on a clear moonlit evening. Following a routine departure at 2105 EST, the aircraft was climbed to 3,000 ft for the flight back to Coolangatta. Early in the cruise phase of the flight, the pilot found that the fourth aircraft was catching up to his and he elected to descend to 2,000 ft to ensure continued separation.

At 2127 EST, the pilot reported to Coolangatta Approach Control that the aircraft had severe problems, but did not inform the controller of the nature of his emergency. However, the controller activated the airport emergency procedures when he observed on his radar display that the aircraft was losing altitude. The pilot had his second VHF radio transceiver tuned to his company frequency, and was answering transmissions received from other company pilots on this frequency while transmitting on the Coolangatta Approach frequency.

The pilot later said that after the aircraft passed the seaway at Southport, the right engine surged, which resulted in the aircraft yawing. After he switch the electric fuel pump to "on", the symptoms disappeared. About a minute later he switched the pump off, then on again. He said that when the engine began surging again, he shut the engine down, feathering the propeller. Left engine power was increased and the aircraft maintained 1,500 ft in level flight. He switched the left engine's fuel supply to the right main tank, believing that this action would ensure supply from both main fuel tanks.

The pilot said that after the aircraft passed Burleigh Heads, many things appeared to go wrong at once. The left engine began to splutter and did not respond to the throttle. He recalled attempting to restart the right engine. This proved to be unsuccessful. As the descent continued he planned to land on a beach.

The pilot selected a stretch of beach for a forced landing. During late final approach, aided by bright moonlight, he noticed that any overrun would take the aircraft into a crowded car park. He changed his aim point to the stretch of beach south of the Currumbin Lifesavers Clubhouse. Following the flare for landing, the right wing struck a low rocky outcrop and the aircraft crashed into the surf. The entire wing assembly separated from the fuselage, which came to rest on its left side. Some of the nine passengers, and the pilot, escaped from the semi-submerged fuselage while bystanders rescued others.

Personnel information

The pilot was 45 years of age and had commenced flying training in October 1990. He was issued with a commercial pilot licence on 30 June 1993. He continued his training and, on 3 June 1994, gained a grade 3 instructor rating valid for single-engine aircraft. He was appropriately endorsed to fly the Britten-Norman Islander BN-2 series of aircraft. The pilot held a current command instrument rating valid for multi-engine aircraft. He satisfied the recency requirements for single-pilot flight under instrument flight rules, as contained in Civil Aviation Order 40.2.1. The pilot had a total flying experience of 881 hours, of which 606 were as pilot in command. He had recorded about 373 hours in multi-engine aircraft, of which 177 were on the Britten-Norman Islander aircraft. In the previous 30 days he had flown a total of 38 hours, all on the aircraft type.

The pilot had been employed by the company on a part-time basis until February 1996, when he became a full-time pilot. During his employment as a part-time pilot, he had worked in the maintenance hangar as a general hand assisting the licensed aircraft maintenance engineers who serviced the company's aircraft.

Medical information

The pilot's class 1 medical certificate was without restriction and was current until 7 May 1996. The pilot reported that he was not suffering from any illness and that he was fit to undertake the flight.

Aircraft information

The aircraft, a model BN-2A-21, Serial No. 415, was manufactured by Britten-Norman Limited in England in 1974. It was a high-wing, twin-engine, propeller-driven aircraft with a maximum allowable take-off weight of 2,994 kg. The aircraft was imported from Singapore in 1995 and placed on the Australian Aircraft Register on 25 October 1995 when Airworthiness Certificate AFD/10663 was issued. Maintenance Release Certificate No. PA/51001, issued on 11 January 1996, was valid until 11 January 1997, or 6,020.8 hours total time in service (TTIS). The aircraft TTIS was 6,013.4 hours at the time of the accident. There were no identified outstanding maintenance requirements. The aircraft was fitted with forward facing seats and certified to carry 11 persons.

The aircraft was powered by two Avco Lycoming IO-540-K1B5 engines driving Hartzell fully feathering propellers. These components were within their mandatory service lives. The design of the propellers provides a feathering spring and dome air pressure to drive the blades into the feather position when the control is selected to feather. The blades may also go to feather when oil pressure has been lost if the blade pitch is on the coarse pitch side of the propeller stops. The propeller stops prevent the propeller from moving to feather during engine shutdown in normal operations.

The pilot flew the aircraft on the outbound flight earlier in the day. He did not report any defects.

Fuel system

The aircraft fuel system included four individual wing tanks: two integral main tanks located outboard of each engine, and two auxiliary tanks at the wing-tips. The two main tanks have a total capacity of 518 L, and the two auxiliary tanks 223 L. Two main fuel tank selector valves provide for selection of OFF, PORT, and STARBOARD. When the selector is positioned to the opposite wing named on the selector, the engine uses fuel from that main tank only, in crossfeed. Two auxiliary fuel switches provide for selection of MAIN or TIP, which can also be crossfed in the same way by selecting the wing named on the selector and operating on TIP.

Before departure from Coolangatta in the morning, the aircraft was refuelled to 240 L in the main tanks and 100 L in the auxiliary tanks. The flight to Tangalooma and return required approximately 120 L.

Engine handling during cruise

The operator of the aircraft required pilots to set the engine fuel mixture after the aircraft had levelled out in cruise. The normal technique was to lean the engine fuel mixture to peak exhaust gas temperature and then enrich the mixture to lower the exhaust gas temperature by 50 degrees (two divisions on the exhaust gas temperature gauge).

Weight and balance

The aircraft weight at the time of the accident was calculated at 2,749 kg, 245 kg below the maximum allowable take-off weight. The centre of gravity was within allowable limits.

Propeller controls

The manufacturer restricted the propeller controls for normal operations by offsetting the rear segment of the slots to prevent inadvertent feathering which would otherwise be possible when selecting coarse propeller pitch. To select feather, the pilot has to move the lever sideways slightly to bypass the 2-mm notched stop or detent.

Meteorological information

The Bureau of Meteorology prepared an analysis of wind conditions in the Coolangatta area. The low-level wind was a light northerly, less than 5 kts at the surface and increasing to about 10 kts at 2,000 ft. The Coolangatta Automatic Terminal Service reported a light north-westerly wind at 4 kts, a temperature of 21 degrees C, and a QNH of 1,018 hPa.

Witnesses reported that the night was clear, with a near-full moon about 20 degrees above the eastern horizon. Visibility was in excess of 10 km. The tide was about 1 hour short of high tide, which led to high cresting waves washing over the wreckage.

There was no evidence that weather conditions contributed to the accident.

Aids to navigation

The aircraft was equipped with very high frequency omni-directional radio range (VOR), automatic direction finding (ADF) and distance measuring equipment (DME) navigation aids. The flight was planned to operate under instrument flight rules; however, the weather was such that visual navigation was possible. The pilot did not report any navigation aid defects or difficulties.

Communications

The aircraft was fitted with two very high frequency (VHF) radio transceivers appropriate to the flight. Both radios were in use, monitoring air traffic control (ATC) and the company frequency at the same time. However, only one transmitter at a time could be used. The pilot had communicated without difficulty with Brisbane Flight Service, Brisbane Approach, and Coolangatta Approach before reporting problems.

The sound of an engine operating at high revolutions per minute was audible in the background of 17 subsequent transmissions. Engine noise was not apparent in the last transmission at 2137:37 but an aural warning tone could be heard. A stall-warning horn was the only aural warning device fitted to the aircraft.

Communications recorded on the ATC automatic voice recorder (AVR) tapes

All communications between the aircraft and air traffic services were recorded on automatic voice recorders in Brisbane and Coolangatta. The first indication of any significant problem was when the pilot transmitted at 2127:34 that he was experiencing severe problems with the aircraft. However, the pilot did not elaborate on the problems. A series of unnecessary transmissions were made by the pilot throughout the emergency sequence, some in answer to unrecorded questions received on his second radio which was monitoring the company frequency.

At 2131:05 the pilot reported that he seemed to have the aircraft under control again. At 2132:01 he transmitted "I'm having problems maintaining height with whatever this configuration is" and 50 seconds later, "OK guys, I'm just going to try a restart". This was the first indication to the Coolangatta approach controller that the aircraft was operating on one engine. The aircraft was then at approximately 600 ft. At 2133:05 another company pilot asked whether he had lost one (engine) or both. The pilot's answer indicated that the aircraft was operating on one engine which was not delivering the power he expected. The last transmission made by the pilot was at 2137:37 in which he said that he was going to land the aircraft on the beach.

Safety equipment

An emergency locater transmitter was not installed in the aircraft.

The restraint harnesses appeared to have effectively restrained all passengers and the pilot. The serious injuries received by both front-seat occupants were probably due to the cockpit structure collapsing, thereby reducing the occupiable space.

The Civil Aviation Orders required that the aircraft, which was authorised to carry more than nine passengers, be equipped with life jackets for each occupant where the take-off or approach paths extended over water. The aircraft was not equipped with life jackets on this flight.

Wreckage and impact information

The right wingtip separated when it struck a low rocky outcrop. The aircraft yawed right and landed in waist-deep water in the surf some 10-15 m further on. The force of impact of the fixed main gear with the sand and water caused the wing assembly to separate from the fuselage. The fuselage came to rest on its left side. Both engine/propeller combinations remained attached to the wings. Both propellers were bent. The wing flaps were fully retracted. Wave action exacerbated the impact damage and filled the structure with sand.

Aircraft maintenance documentation

The aircraft logbooks and maintenance work sheets were examined. In the period from November 1995 to late February 1996, the records showed that there were six reports of low engine power, mostly involving the right engine. The last report of low engine power was on 24 February 1996, when no fault was found. The aircraft had operated since then without any apparent engine defects requiring rectification. The recording of defects by maintenance personnel was incomplete due to omissions. Pilots had not recorded defects in the aircraft's maintenance release but had annotated a whiteboard in the chief pilot's office which was periodically checked by the chief licensed aircraft maintenance engineer. Defects which required urgent attention were also directly referred (verbally) to the engineer.

Aircraft systems examination

Approximately 100 L of fuel were recovered from the right main and left auxiliary (tip) tanks. The fuel, apart from salt water in the tip tank, was clean avgas. The main fuel-feed and vent lines were inspected and found to be free of any blockages. The left main tank was ruptured. The right auxiliary tank had separated and the cap was off. Neither tank contained fuel. The fuel manifold of both the right and left engines contained fuel. The left fuel gascolator was found to be full of clean fuel. The right gascolator was loose, having sustained impact damage. It contained salt water and sand. The inlet filters in both left and right fuel control units were clean.

Due to the separation of the overhead panel from the fuselage, an examination of the main fuel selectors could not determine the settings. The two auxiliary fuel switches were set to MAIN. This selection was confirmed by the position of the electromechanically activated fuel valve in each wing.

The engines and propellers were dismantled and examined. The investigation gave considerable attention to the fuel injectors due to previously reported problems evident from the aircraft's maintenance history. No evidence of contamination or blockage was found with the injectors, other than some minor salt and sand deposits in two injectors from the left engine, consistent with immersion in the surf.

The condition of each engine was consistent with a low power setting at impact. Both propellers were bent and each was found to be within its normal pitch range. The fuel control units from each engine were functionally bench tested and later dismantled. No fault was found with either unit. Both magnetos from each engine were examined and found to be functional, apart from salt water damage.

The airframe, avionics and instrumentation were examined, but no pre-existing defects were found. Both left engine magneto switches were on but only the left magneto switch of the right engine was on. This is consistent with an incompleted air start attempt as the manufacturer recommends the use of only the left magneto during start. No other useful information was obtained from the engine controls located in the centre console due to the break-up of the wreckage.

Tests and research - aircraft performance

Test flights were arranged to determine certain aircraft performance parameters not available from the manufacturer's data. The pilot conducting the tests was a qualified experimental test pilot. The aircraft used was a Britten-Norman BN-2A-20 with similar performance to that of the accident aircraft, and was ballasted to replicate its weight. The temperature was 19 degrees, within 2 degrees of the temperature at the time of the accident. The Owners Handbook specifies 65 kts as the best single-engine rate of climb speed (blue line on the airspeed indicator). The manufacturer indicated that this speed represents the speed at maximum allowable weight at which the margin of engine power in excess of that required for flight is greatest. The manufacturer indicated that the aircraft should be flown at this speed following an engine failure during the critical initial climb after takeoff.

The following parameters were noted:

(a) At 65 kts, to maintain level flight at 2,000 ft, flaps up and right propeller feathered; power (left engine) required was 19 inches manifold air pressure [MAP] (propeller in full fine pitch).

(b) At 2,000 ft, to maintain level flight, flaps up, left engine at full power, right propeller feathered; stabilised speed was 102 kts.

(c) At 2,000 ft, to maintain level flight, flaps up, left engine at full power, right propeller windmilling (fuel mixture closed); stabilised speed was 80 kts.

The test pilot found that at an air speed greater than 80 kts level flight was not possible with one propeller windmilling. The aircraft would descend at the approximate rate of 200 ft/min. for a 10-kt increase in air speed.

The test flights were conducted in daylight and in visual meteorological conditions with a distinct horizon as an aid to aircraft attitude control. These conditions were significantly better than those on the accident flight. The test pilot found that in order to obtain the best possible performance, fine attitude control was necessary. A significant rate of descent was easily set up by minor attitude deviations and the elevator required careful trimming until stabilised speeds were obtained.

Comparison of automatic voice recorder information

A further flight was conducted in the test aircraft to establish the engine power settings heard in the background of transmissions from the accident aircraft recorded on the Coolangatta AVR tape. A series of transmissions was broadcast from the test aircraft to Coolangatta Surface Movement Control. Each transmission was made with the left engine at a specific power setting and the right propeller windmilling. The power settings varied from cruise power to full rated power. The test transmissions were recorded on the Coolangatta AVR tape and were compared with those from the accident AVR tape. The result of this comparison indicated that the accident aircraft was operating on one engine and that the engine was operating in excess of 2,590 RPM and at greater than 25 inches MAP from 2127:49 until just before impact at 2137:37.

In-flight engine start procedure

The pilot reported that he attempted to start the right engine when he realised that it was unlikely that the aircraft would reach the aerodrome at its current performance. He was unable to restart the engine. Subsequent research found that the manufacturer's Owners Handbook was found to contain a procedure for air-starting an engine which was applicable to the Avco Lycoming O-540 carburettered engine and not the IO-540 fuel injected engine as fitted to this aircraft. The investigation did not reveal whether the pilot used this checklist on the night.

During a test flight the Owners Handbook emergency checklist was used in an attempt to start the right engine, propeller feathered. The test pilot was unable to start the engine using the procedure in the checklist. When the correct start procedure in the Avco Lycoming Operators Manual was used, the engine started immediately. The propeller did not unfeather until the engine started. The aircraft manufacturer confirmed that unfeathering was not possible without an engine start.

The aircraft manufacturer confirmed that the Avco Lycoming Operators Manual procedure was the correct procedure to use in an air start. The manufacturer also said that the Owners Handbook was not an approved document and was provided for advice only. The introduction in the first edition of the Owners Handbook, dated February 1971, states in part that more detailed information is contained in the flight and maintenance manuals.

Information from the pilot

The pilot was aware of incidents involving power losses, including one where a gascolator came loose and sprayed the wing with fuel. As pilot, he was involved in one incident where some fuel injectors to the right engine were blocked. He left the propeller windmilling on that occasion because the aircraft was only 3-4 minutes from landing. The engine stopped during the landing roll but the pilot was able to restart the engine for the taxiing phase.

Observation of pilot's instrument rating renewal test

On 3 July 1996, a Civil Aviation Safety Authority flying operations inspector (FOI) observed an instrument rating renewal test on the pilot. During debriefing the significance of the best single-engine rate of climb speed was discussed. The FOI reported that the pilot did not understand the effects on aircraft performance if the speed deviated from the best single-engine rate of climb speed.

Information from witnesses

Some passengers reported that they saw the right propeller rotating before the final impact.

Witnesses near the beach said that the wind was almost calm. They heard engine noise as the aircraft approached and, when they looked towards the source of the sound, saw the aircraft with its landing lights on. About 10-15 seconds before impact, all engine sound ceased.

Recorded radar data

A secondary surveillance radar transponder with an altitude encoder was fitted to the aircraft. Consequently, aircraft pressure altitude, position and ground speed, as well as time, were recorded on the radar tape. The recorded radar data has been converted to altitude above mean sea level, local time and airspeed. However, the normal performance for this type of aircraft is 126-130 kts indicated airspeed in cruise, and all these aircraft were achieving approximately 130 kts groundspeed. Given this, the winds on the night of the accident flight were probably lighter than assessed by the Bureau of Meteorology.

The radar data showed that the accident aircraft was the slowest aircraft in the cruise phase, at 3,000 ft, compared to the other aircraft. Later, during and after descent to 2,000 ft, airspeed increased to about 130 kts and the other aircraft had airspeeds ranging between 126 kts to 135 kts. The first indication of a problem was at 2127:34 when the pilot transmitted that he had severe problems. Radar recorded that the aircraft descended from 2,000 ft at 2127:53, to approximately 200 ft at 2135:16. The airspeed during this period was approximately 90 kts and the rate of descent averaged 245 ft/min.

In the 1 minute 50 seconds before the aircraft disappeared from radar, the rate of descent reduced to an average of 55 ft/min and the aircraft airspeed progressively reduced from 87 kts to 70 kts.

ANALYSIS

Engine handling

From the pilot's evidence, the right engine surged a number of times. However, no defects were discovered which could explain the symptoms of the right engine surging. Such symptoms would be consistent with air or water in the fuel. Due to the damage to the aircraft, neither possibility could be established.

During level flight at 3,000 ft, the radar data showed that the aircraft was initially travelling at approximately 120 kts. The aircraft's speed increased to approximately 130 kts during and after descent to 2,000 ft. This higher speed continued in cruise and was probably due to the pilot setting a power setting greater than cruise power. Normal company procedure required pilots to lean the fuel mixture at cruise power once the aircraft was stabilised in level flight. If the pilot had not increased the fuel mixture to the engines to compensate for the increased power setting and lower altitude, the resulting over-lean mixture could have caused rough running. There is no evidence that the engine problem was of such severity that it should have been shut down. The pilot's intention to restart the engine later indicated that his earlier action in shutting the engine down was premature.

The pilot had been involved in a previous incident involving this aircraft when the right engine lost power due to the blockage of two fuel injectors. On that occasion he elected not to feather the propeller. This incident and the pilot's knowledge of the aircraft's maintenance history may have predisposed him to expect problems with the right engine and to conclude that the injectors were blocked again.

Propeller feathering

The pilot said that he had shut the right engine down by feathering the propeller, yet evidence indicated that the propeller was windmilling during the emergency sequence. The propeller was found to be in the normal operating range at impact and some passengers confirmed that the right propeller was rotating more slowly than the left propeller during the emergency. The pilot could not restart the engine when he attempted to do so. This information, together with the fact that the propeller cannot be unfeathered without an engine start, proved that the propeller was not feathered when the pilot thought he had done so. He probably brought the propeller lever back into the coarse pitch detent only, instead of fully back into the feather range.

Aircraft handling and performance

The series of test flights confirmed that level flight was possible with the right propeller windmilling or with it feathered, provided that the left engine produced sufficient power. These tests indicated that the flight could have been concluded safely had the pilot flown the aircraft near the recommended best single-engine rate of climb air speed. The radar data showed that the pilot did not fly the aircraft at or near the single-engine best rate of climb speed until just before impact.

The transmission made by the pilot at 2132:01 which included the comment "whatever this configuration is", indicated that the pilot did not understand the reason for the aircraft's apparent poor performance. Following a flight test, the pilot demonstrated that he was not aware that the best flight performance that could be obtained with one engine inoperative was at the best single-engine rate of climb speed.

The pilot's impression that the left engine was not delivering power was probably due to his rationalisation of the aircraft's apparent poor performance. His impression of low power was not supported by the performance profile of the aircraft as shown from recorded radar data, or by the analysis of engine sound during 17 transmissions over a 10-minute period which showed that the engine was operating close to rated power. The pilot would have been aware that the aircraft was capable of level flight at 90 kts with a feathered propeller, the speed maintained during the emergency sequence. However, the propeller was not feathered.

Engine restart

The attempt to restart the engine was made late and at a time when the pilot needed to concentrate on flying the aircraft to its best performance. The reason for the pilot's inability to restart the engine was not conclusively established. Had he used the electric fuel pump while the engine windmilled, it is likely that the engine would have been flooded.

Pilot knowledge and workload

The pilot was a qualified flying instructor. He was also the holder of a command instrument rating for twin-engine aircraft. However, the pilot appeared to demonstrate a lack of understanding of certain aspects of the aircraft's operation, including performance limitations of operating a twin-engine aircraft on one engine, and necessary details of the aircraft's fuel system. This lack of knowledge would have increased the pilot's difficulties in dealing with the apparent engine and performance problems.

During the emergency period, the pilot appeared to be experiencing a high workload. In addition to the difficulties in identifying the nature of the aircraft's performance problems, there were a large number of radio transmissions made to and from other company aircraft. This workload would have contributed to the pilot's difficulties in dealing with the apparent engine and performance problems.

SIGNIFICANT FACTORS

1. The pilot shut down an engine following surging but did not feather the propeller.

2. The aircraft was not flown at (or near) its best single-engine performance speed after the right engine was shut down.

SAFETY ACTION

The Bureau of Air Safety Investigation is continuing its investigation into the incorrect airstart procedure appearing in the Owners Handbook as supplied by the aircraft manufacturer. The results of any recommendation action that may subsequently arise will be published in the Quarterly Safety Deficiency Report.