ACCIDENT

Aircraft Type and Registration:	Britten Norman Islander BN-2A-27, VP-MNI
No & Type of Engines:	2 Lycoming O540 piston engines
Year of Manufacture:	1971
Date & Time (UTC):	17 April 2011 at 1915 hrs
Location:	John A Osborne Airport, Montserrat
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 7
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose structure, nose landing gear, left wing tip and left propeller
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	2,332 hours (of which 839 were on type) Last 90 days - 135 hours Last 28 days - 51 hours
Information Source:	AAIB Field Investigation

Synopsis

After a normal landing the right brake failed. The pilot used the left brake to steer the aircraft into the grass to the left side of the runway to avoid the steep drop at its end. After departing the side of the runway the aircraft hit a raised embankment. The loss of right braking was attributed to trapped air in the hydraulic lines which was probably introduced during a right brake O-ring seal replacement prior to the accident flight. Following this repair work the right brakes had not been bled in accordance with the aircraft maintenance manual (AMM). The investigation also revealed that the aircraft manufacturer and some engineering organisations used a different brake bleeding procedure from that published in the AMM. One Safety Recommendation has been made.

History of the flight

Following an uneventful flight from VC Bird Airport, Antigua, the aircraft made an approach to Runway 10 at John A Osborne Airport, Montserrat. After a normal touchdown the pilot applied the brakes and noticed that there was no resistance from the right brake pedal. While maintaining directional control with the rudder pedals the pilot tried to "pump" the brake pedals but this had no effect on the right brakes. To avoid departing the end of the runway the pilot applied left brake and allowed the aircraft to veer left onto the grass just beyond the taxiway exit. The aircraft struck an embankment located 20 m north of the runway edge, about 150 m from the end of the runway (see Figures 1 and 2). The impact, which was estimated by the pilot to be at about 10 kt, resulted

Figure 1

Accident site

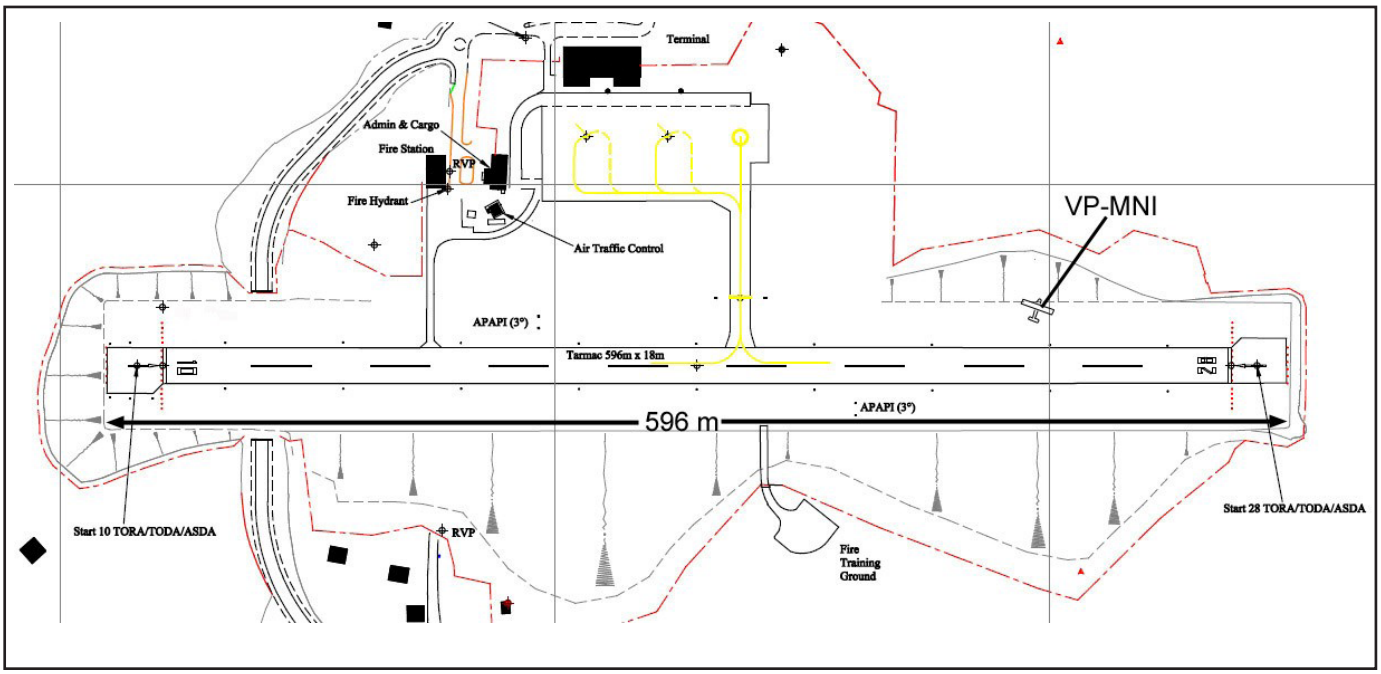

Figure 2

Accident site location relative to the runway

in damage to the nose structure and caused the nose landing gear leg to collapse. The left wing tip leading edge was also damaged when it struck the embankment. After the aircraft came to rest the passengers were able to exit the aircraft via the main door.

Aircraft examination

The aircraft was examined by the aircraft owner's engineering representative. He reported that there were no visible brake fluid leaks and that the left brake operated normally, although the pedal was slightly 'spongy'. However, when the right brake pedal was operated it deflected fully with no resistance and remained depressed. When the right brake pedal was tapped it returned to its normal position. Then, when the pedal was pumped slowly, the brake pressure increased and the right brake began to operate. When the parking brake was applied the right brake remained solidly engaged for a 10-minute test period with no evidence of leakage. When the parking brake selector was released the brake remained on until a greater pressure was applied at the brake pedal – this was consistent with normal operation of the brakes.

The rudder cables and nosewheel steering cables were confirmed to be connected and properly routed. The engineer concluded that the right brake had failed to operate during the landing due to trapped air in the hydraulic lines.

Description of the brake system

The Islander is equipped with four conventional hydraulic fluid operated brake units, one fitted at each main landing gear wheel. The brake system includes four hydraulic master cylinder reservoirs, one fitted at each toe-operated brake pedal which form part of the rudder pedals (see Figure 3). When a brake pedal is actuated, fluid under pressure is routed via a combination of flexible hoses and rigid pipelines to the brake units at the wheels. Bleed screws are located at the top of each main gear leg and at each wheel brake unit. These bleed screws are used to bleed any air within the system. Trapped air in the system can cause the brakes to feel 'spongy' and can prevent brake actuation.

Maintenance history

The same pilot had flown the aircraft into VC Bird Airport, Antigua prior to the accident flight, and noticed on landing that the right brake pedal had to be depressed "almost to the floor" to get pressure. She reported this to the local engineer who inspected the aircraft and found a leak at the right outer brake assembly. He determined that the piston O-ring seal on the right outer brake assembly needed to be replaced. During the replacement of the O-ring a small amount of fluid was lost. He therefore replenished the right master cylinder reservoirs and carried out a brake bleeding procedure with the assistance of the pilot.

The engineer reported that he bled the right brake system by opening the bleed screws on both the right inner and right outer brake assemblies, while calling for the pilot to pump the right brake pedal. When the air was bled from the system he topped up the right master cylinder reservoirs with hydraulic fluid. The brakes were then tested and functioned normally. About 45 minutes to 1 hour after this work was completed the pilot taxied the aircraft for departure and confirmed that both brakes were operating normally.

Brake bleeding maintenance procedures

The aircraft maintenance manual (AMM) for the Islander, chapter 2.9, contains a procedure for bleeding the brake system. The procedure involves gaining access to the bleed screws on top of each main landing gear leg by

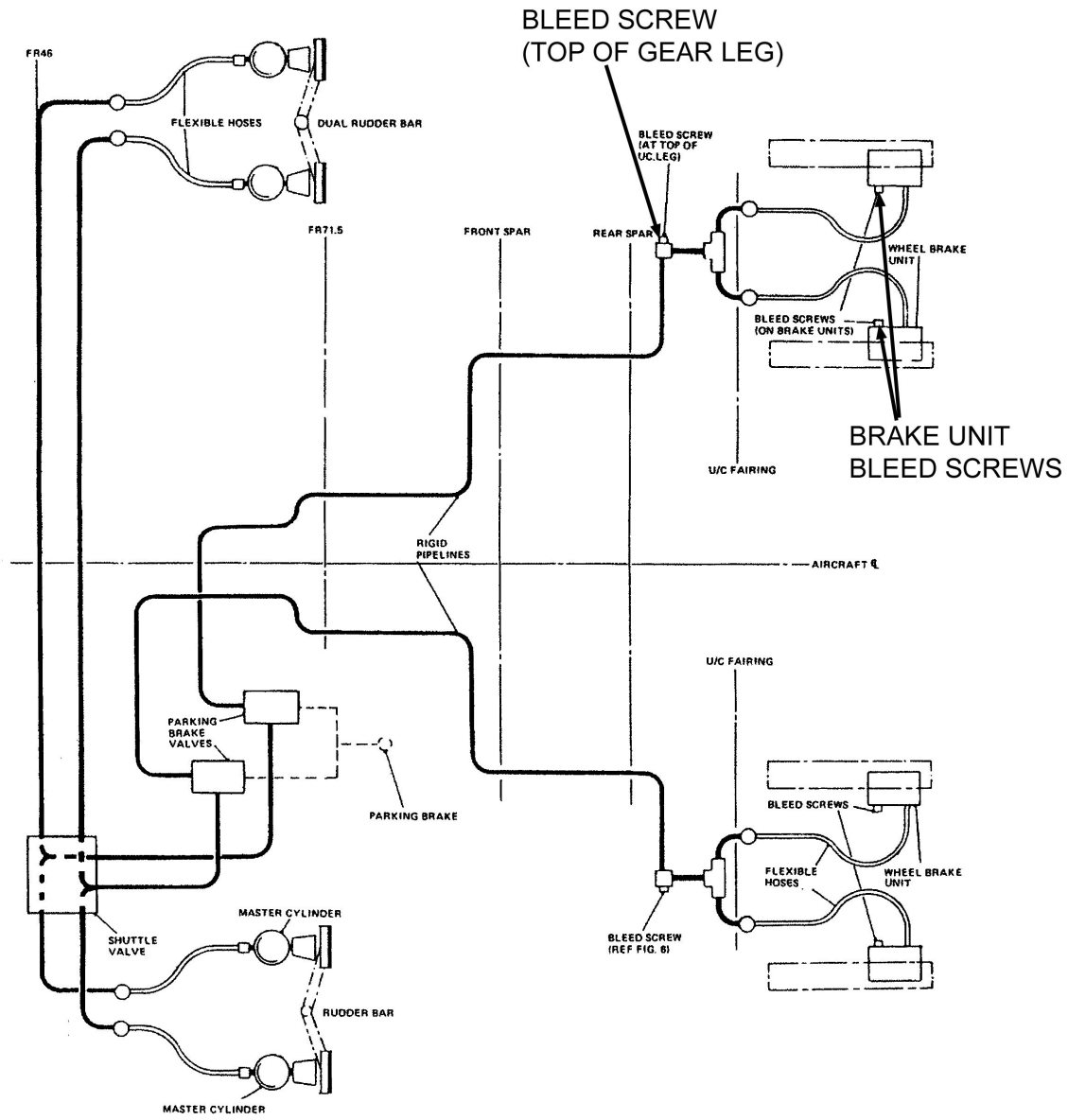

Figure 3

Diagram of the brake system

removing access panels on the upper surfaces of each wing. To bleed the right brake system a polythene tube is attached to the bleed screw at the top of the right main gear leg and tubes are attached to both right brake unit bleed screws. The polythene tubes from each brake unit bleed screw are then placed in a clean container. With the upper bleed screw closed and both brake unit bleed screws open, the right brake pedals are then pumped (at both the pilot and co-pilot positions) until air-free fluid emerges into the container. When clear fluid is seen to be flowing, both bleed screws are tightened. Then the upper bleed screw at the top of the landing gear leg is opened and the same brake pedal pumping procedure is followed. The master cylinder reservoirs are then topped up.

The aircraft manufacturer publishes a different brake bleeding procedure for the Trislander aircraft, even though the brake system on the Trislander is the same as that on the Islander. The brake bleeding procedure in the Trislander AMM calls for the bleeding procedure to be carried out at the upper bleed screw on top of the landing gear leg first. Afterwards, bleeding is carried out at the brake unit bleed screws, but in turn, rather than both at the same time as in the Islander procedure. The Trislander procedure also calls for the polythene tubes to be placed in a container partially filled with hydraulic fluid, rather than in an empty container as in the Islander procedure.

At the time of writing the aircraft manufacturer had not provided an explanation for the difference in procedures. However, they did supply a copy of their production brake bleeding procedure used following assembly of Islander aircraft. This procedure is similar to the Trislander AMM procedure, but instead of calling for the brake pedal to be pumped with a bleed screw open, the production procedure calls for the following repeated sequence for the left brake:

> *'Open bleed valve; push pilot's left hand pedal down and hold; close bleed valve; release pilot's left hand pedal; open bleed valve; push co-pilot's left hand pedal down and hold; close bleed valve; release co-pilot's left hand pedal.'*

and repeat until air-free fluid flow is achieved. This procedure is then repeated at the individual brake units.

The engineering representative for the owner of VP-MNI reported that he had found that the procedure in the Islander AMM did not always result in all trapped air being expelled. He advocated a fourth procedure which involved opening the bleed screw at the top of the landing gear leg and attaching a tube submerged in a container of fluid. A hand-operated oil pump is then attached to a brake unit bleed screw. This pump is then operated until air-free fluid flows from the bleed screw at the top of the landing gear leg. The process is repeated at each brake unit bleed screw. After refilling the reservoirs the brake pedals are then pumped until clear fluid flows from the bleed screws on top of the wing. The procedure also calls for the aircraft to be left to stand for an hour before checking for 'spongy' brakes.

Two UK operators of Islanders and Trislanders were contacted to find out their brake bleeding procedure. One stated that they followed the first part of the Trislander AMM procedure and bled from the upper bleed screw while pumping the brakes, but then used a hand-operated oil can to pump clean fluid into each brake unit bleed screw similar to the procedure used by the engineering representative for the owner of VP-MNI. They stated that if there is any air trapped between the upper bleed screw and the brake units it is more effective to clear this air by pumping it up towards the upper bleed screw than by trying to pump it down towards the brake units. The second UK operator agreed that it was not always possible to eliminate all the air by following the AMM procedure and they also sometimes employed a hand pump.

Pilot licensing

Aviation activities in Montserrat are regulated by Air Safety Support International (ASSI[1]) and are carried out in accordance with the *Air Navigation (Overseas Territories) Order 2007 as amended* (AN(OT)O)

Footnote

[1] Air Safety Support International (ASSI) is a subsidiary company of the UK Civil Aviation Authority and has been designated by the Governor of Montserrat to perform the civil aviation regulatory tasks on behalf of the Governor.

and the *Overseas Territories Aviation Requirements* (OTARs). At the time of writing ASSI did not issue pilot's licences. The pilot of VP-MNI held a JAA (Joint Aviation Authorities) Commercial Pilot's licence issued by the UK CAA (Civil Aviation Authority) with a Montserrat Certificate of Validation issued by ASSI. The pilot also held a JAA Class 1 Medical Certificate issued by the UK CAA. The Montserrat Certificate of Validation enables operations using Montserrat-registered aircraft but ceases to be valid if the UK licence or medical becomes invalid.

The pilot of VP-MNI was about two months pregnant at the time of the accident and she believed that her licence remained valid because she had consulted a JAA aviation medical examiner who had approved her for further flight duties in accordance with the OTARs. The section on '*Pregnancy*' in OTAR 67.209 states that a pregnant pilot can continue exercising the privileges of their licence up to the 30th week of gestation[2]. The section on '*Medical Requirements*' in the AN(OT)O states that a medical certificate shall be suspended on the confirmation of pregnancy, but this suspension may be lifted by the Governor:

> *'for such period and subject to such conditions as he thinks fit.'*

According to ASSI this suspension would normally be lifted until the 30th week of pregnancy in accordance with the OTARs. However, ASSI stated that the pilot should have notified the UK CAA about her pregnancy and would have been subject to CAA rules in addition to the OTARs due to her holding a UK licence. The UK Air Navigation Order states that a UK pilot must notify the UK CAA as soon as pregnancy is confirmed and that this will result in the medical certificate being suspended. The suspension can then be lifted by the CAA following a medical examination. If the examination indicates a normal pregnancy then the CAA will lift the suspension until the 26th week of gestation, but with a multi-pilot limitation in the case of Class 1 certificate holders (in accordance with JAR-FCL 3.195). The pilot of VP-MNI ceased flying after the 24th week of her pregnancy but she was unaware of the UK rules and had been operating single-pilot in the Islander up until that point. The airline operator was aware of the pilot's pregnancy but was unaware that the pilot needed to comply with UK rules.

The International Civil Aviation Organisation (ICAO) has published the following standards relating to pregnancy in Annex 1 on *Personnel Licensing*:

> *'6.3.2.21 Applicants who are pregnant shall be assessed as unfit unless obstetrical evaluation and continued medical supervision indicate a low-risk uncomplicated pregnancy.'*
>
> *6.3.2.21.1 Recommendation. – For applicants with a low-risk uncomplicated pregnancy, evaluated and supervised in accordance with 6.3.2.21, the fit assessment should be limited to the period from the end of the 12th week until the end of the 26th week of gestation.'*

Aerodrome information

The runway at John A Osborne Airport is 596 m long – a distance which includes the two 28 m displaced thresholds at both ends. The declared landing distance available (LDA) for Runway 10 is 540 m. There is a

Footnote

[2] OTAR Part 67 was based on the original Bermuda Rule Part 67 which included the 30th week gestation limit. During the drafting of OTAR Part 67 ASSI requested the UK CAA's Medical Division for comments on Bermuda Rule Part 67 and since no comments on the pregnancy requirements were made they were adopted without change in OTAR Part 67.

near vertical drop in excess of 200 feet at the end of this runway. On 31 May 2011 another Islander aircraft, registration VP-MON, almost departed the end of Runway 28. This incident was the subject of an AAIB Special Bulletin S2/2011 published on 21 July 2011. Issues relating to the aerodrome will be discussed in the final report on the VP-MON incident.

Analysis

On landing, the aircraft suffered a loss of right braking and, in order to avoid the steep drop at the end of the runway, the pilot elected to use the left brake to steer the aircraft into the grass to the left side of the runway where it hit a raised embankment. The probable cause for the loss of right braking was trapped air in the right brake hydraulic lines. This air may have been present prior to the O-ring seal removal but was more likely to have been introduced during the seal removal and replacement. The engineer had carried out a brake bleeding procedure but he had not completed the full procedure as described in the AMM. He had not opened the bleed screw at the top of the right landing gear leg, and therefore air may have remained trapped in these lines. The investigation revealed the existence of several different brake bleeding procedures. The aircraft manufacturer had three different brake bleeding procedures, namely the Islander AMM procedure, the Trislander AMM procedure and their own production procedure. Three engineers from three different maintenance organisations had suggested that sometimes the manufacturer's procedures were inadequate for completely bleeding all the air out and that a hand pump attached to the brake bleed screws was sometimes required. Therefore the following Safety Recommendation is made:

Safety Recommendation 2011-093

Britten-Norman Aircraft Limited should review the different brake bleeding procedures for the Islander and Trislander aircraft including those used by engineering organisations, determine the most effective procedure and publish it in the aircraft maintenance manuals.

The pilot's pregnancy had no bearing on the cause of the accident, but the investigation revealed differences in the rules relating to pregnancy. The OTAR rule permitting flight up to the 30th week of gestation is different from the CAA rule of 26 weeks and the ICAO recommendation of 26 weeks. This difference resulted from OTAR 67 being based upon Bermuda Rule Part 67. The OTARs and ICAO Annex 1 allow for single-pilot operations while pregnant, whereas the CAA rules only permit multi-pilot operations by pregnant pilots holding a Class 1 medical.

Safety action by ASSI

In light of these findings ASSI have stated:

'As part of the ASSI ICAO Corrective Action Plan, OTAR 67 will be subject to a thorough overview and revision in association with the UK CAA Medical department'.

Safety action by the aircraft manufacturer

The aircraft manufacturer responded to Safety Recommendation 2011-93 with the following statement:

'Britten-Norman Aircraft Ltd are aware of detail differences in the brake bleeding procedures published in the aircraft maintenance manuals for different marks of aircraft with similar brake

systems. All of the procedures are considered to be effective providing they are followed correctly. Notwithstanding this, it is accepted that variations to the procedures may result in improved efficiency of the brake bleeding process with or without the use of additional equipment. Additionally, there would be merit in having a common procedure which takes advantage of best practice developed by the aircraft operators over years of in-service experience. Britten-Norman has, therefore, instigated a review of the different known bleeding procedures with a view to developing a common procedure which can be tested and approved prior to being published in the aircraft maintenance manuals.'