

Investigation Report

Identification

Type of Occurrence:	Serious incident
Date:	31 March 2015
Location:	Wangerooge
Aircraft:	Airplane
Manufacturer / Model:	Britten Norman Limited / BN-2B-26
Injuries to Persons:	None
Damage:	Minor damage to aircraft
Other Damage:	None
State File Number:	BFU 7X004-15

Factual Information

History of the Flight

The pilot stated that at about 1600 hrs¹ he finished his lunch break and took over the airplane. He removed the rudder arrestor before boarding the airplane. At that time the rudder was intact. Then he taxied to the departure point of runway 28 on the Island of Wangerooge. From the apron, the taxiway initially led approximately 1,000 m towards south-east and then for about 950 m east parallel to the runway to the departure point. During the initial climb after take-off at approximately 1608 hrs, the pilot

¹ All times local, unless otherwise stated.

noticed malfunction of the rudder. The pilot radioed another airplane up in the air with him. The pilot of the second aircraft visually inspected the rudder and determined that the rudder was not moving even if the pedals were actuated. The pilot of the damaged aircraft decided to perform a precautionary landing. He used asymmetric thrust settings of the engines and landed at Harle Airport. The landing occurred without further problems.

On board were the pilot and eight passengers.

Personnel Information

The 59-year-old pilot held a valid pilot's licence issued in accordance with Part FCL and the commensurate ratings. His class 1 medical certificate was valid until 30 May 2015. He had a total flying experience of 7,974 hours and 21,300 landings. Of these he had conducted 2,250 hours and 11,250 landings on BN-2.

Aircraft Information

The Britten Norman BN-2 is a twin-engine high-wing aircraft in all-metal construction. The fixed tricycle landing gear had a nose wheel configuration. Maximum take-off mass was 2,994 kg. It was powered by two Lycoming O-540-E4C5 piston engines. At the time of the occurrence it had a total operating time of 8,484:36 hours and 84,171 landings. The aircraft had a German Certificate of Registration and was operated by a German operator.

The airplane was equipped with a fuselage mounted tail plane. Rudder pedals in the cockpit controlled the rudder via two control ropes in the fuselage, which move a lever in the area of the vertical tail. The lever is connected with the rudder via a control rod. The control rod transforms the movements of the lever to rudder deflections.

The Flight Manual Chapter 2 Limitations stated that the airplane must not be taxied in wind speeds in excess of 55 kt. It also stipulated that the airplane was capable of landing with a 30 kt cross wind.

The last maintenance action, where the rudder control was inspected and lubricated, was the 50-hour check performed on 2 March 2015. On the day of the inspection the aircraft's total operating time had been 8,451:28 hours and 83,693 landings. Since the last inspection the airplane had flown 33:08 hours and performed 478 landings.

Meteorological Information

The Deutscher Wetterdienst (German meteorological service provider, DWD) stated that at the time of the occurrence a storm front with high wind speeds prevailed at the North Sea shore. The following wind values were recorded at 16:00 hrs at automatic weather stations in the area: Spiekeroog 300° with 60 kt – gusts up to 76 kt; Norderney 290° with 43 kt – gusts up to 66 kt; Bremerhaven 290° with 43 kt – gusts up to 60 kt; Wittmundhafen 290° with 37 kt – gusts up to 60 kt. The surface wind chart showed at 16:00 hrs in the area of Wangerooge a mean wind of 53 kt from 290°.

Wangerooge Airport was equipped with an air speed indicator, which was mounted on top of the control tower. The Flugleiter (A person required by German regulation at uncontrolled aerodromes to provide aerodrome information service to pilots.) could read the wind data on a display in the control tower. The control tower is located at the northern edge of the airport, approximately 1,340 m north-west of the runway threshold 28. The wind data was recorded and made available to the BFU. Between 1600 and 1630 hrs the wind came from the north-west with 47 - 53 kt. The Flugleiter had given the pilot the prevailing wind information prior to take-off.

Ground visibility was 10 km.

Aerodrome Information

Wangerooge Airport is located at the North Sea island Wangerooge and has two runways. The asphalt runway was 850 m long, 20 m wide, and had the orientation 10/28. The grass strip was 500 m long, 30 m wide, and had the orientation 02/20. From the apron the taxiway initially led approximately 1,000 m towards south-east and then for about 950 m east parallel to the runway to the departure point.

Harle Airport had one asphalt runway with a length of 510 m, a width of 20 m, and the orientation 09/27.

Wreckage and Impact Information

The rudder control rod was torn off the clevis, which was mounted to the rudder lever (Appendix Image 1). Two thirds of the part of the control rod mounted to the clevis were missing. The remaining third was bent backward (Appendix Image 2). The three rudder hinges were damaged. Image 3 (Appendix) shows the centre hinge.

The fracture pieces were examined at the Technische Universität Braunschweig, Institut für Füge- und Schweißtechnik (ifs). The fracture surface was subject to macroscopic and microscopic examination. Metallographic specimens were prepared and measurements of hardness conducted.

The aircraft manufacturer stated that Aluminium-Copper Alloy L 105 had been used, as is often the case in aircraft design. It is seamless drawn tubing similar to Alloy 2014A.

The examination of the fracture surface with a scanning electron microscope showed destroyed fracture structures. But there were enough intact fracture structures left. These showed repeated evidence of fracture by shear stress consisting of slip lines and shear dimples (Appendix Images 4 and 5). The residual fracture occurred as ductile forced rupture (Appendix Image 6).

The metallographic examination did not reveal any irregularities in the material structure. The hardness of the fracture area had a slightly higher mean value than the unaffected area of the component cross section.

Fire

There was no fire.

Additional Information

After the occurrence, the operator changed the maximum wind speed for taxiing from 55 kt to 50 kt.

Analysis

The rudder control rod failed due to ductile forced rupture in the form of a fracture by shear stress. The increased hardness of the fracture area was due to deformation hardening.

It is highly likely that the forced rupture occurred due to the high wind stress the rudder had transferred to the rod during taxiing in strong and gusty crosswind and tailwind. The wind stress occurred because of the strong and gusty west wind prevailing at the time of the serious incident. The gusty wind resulted in wind stress changes on the rudder during taxiing which was the critical factor.

In regard to the certified aircraft flight envelope the wind situation was marginal. Due to the prevailing gusts, it is highly likely that the maximum allowable wind speed for taxiing was temporarily exceeded.

The airplane had had a certificate of registration and the stipulated maintenance had been conducted. The wind speed stipulated in the handbook had not been exceeded.

The pilot was properly qualified. In addition, he was very experienced flying the aircraft type and very familiar with island flying operations. After the control rod had fractured, he handled the situation appropriately, and completed the flight in a controlled manner and without further problems.

Conclusions

The rudder control rod failure was the result of a forced rupture, which had been caused by the wind load affecting the rudder. The reason for the wind load was the strong, gusty wind (storm) in combination with the specified taxiway to the runway.

Safety Recommendations

Safety Recommendation No. 03/2016

The aircraft manufacturer should subject possible wind loads affecting the vertical tail, which are the result of wind speeds and air impingement angle during taxiing, to differentiated consideration and counteract resulting negative effects.

Investigator in charge:

Nehmsch

Braunschweig 25 November 2016

Appendix



Image 1: Rudder lever including clevis



Image 2: Torn-out control rod



Image 3: Damaged centre rudder hinge

Photos (3): Operator

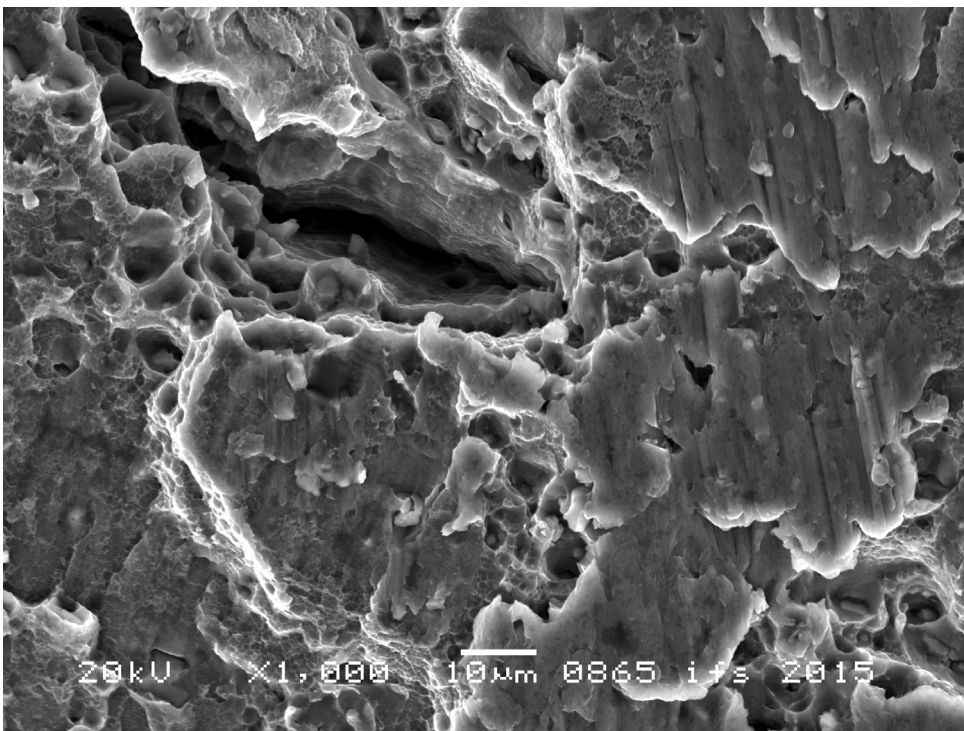


Image 4: Ductile fracture surface with shear lines

Photo: ifs

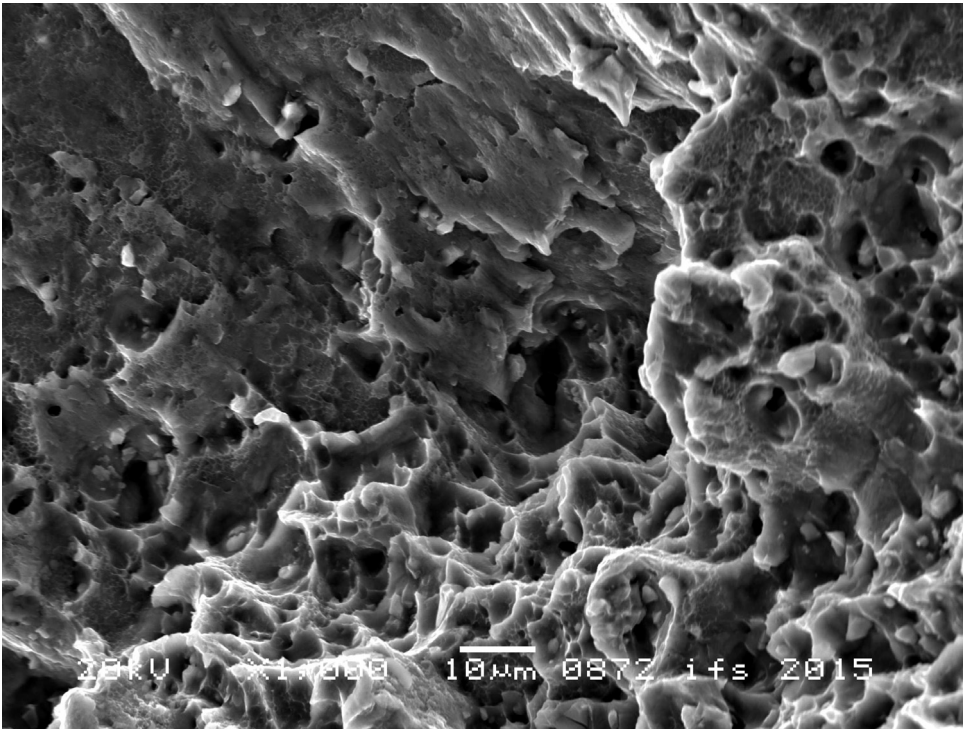


Image 5: Ductile forced fracture structure with shear dimples

Photo: ifs

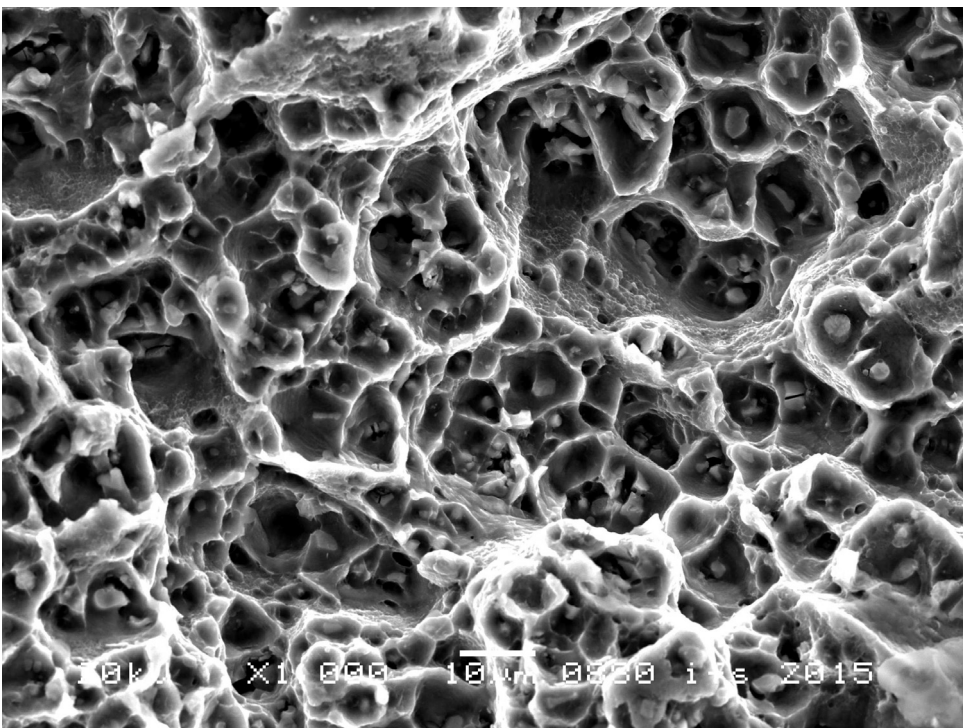


Image 6: Ductile forced rupture and residual fracture structure

Photo: ifs

This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FIUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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