**AAIB Bulletin No: 4/94** **Ref: EW/C93/9/3** **Category: 1.1**

## INCIDENT

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| **Aircraft Type and Registration:** | Boeing 767-336, G-BNWG | |
| **No & Type of Engines:** | 2 Rolls-Royce RB211-524H turbofan engines | |
| **Year of Manufacture:** | 1989 | |
| **Date & Time (UTC):** | 17 September 1993 at 1934 hrs | |
| **Location:** | London Heathrow Airport | |
| **Type of Flight:** | Public Transport | |
| **Persons on Board:** | Crew - 11 | Passengers - 186 |
| **Injuries:** | Crew - None | Passengers - None |
| **Nature of Damage:** | Damage to right main landing gear and brake components | |
| **Commander's Licence:** | Airline Transport Pilot's Licence | |
| **Commander's Age:** | 46 years | |
| **Commander's Flying Experience:** | 12,000 hours (of which 1,800 were on type)<br>Last 90 days - 174 hours<br>Last 28 days - 57 hours | |
| **Information Source:** | AAIB Field Investigation | |

This incident is similar to that involving Boeing 767-336, G-BNWS at London Heathrow Airport on 9 September 1993.

### History of the flight

The first officer was the handling pilot for a manual landing on Runway 27R. The surface wind was calm and the weather was good. Following a normal landing, using autobrake No 2 and full reverse thrust, the autobrakes were disengaged by applying manual braking; at this point the brakes snatched noticeably. After vacating the runway, the crew noticed a 'Landing Gear Monitor' status message and then, while taxiing, noted that the right hydraulic quantity was decreasing. Then, as the aircraft arrived on stand the 'Hydraulic Quantity' warning message illuminated. Following engine shutdown, the commander was informed that the brakes were "steaming" and he called for the AFS. The AFS arrived quickly and washed away the hydraulic fluid which was leaking from the landing gear. The passengers were disembarked normally but expeditiously.

## Technical examination

When the landing gear was examined, it was found that the brake reaction rod had become detached from the piston housing on the brake for the No 8 wheel (outboard aft wheel on the right-hand main landing gear). Witness marks on the brake reaction rod showed that the brake piston housing had then rotated rapidly on the axle, detaching the brake hydraulic lines.

The accompanying figure shows the brake components of the 767 main landing gear. The torque loads from each brake assembly are reacted by the brake reaction rod, which is attached to the torque arm of the piston housing by the brake attachment pin. This pin is retained within the brake piston housing by a single cross bolt. The brake rod centre bolt acts as a pivot pin, securing the forked ends of the fore-and-aft brake reaction rods to a fork lug at the lower end of the inner cylinder of the landing gear leg.

In this occurrence to G-BNWG, the brake attachment pin had migrated out of the brake piston housing as a result of the failure of the retaining cross bolt, the head of which remained with the piston housing. The migration of the brake attachment pin under load was demonstrated by damage to the torque arm on the piston housing; the torque arm had been 'ovalised' on the side adjacent to the brake reaction rod and its bronze bushing had been badly damaged.

Evidence available on the broken cross bolt itself demonstrated conclusively that its failure was caused by overload in shear and that the bolt had not suffered any significant damage before it failed. The manner in which this failure occurred was consistent with a shearing action between the brake attachment pin and the torque arm of the brake piston housing, both of which exhibited damage demonstrating this action. The relative positions of the damage sites suggested that the shearing action had taken place at one end of the cross bolt only and that it had resulted from a slewing, or 'prying', action induced by a very large load applied through the brake reaction rod.

## Previous failures and interim remedial actions

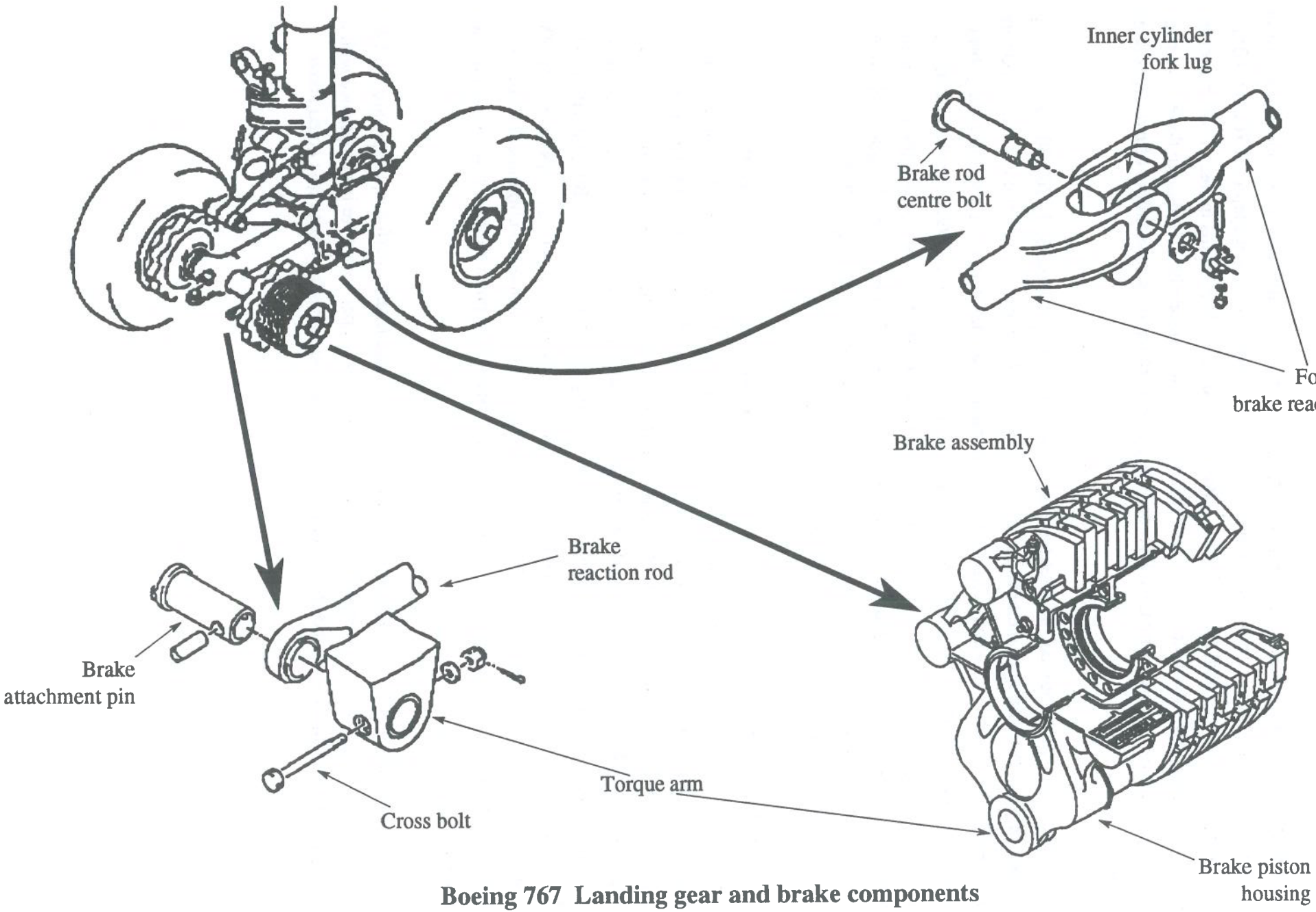
This occurrence to G-BNWG was eight days after a similar, but not identical, occurrence to another Boeing 767-336, G-BNWS, also at London Heathrow Airport. The occurrence to G-BNWS on 9 September 1993 is reported separately in the adjacent item in this AAIB Bulletin. For 767 aircraft, information from the operator, the manufacturer and the CAA show a total of some 20 structural failures in the brake reaction load path over a period of some 15 months. These were predominantly failures of cross bolts (as in G-BNWG on 17 September and G-BNWS on 9 September); a smaller number were failures of the brake rod centre bolt and one was the failure of the piston housing torque

arm itself. There had also been a larger number of brake losses due to failure of the quick disconnect hydraulic fitting for which the interim remedial action, detailed in Service Bulletin SB 767-32-A0125, has been a separate technical issue. Failure of the brake rod centre bolt results in loss of two brakes in-line; the majority of cross bolt failures have resulted in the loss of one brake although there have been at least two instances (including G-BNWS on 9 September) of simultaneous failure of two cross bolts in-line.

These cross bolt and centre bolt failures have occurred to aircraft, predominantly 767-300 series, using carbon brakes. According to the airframe manufacturer, the high loads in the brake reaction rods are the result of 'squeal' vibration, characterised by rotational deflection of the stationary brake components about the axle centrelines. During September and October 1993 a series of dedicated instrumented flight tests were conducted to develop understanding of the mechanism and to evaluate a number of potential interim and long-term remedial actions. In the United Kingdom, the CAA imposed a Brake Energy requirement reduction with both operators of Boeing 767-300 series aircraft, equivalent to the loss of two brakes, in addition to other interim measures.

The records show that failures of the brake rod centre bolt are related to the number of landing cycles and that increased frequency of inspection and replacement of these bolts is likely to be effective in containing the problem. The low number of cycles on some failed cross bolts, however, and the lack of pre-existing damage on the cross bolt from G-BNWG, indicate that failure of the cross bolt is largely independent of the number of landings. Separate Service Bulletins have been issued concerning the brake rod centre bolt and the piston housing cross bolt. Service Bulletin SB 767-32-A0116 details inspection and replacement of brake rod centre bolts and bushings, repeated every 800 flight cycles. Service Bulletin SB 767-32-A0126 includes a modification to eliminate the cross bolt and, in its stead, installs a 'keeper' pin to retain the brake attachment pin within the piston housing and the brake reaction rod.

On 22 February 1994 the CAA completed the lifting of the Brake Energy performance penalty on UK operators of 767-300 aircraft equipped with carbon brakes as both operators were in compliance with a package of Service Bulletins issued by the airframe manufacturer, including those SBs noted above.




**Boeing 767 Landing gear and brake components**
**(G-BNWG, 17/9/93 and G-BNWS, 9/9/93)**