

**INCIDENT**

<b>Aircraft Type and Registration:</b>	Boeing 757-236, G-BMRE	
<b>No &amp; Type of Engines:</b>	2 Rolls-Royce RB211-535C-37 turbofan engines	
<b>Year of Manufacture:</b>	1988	
<b>Date &amp; Time (UTC):</b>	30 July 2005 at 0819 hrs	
<b>Location:</b>	Nottingham East Midlands Airport, Derbyshire	
<b>Type of Flight:</b>	Training	
<b>Persons on Board:</b>	Crew - 4	Passengers - None
<b>Injuries:</b>	Crew - None	Passengers - N/A
<b>Nature of Damage:</b>	Damage to No 3 wheel and brake assemblies	
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence	
<b>Commander's Age:</b>	58 years	
<b>Commander's Flying Experience:</b>	18,000 hours (of which 8,000 were on type) Last 90 days - 30 hours Last 28 days - 14 hours	
<b>Information Source:</b>	Operator's Safety Department Investigation Report and Aircraft Accident Report Form submitted by Operator's Flight Safety Officer	

**Synopsis**

The aircraft had been positioned at Nottingham East Midlands Airport early in the morning of 30 July 2005, following which various maintenance activities took place, including changing the No 3 wheel brake unit. The aircraft subsequently took off to fly training circuits but, on the second touch-and-go, the Control Tower advised the crew that flames were seen to be coming from the right main landing gear. The commander elected to continue the touch-and-go and to fly a circuit with the landing gear down, as he was concerned about stopping the aircraft in the runway distance remaining. After a successful landing, the aircraft was brought to a stop on the runway and inspected by the fire service, prior to being towed to a stand.

The fire was later attributed to a failure in the No 3 brake unit. This was caused by the end cap of the brake torque rod not being refitted during the maintenance activity, thus allowing one end of the brake torque rod to become detached and scrape along the ground during the landing. The brake unit rotated with the wheel during the rollout, causing damage to the wheel, severance of the brake hose and damage to the brake temperature monitoring components.

**History of flight**

The aircraft had been positioned at Nottingham East Midlands Airport at 0157 hrs on the morning of the incident, following which various maintenance activities

were carried out, including changing the No 3 wheel brake unit. It was planned to fly training circuits later that morning, commencing around 0800 hrs with a flight crew consisting of the Operator's Chief Training Captain (the commander), two student co-pilots and a fully qualified co-pilot acting as a safety pilot. The student pilots were to occupy the right hand seat, in turn, with the safety pilot on the jump seat. Later that day, following the crew training detail, it was intended that the aircraft would participate in an air display.

The takeoff and first touch-and-go on Runway 27 were uneventful but, on the second touch-and-go, the Control Tower advised the crew that flames were seen coming from the right landing gear. The commander elected to continue and to fly a circuit with the landing gear down, thus allowing him to assess the situation in the air. This also reduced the risk of an overrun during a rejected takeoff on the runway remaining. The commander instructed the student co-pilot to continue flying the aircraft in a visual circuit so that he could assess the situation. There were no reported abnormal indications on the flight deck but the commander recalled the entry in the technical log relating to a brake change on the right gear leg. He decided to let the student co-pilot continue with the circuit and land the aircraft under his guidance, but to take control during the landing roll.

ATC requested that the aircraft to be brought to a stop on the runway and for the crew to then shut down both engines. Accordingly, the APU was started prior to the approach and, after touch down, the commander took control and brought the aircraft to a stop using reverse thrust and the left wheel brakes. Subsequently, the Fire Officer at the scene reported a hydraulic leak and damage to the right main landing gear but that there was no evidence of smoke or flames having affected the wheels. After an inspection the aircraft was towed to a stand.

### **Boeing 757 Main Landing Gear Brake installation**

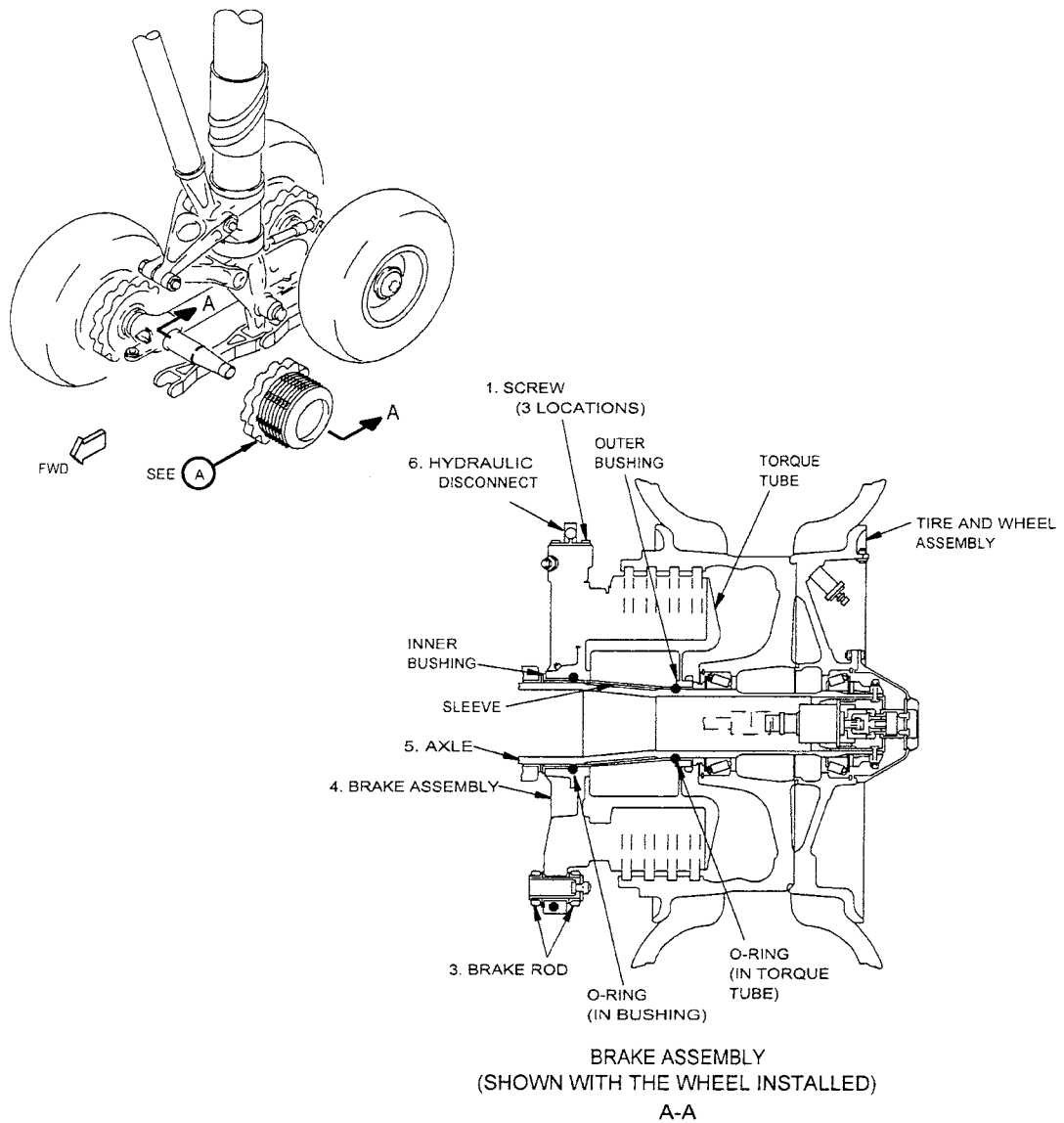
The Boeing 757 has two main landing gear legs, each configured with four wheels. Each of the main gear wheels has a brake unit, and each unit is connected to a brake rod to prevent the brake unit rotating when the brakes are operated. A diagram of the installation of a typical brake unit is shown in Figure 1.

The brake rods are attached to the brake units by means of a pin, end cap, lockbolt and a nut, and their installation is illustrated in Figure 2.

### **Operator's investigation**

The Operator's Safety Department conducted an engineering investigation using Boeing's Maintenance Error Decision Aid (MEDA), which included interviews with the relevant shift supervisor and the two maintenance engineers who carried out the brake unit change. During these interviews, it was emphasised by the operator that the purpose of the investigation was not to apportion blame but to establish what happened in order to prevent recurrence. It was noted by the operator that all personnel interviewed had an open and positive attitude to the investigation and were entirely co-operative throughout.

It was established that the brake rod pin end cap had not been fitted, which resulted in a situation in which the pin worked its way free from the brake assembly. This allowed the brake rod to hang vertically downwards and impact the ground during a landing, and the brake assembly to rotate and sever hydraulic and electrical lines. This sequence of events is corroborated by the operator's report in which it was stated that:



- 1 TIGHTEN TO 100-200 POUND-INCHES
- 2 INSTALL THE PIN WITH THE HEAD ON THE TRUCK SIDE AS SHOWN (PREFERRED)  
INSTALL THE PIN WITH THE HEAD ON THE BRAKE SIDE (OPTIONAL, NOT SHOWN)

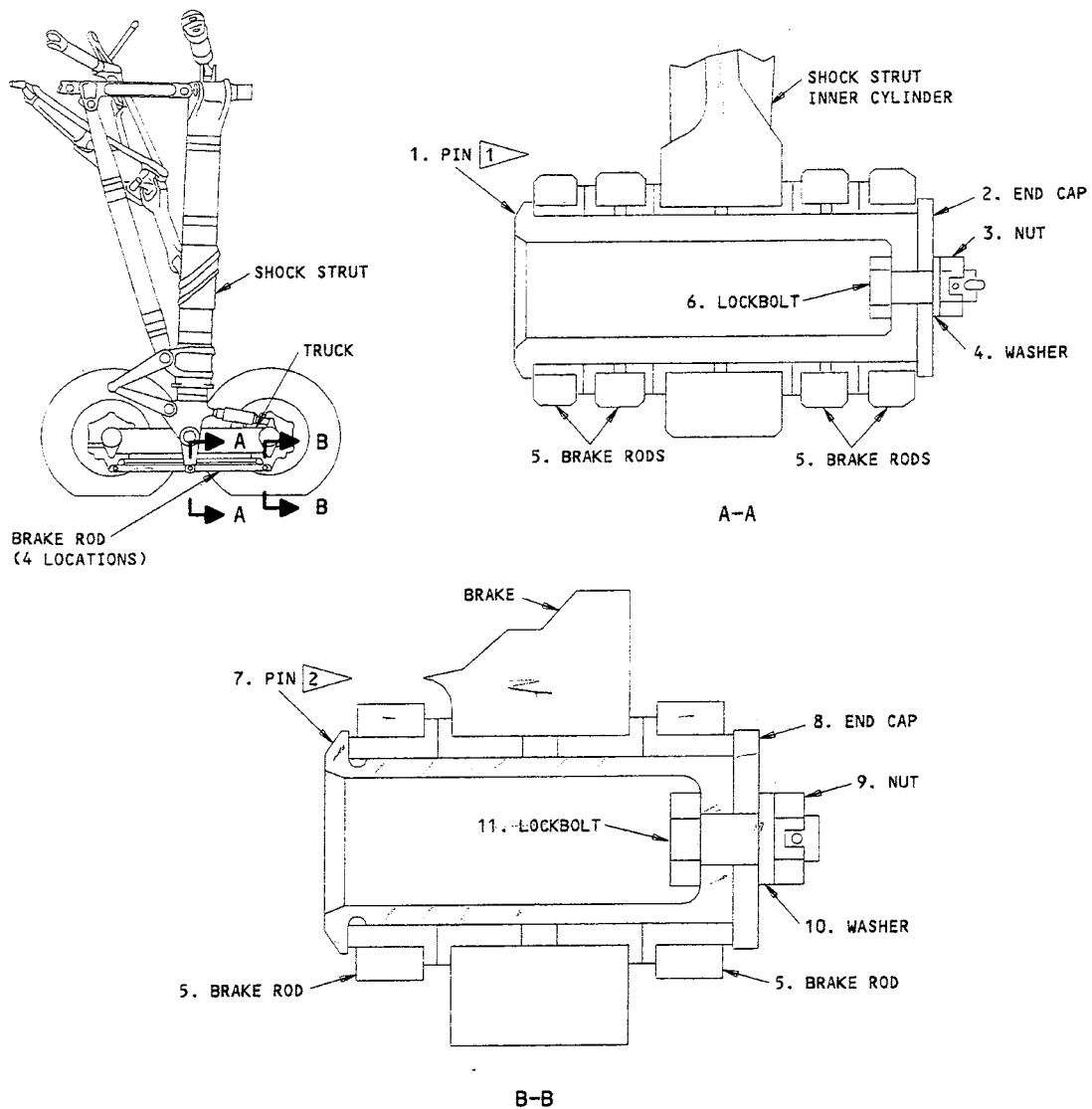
Main Gear Wheel Brake Installation  
Figure 401 (Sheet 1)

**Figure 1**

Boeing 757 Main Gear Brake Installation showing brake rod (item 3)

(Ref. Boeing Maintenance Manual 34-41-10)

(Information contained in Figure 1 is for illustrative purposes only)



- 1 INSTALL THE PIN WITH THE HEAD INBOARD
- 2 INSTALL THE PIN WITH THE HEAD ON THE TRUCK SIDE (PREFERRED)  
INSTALL THE PIN WITH THE HEAD ON THE BRAKE SIDE (OPTIONAL)

Main Landing Gear Brake Rod Installation  
Figure 401

**Figure 2**

Detail of Boeing 757 Main Gear Brake Installation showing attachment of brake rod. Note end cap (item 8)

(Ref. Boeing Maintenance Manual 34-41-10)

(Information contained in Figure 2 is for illustrative purposes only)

*'the brake rod was worn down to approximately 60% of its original length during the aircraft landing roll'. The rod, being made from steel, would be likely to have produced a wealth of sparks during the second touch-and-go and the subsequent landing.*

MEDA is an event-based investigative tool and the investigation established that the end cap was missing from the No 3 Wheel Brake Unit following the maintenance activity to replace the brake unit. The circumstances leading to this event were identified as follows:

On 29 July, the aircraft arrived at Nottingham East Midlands Airport (NEMA) at 2025 hrs where a service check had been scheduled. Routine maintenance and some additional maintenance tasks were planned to be carried out that night on several aircraft, and the shift supervisor had arranged his personnel into two teams for the shift. One of these teams had been allocated to conduct the service check and wheel changes on G-BMRE, and the supervisor considered that this was perfectly acceptable in terms of workload. The team noticed that the brake pin wear indicator on No 3 wheel was below a 'company' acceptable level and, mindful that the aircraft was to conduct a training detail and take part in a flying display later in the day, it was decided to change the brake unit that night. However, the maintenance activity was not carried out immediately as the aircraft was used for two further sectors, returning to NEMA at 0157 hours the following morning. The supervisor then allocated a further two teams to the task, thus providing extra manpower for the required maintenance so that all the tasks could be completed within the shift time period. One of the

original team, who were allocated to the aircraft to carry out the brake unit change, recommended that the change be carried out later that morning, in daylight, but this was not considered necessary by the supervisor. No reference was made at this time to the Maintenance Operations Control department.

The work to change the brake was subsequently carried out by torchlight and, although arc lighting was available, they considered it too awkward to use for routine maintenance activities on the line. During this work, the maintenance personnel were subjected to numerous interruptions. One was asked to carry out a duplicate inspection on another item of the service, whilst another team required the use of the jack to change a wheel. Another maintenance engineer was carrying out a greasing task of the service, which resulted in numerous dirty rags lying about the wheel area. Neither of the engineers changing the brake unit realised that they had not fitted the brake rod pin end cap, partly due to the fact that the lockbolt did not rotate when tightened. From previous experience, they understood that the lockbolt would move when tightened should the end cap not be fitted.

There was no requirement for a duplicate inspection following a brake unit change.

### **Safety action**

The MEDA process employed by the operator established that the end cap from the brake torque rod of the No 3 wheel brake had not been re-fitted during the maintenance activity to change the brake unit. Contributory factors were identified as:

- *Repetitive task, or the 'know how'<sup>1</sup> principle*
- *Inadequate task planning*
- *Peer and time pressure*

As a result of their investigation, the operator's Safety Department has identified safety actions to the aircraft operator's management, the intent of which is as follows:

- The authority to change the established maintenance programme, to include additional activities, should be reviewed and 'risk managed'.
- Maintenance personnel should be reminded of the need to review maintenance procedures before carrying out maintenance tasks.
- Whilst there is no requirement for a duplicate inspection following a brake unit change, consideration should be given for the need to conduct an independent check following such activity.
- Additional or refresher training for engineering Supervisors should be considered to ensure that correct maintenance procedures are followed at all times, and to make such personnel more aware of the pitfalls of conducting maintenance activity in poor environmental conditions, including poor lighting.

Also, as a result of this incident, a series of safety training days has been organised by the operator, during which this event is used as a case study.

In consideration of the safety action proposed by the operating company, it is considered not necessary to make any formal Safety Recommendations.

### Conclusions

The flight crew were unaware of a problem until ATC warned them that flames were seen coming from the right landing gear. The commander's recollection of the entry in the technical log referring to a brake change enabled him to make a prompt and good decision to continue with the go-around and not attempt to stop the aircraft on the runway remaining. A decision to stop could have further jeopardised the aircraft due to the possibility of overrunning the end of the runway.

A combination of factors affecting the maintenance team's performance in carrying out the brake unit change, were identified. These were: multiple interruptions during the task, poor lighting conditions and a change to their routine maintenance tasks, a change that was taken without consultation with Maintenance Operations Control.

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#### Footnote

<sup>1</sup> A situation where a repetitive task is carried from memory, rather than by reference to the maintenance manual, due to the familiarity of the task.