INCIDENT

Aircraft Type and Registration:	Boeing 747-200, ZS-SAL
No & Type of Engines:	4 Pratt and Whitney JT9D-7J turbofan engines
Year of Manufacture:	Not known
Date & Time (UTC):	2 April 2000 at 2139 hrs
Location:	London Heathrow Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew – N/A Passengers – N/A
Nature of Damage:	Damage to left wing landing gear No 2 wheel, right main gear door and right wing landing gear
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	N/A
Commander's Flying Experience:	N/A
Information Source:	AAIB Field Investigation

Incident during taxiing for departure

After an overnight stop, the aircraft was subjected to a daily check by the handling company for the operating airline prior to an intended flight to Johannesburg. This included a visual check of the wheels, tyres and brakes for condition and wear, in addition to checking of the tyre pressures; all checks were satisfactory.

Towards the end of the taxi out to the hold for Runway 9R, which was reported to have been conducted at speeds no higher than 9 kt, the crew heard a loud bang and felt a slight 'bump'. Almost immediately all of the anti-skid warning lights associated with the right wing landing gear illuminated on the flight deck. About this time a passenger informed the cabin crew that he had seen a tyre roll from under the aircraft across the grass between the taxiway and the runway. The aircraft stopped at the holding point and was duly inspected by airport personnel. It was evident that the inboard rim of the No 2 wheel (front inboard wheel of the left wing landing gear) had completely detached from the wheel and this had allowed the tyre to come off. After wheels Nos 1 and 2 had been changed, the aircraft was towed back to the gate where the passengers disembarked normally.

Secondary damage

Further examination of the aircraft revealed that fragments of the failed inboard rim had been jettisoned by the released inboard wall of the tyre and caused impact damage to the right main gear door, the right wing landing gear and its folding door. In addition, a wiring conduit which was mounted on the right wing gear drag brace, and contained the anti-skid units wiring, had been severed in two places. The No 2 wheel, tyre and rim fragments were collected and taken to the AAIB for detailed examination.

Wheel examination

The tyre was intact and in good condition, with no evidence of unusual damage. The wheel comprised 'inboard' and 'outboard wheel halves' which were bolted together to form a complete hub, as illustrated in the diagram at Figure 1 (Note: although this cross section correctly shows the smaller 'outboard wheel half', coloured in red, in this wheel position this wheel half is on the inboard side of the wheel). The larger 'inboard wheel half' (coloured yellow in the latter diagram) was designed to mate with the brake pack, with each wheel half containing a taper roller bearing.

The fracture had occurred in the region where the inboard side rim adjoined the cylindrical section of the wheel hub, as indicated by the 'fracture line' drawn in the diagram at Figure 1, and illustrated in the lower photograph of the wheel. The rim had fractured into three sections, as shown in the photograph at Figure 2; each rim section weighed between 3 and 6 lbs. Metallurgical examination of the fracture surfaces found that all exhibited the characteristics of a single event overload, but initiated by a high cycle tension fatigue crack in the bead radius of the rim, which had extended over a length some 4 inches. The associated fracture characteristics suggested that this fatigue crack had initiated from a single point, possibly a surface defect, rather than from several points as may occur when service loading is higher than predicted.

Information supplied by the wheel manufacturer indicated that the tyre bead seat radius on this wheel was a critical area for tension fatigue stresses and therefore, in order to increase its resistance to fatigue cracking, this region of the wheel was shot peened at manufacture to generate compressive stresses in the surface region of the radius.

After the wheel had been cleaned at the manufacturer's UK facility, it was readily apparent that the peening effect had previously been polished out over a length of some 9 inches, and that the fatigue crack origin had been located within this polished band. The effect of this polishing had been to remove most of the compressive layer induced in the radius surface by the peening at manufacture, and the polishing had also left many scores in the new surface. These polishing effects are illustrated in the photographs at Figure 3. The photograph and diagram of the fatigue initiation area at Figure 4 shows that the fatigue origin was no longer present, due to a small layer of material from the surface having been removed by the polishing operation. This indicated that the embryonic fatigue crack had initiated before the polishing operation and had not been completely polished out.

The Component Maintenance Manual (CMM) for this wheel recommended that an eddy current or ultrasonic inspection technique should be used to check for cracks in the area of, and on both sides of, the bead seat radius and stated that 'no wheel shall be returned to service with cracks'. Some reworking of the bead seat areas was permissible within the limits specified in the CMM, but it was a requirement that the surface treatment should be restored.

Whilst at the manufacturer's facility, the opportunity was taken to check for any other cracks or defects in the 'inboard wheel half', using their normal ('Hocking') eddy current test method where a probe, which lightly rests against the surface, is traversed upwards as the wheel rotates. Several defects were identified, as shown in Figure 5, together with areas of polishing where presumably previously identified defects had been removed. Following this inspection, the relevant parts of this wheel were passed to the manufacturer for further examination.

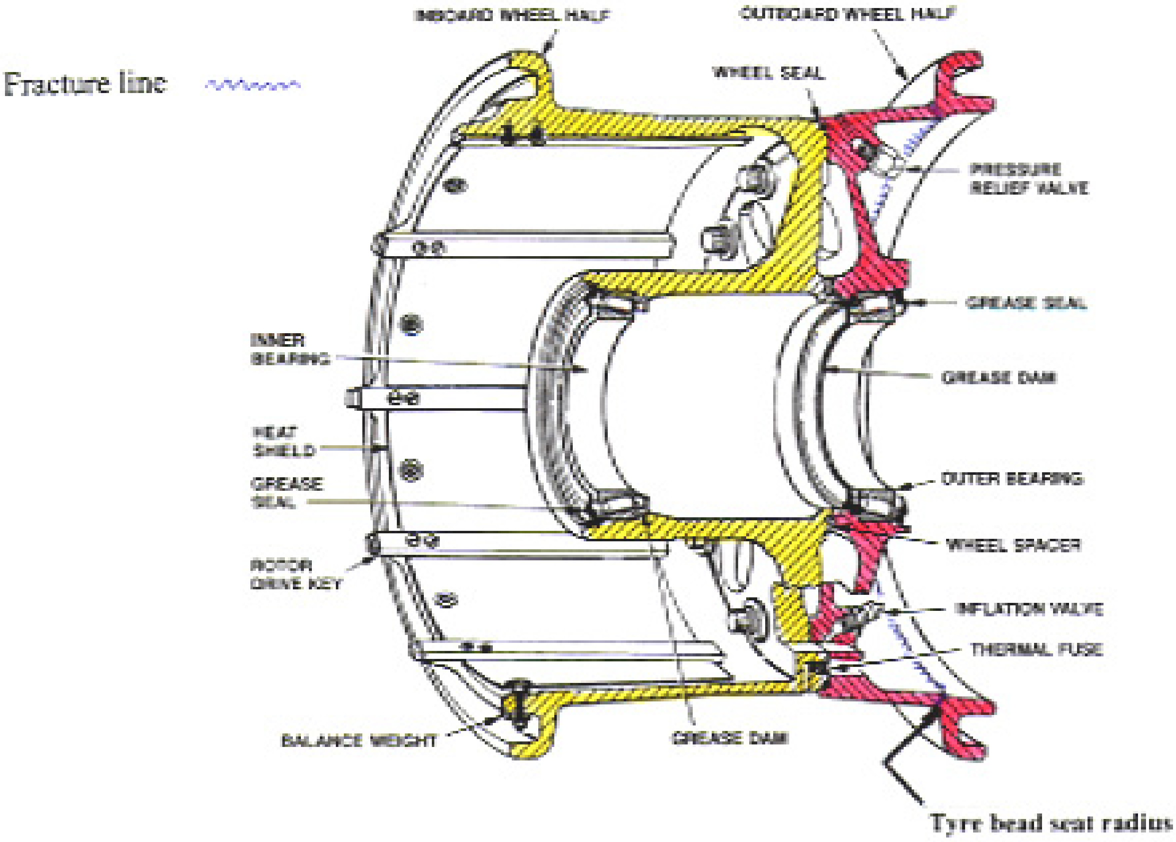
Wheel history

The failed wheel assembly, Part No 2603561, was a very early standard of this wheel type which had been designed for the Boeing 747-200/300. The current standard of this wheel has many modifications incorporated, including a change to a 'compound bead' seat radius for improved fatigue resistance.

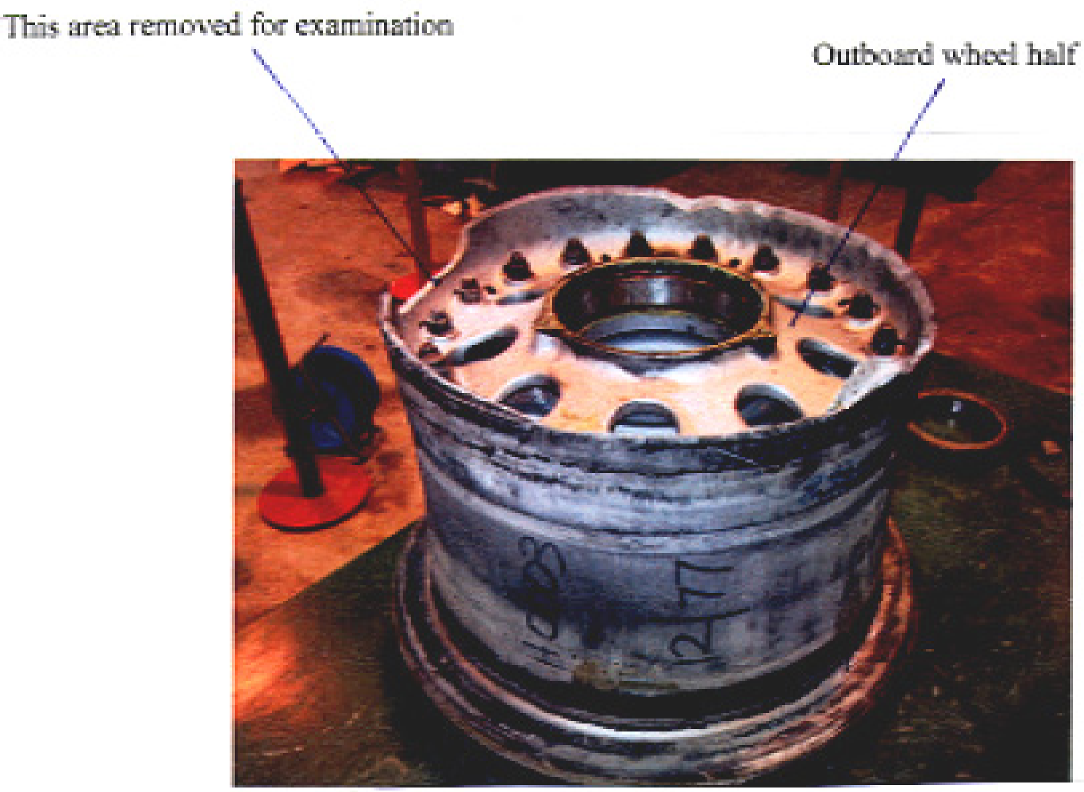
At the time of this incident, the total cycles accumulated by the failed 'outboard half' (Serial No H192) of this wheel assembly, which was manufactured in October 1995, were 7,174 and its total number of associated tyre changes were 101. The operator's records also indicated that it had last been checked for cracks using the 'Hocking' eddy current system on 7 February 2000, when no cracks were detected, and since that time it had accumulated 84 cycles.

By comparison, the 'inboard wheel half' (Serial No H0003) was manufactured in December 1977 and had accumulated a total of 6,436 cycles. The CMM requires wheel halves of the above age to be inspected every three months.

WHEEL DETAILS



747-200/300 WHEEL P/N 2603561-15/16



Identification marks on failed half:-

I BENDIX, 49X17, TYPE VII, ASSY 2603561, CHG, SA260378,MFD1075, PN260377K, 5083409, ISBN, FAATSOC 2660B0014, H192, SAA 168

Figure 1

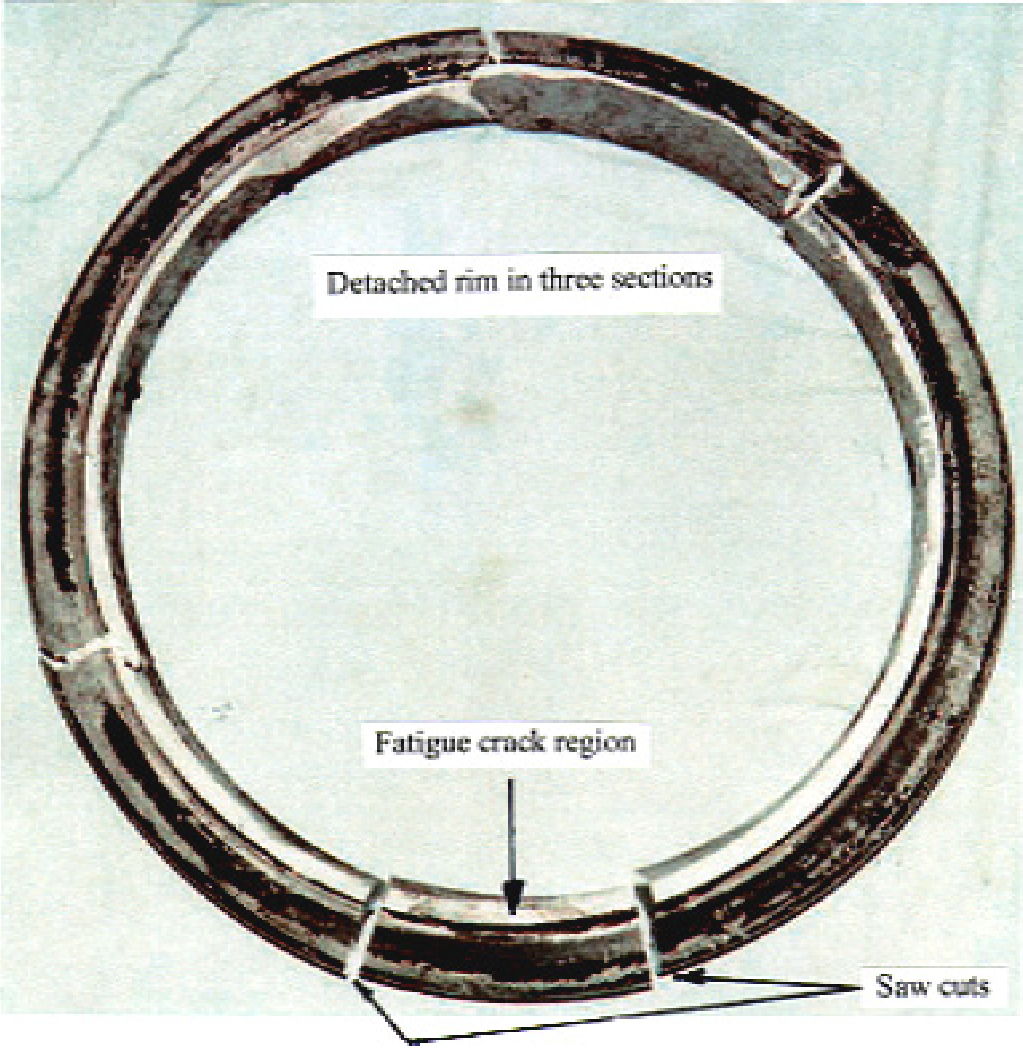
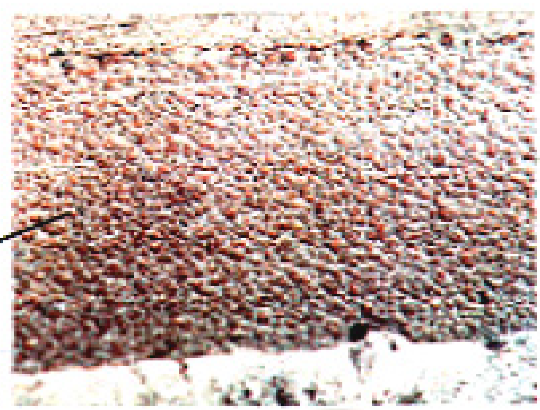
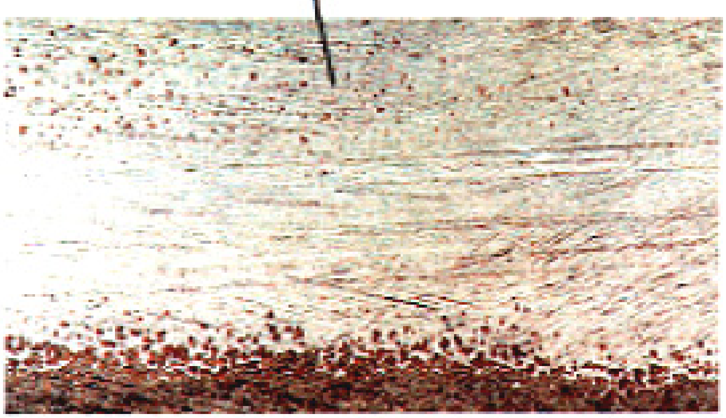


Figure 2

a



b



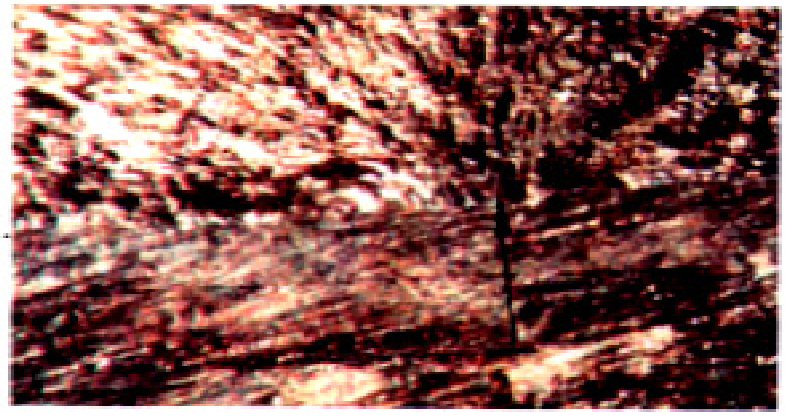
c

a. Tyre bead seat radius showing region where shot peened surface has been polished away. Crack origin to left of picture.

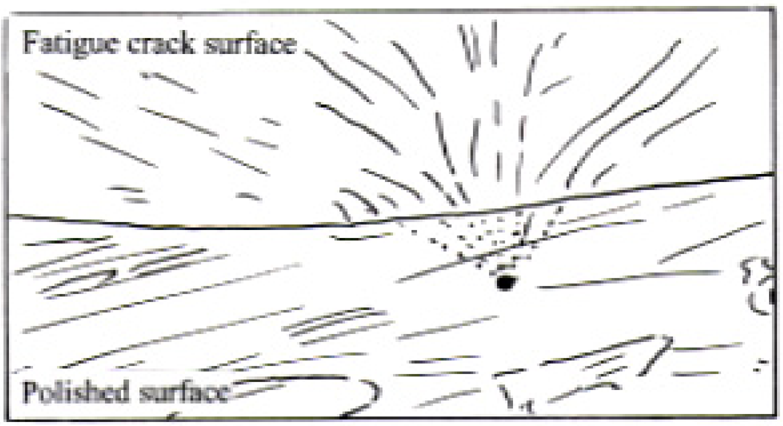
b. Detail of 'correct' shot peened surface.

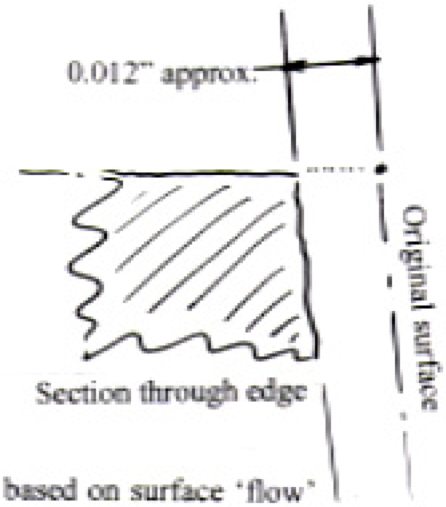
c. Detail of surface where shot peened surface is polished away with resulting scratches.

Figure 3



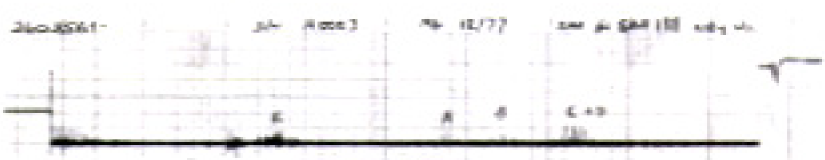
Detail of crack origin area, x45, showing intersection of fatigue surface and polished surface.

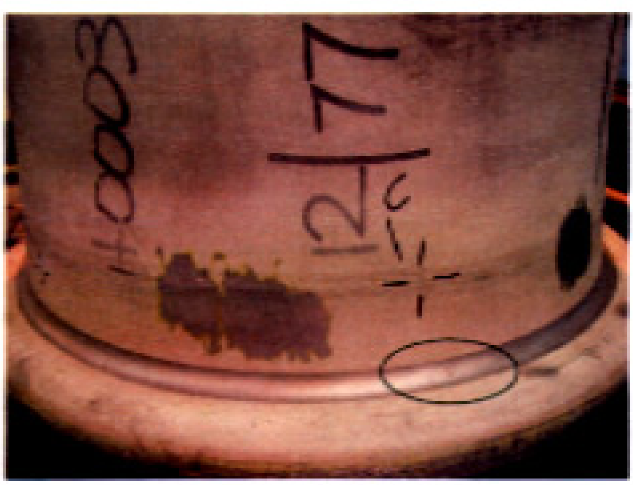




Photograph and diagram illustrating likely position of crack origin based on surface 'flow' lines tending towards a single point.

Figure 4





Defects identified in inboard wheel half

Figure 5