AAIB Bulletin No: 8/94 **Ref: EW/C94/6/4** **Category: 1.1**

INCIDENT

Aircraft Type and Registration:	Boeing 747-136, G-AWNO	
No & Type of Engines:	4 Pratt and Whitney JT9-D turbofan engines	
Year of Manufacture:	1973	
Date & Time (UTC):	14 June 1994 at 1425 hrs	
Location:	West of London Heathrow Airport	
Type of Flight:	Public Transport	
Persons on Board:	Crew - 18	Passengers - 370
Injuries:	Crew - None	Passengers -None
Nature of Damage:	Localised fire damage to No 3 engine	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	N/K	
Commander's Flying Experience:	N/K	
Information Source:	AAIB Field Investigation	

The aircraft had just taken off from Runway 27R, Heathrow, on a flight to New York with the first officer handling when, at a height of around 1,000 feet, the No 3 engine fire fault light illuminated on his annunciator for approximately 5 seconds. Some 10 to 15 seconds later, at around 2,000 feet, the No 3 engine fire switch illuminated with a full fire warning. The commander and engineer officer actioned the relevant fire drill whilst the first officer continued to fly the standard instrument departure and informed ATC of the event, asking them to standby. The engine was shut down in accordance with the checklist and the fire warnings ceased as soon as the first fire bottle had been discharged. Under the direction of ATC, the aircraft was climbed to 10,000 feet to the south west of the Isle of Wight where fuel was dumped. An uneventful three engined precautionary landing was later made at London Heathrow Airport with the fire service in attendance, the crew later reporting that throughout the event ATC had been very helpful. After landing, the fire vehicle crews made a visual check of the engine and, as there were no signs of a fire, the aircraft was taxied to a stand where the passengers disembarked normally.

An initial examination by airline maintenance personnel of the No 3 engine revealed a localised area of 'sooting' external to the engine casing, but beneath the cowlings, in the region of the primary and secondary fuel manifold pipes at the 11 o'clock position (viewed from the rear). Sooting had occurred

to most items in this region, including a cable loom, although heat damage was present on the feed wires to the fire detector loops. Close inspection of this area revealed that hard contact was present between the primary fuel manifold pipe and the underside of the left side thrust member (Figures 1 and 2) and between the primary feed pipes to the No 1 and 2 nozzles from the primary manifold (Figure 5) at the 12 o'clock position. The engine was transferred to a specialist maintenance facility where further investigation was undertaken. After exposing the area of contact on the primary manifold, it could clearly be seen that the pipe wall had been worn through to such an extent that a split of approximately 1 mm in length had developed (Figure 3) and that wear, similar in area and depth, was present on the underside of the thrust member. Significant fretting damage was also present on both nozzle feed pipes. During the time on the wing, no recorded maintenance had taken place on or near to the area of fire.

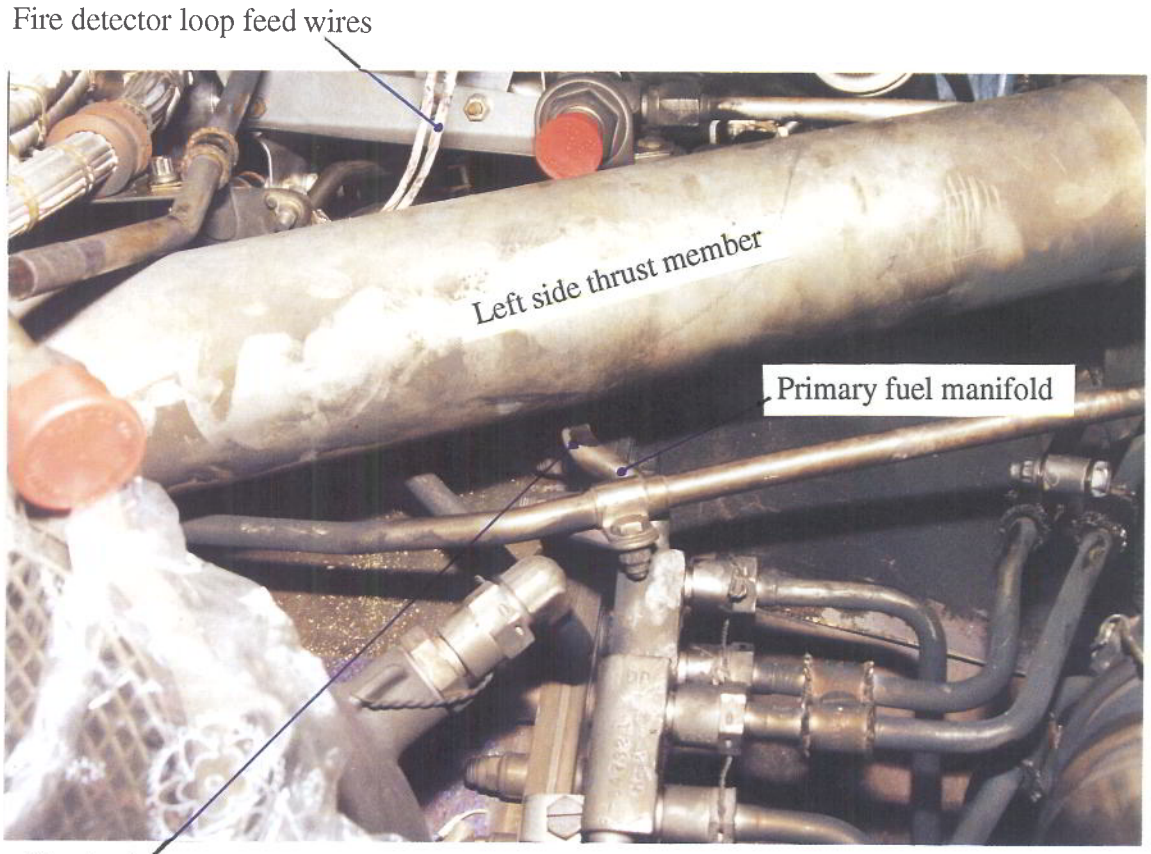
The manifold pipe was removed from the engine, examined and compared with a known serviceable manifold. It became readily apparent that the defective manifold, overall, was deformed slightly and that when strained to the correct shape, the 'S-shaped' bend (normally positioned beneath the thrust member) flexed in such a manner that would cause it to follow a path closer to the underside of the thrust member, by some 0.4 inch.

The primary fuel manifold in the area of the thrust member is the subject of Pratt & Whitney Service Bulletin No 2864, originally issued in 1970, which provided for additional clearance between it and the engine thrust frame, as a result of deflections under load. This was accomplished by modifying the S-shaped bend in the pipe in the region under the thrust frame. The Service Bulletin requires that, after installation, a clearance of 0.3 inch exists between these two items. Reference is also made to this clearance in the engine Overhaul Manual, Installation 19 (Engine Support Set), the document to which the maintenance organisation work. This engine was overhauled some 809 hours/117 cycles prior to the fire, at which time the records indicated that the manifold was passed fit for further service, and at the appropriate time refitted to the engine. This operation, however, is carried out at a different time to the refitment of the thrust frame, at which time the clearance should be checked. Although the worksheet instructions call for the installation to be carried out in accordance with the Install 19 section of the manual, there are no specific instructions on the worksheet. The examination of this engine also revealed that nozzle 1 and 2 feed pipes had not been cleated in accordance with the Overhaul Manual, although this area was visible during all stages of engine build.

It was established from the maintenance organisation that these operations during engine re-build are carried out by personnel who are cleared to be self-authorising, ie installation, inspection and records entry are done by the same authorised person. The maintenance organisation, since this event, are considering writing a specific instruction into the worksheets to check for manifold pipe clearance and manufacturing a simple jig to check the manifolds for correct profile just prior to installation.

General View of Engine Left Side with Fire Affected Area Identified

Figure 1

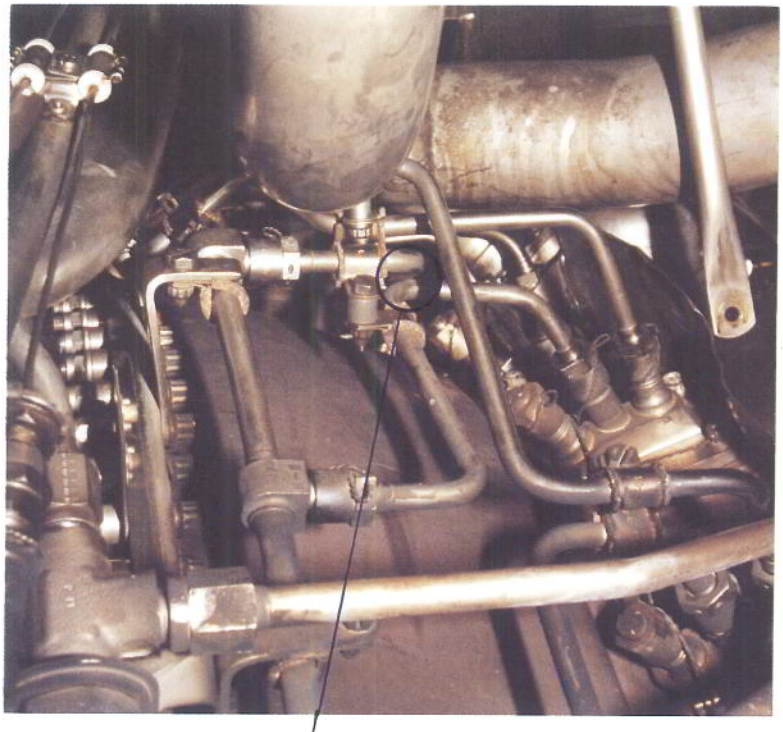


Contact Area Between Thrust Member and Primary Manifold with Thrust Member in Raised Position

Figure 2

Close Up of Fuel Pipe Damaged Area Showing Central Split **Figure 3**

Damaged Manifold (upper) Strained into Correct Shape Above an Undamaged Item. Note difference in 'height' of Curved section **Figure 4**



Photograph of Primary Feed Pipes to the No 1 and 2 nozzles, as installed. Contact area between these pipes identified. **Figure 5**