No: 8/92 **Ref: EW/C92/4/8** **Category: 1a**

Aircraft Type and Registration:	BAe ATP, G-PEEL	
No & Type of Engines:	2 Pratt and Whitney 126 turboprop engines	
Year of Manufacture:	1990	
Date & Time (UTC):	19 April 1992 at 1942 hours	
Location:	Liverpool Airport	
Type of Flight:	Scheduled passenger	
Persons on Board:	Crew - 4	Passengers - 29
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Nose gear collapsed; nose gear door torn off; abrasion to underside of nose and damaged tips on the right propeller	
Commander's Licence:	ATPL(A)	
Commander's Age:	45 years	
Commander's Flying Experience:	10,528 hours (of which 1410 were on type) Last 90 days -112 hours Last 28 days - 28 hours	
Information Source:	AAIB Field Investigation	

History of the flight

The aircraft flew from Belfast to Liverpool where it was prepared for the 1850 hrs service to the Isle of Man. The weather was CAVOK and the wind was 340°/06 kt. as the aircraft took off from runway 27 with the commander handling. When the first-officer raised the landing gear lever, there was a loud 'thump' from beneath the flight deck. As the gear retracted, the main gear lights sequence was normal but the nose gear red light remained on, indicating that the nose gear was neither 'locked up' nor 'locked down'. The gear was then re-cycled. The main gear legs locked down, and up, but the nose gear indication remained red throughout the cycle; the gear was then selected down and the nose gear position light remained red. Whilst the pilots were reviewing the checklist, a hydraulic overheat warning illuminated. (On the ATP, the hydraulic system powers only the landing gear, nosewheel steering, wheelbrakes and airstairs).

The commander elected to remain close to Liverpool Airport whilst the appropriate drills for hydraulic overheat and emergency lowering of the landing gear were completed. The overheat drill was successful and main hydraulic pressure was restored before landing but, despite carrying out a long sequence of alternative selections and aircraft manoeuvres, the nose landing gear remained unlocked. During a flypast of the tower the nose leg was seen to be partially, but not fully, extended. Moreover, the nosewheel steering tiller would not move from a position slightly displaced from neutral. The commander recognised that the nosegear was likely to collapse on landing but, if it did not, there was also a chance that he would be unable to prevent the aircraft from veering-off the side of the runway, at speed. He decided to land at Liverpool and asked for a full emergency services standby. The commander kept the passengers fully informed of the situation and of any unusual manoeuvres. He also instructed the cabin crew to move some passengers aft in the cabin, in order to keep them clear of the plane of the propeller tips, and to move the aircraft's centre of gravity rearwards. After clearing the cabin and flight deck of any loose articles, the crew prepared for a full emergency landing whilst the airport fire vehicles, supplemented by the local authority fire vehicles and ambulances, were assembling on the airfield.

The commander was faced with the choice of burning-off fuel and landing in darkness, or landing in daylight with significant excess fuel. He elected to burn-off fuel until just before dark (sunset was at 1920 hrs) and to land on runway 09 from a visual approach. Instructions to the cabin occupants to adopt forced landing positions were given at the appropriate heights on final approach, which culminated in a 27° flap landing with a V_{ref} of 96 kt. At the commander's request, as the aircraft touched down on its mainwheels, the runway edge and centreline lights were switched off by ATC. Whilst the commander held the nose gear off the runway, the first officer simultaneously shut down both engines, activated the engine fire extinguishers and switched off the batteries. The commander held the nose wheel off for several additional seconds before lowering it gently on to the runway. However the nose leg collapsed forwards almost immediately and the underside of the nose contacted the runway, trailing a large plume of 'sparks'. The aircraft was brought to a halt close to the centreline of the runway and near to its midpoint. The emergency services arrived within seconds and used foam to cool the underside of the nose. All the passengers were evacuated through the left forward exit door after the escape slide had inflated. There were no injuries. Some time later the passengers' baggage was removed from the aft baggage compartment. The girt bar of the rear right escape slide was not disconnected from the floor brackets before this door was opened and the associated escape slide inadvertently deployed. After deployment it was noted that this slide terminated about 3 feet above the runway (Figure 5). Joint Aviation Requirements (JAR) certification requires that slides reach the ground after a nosegear collapse.

Flight data recorders

The flight data recorder (FDR) fitted was a Plessey PV1584F1 combined data acquisition and recorder unit, with a recording duration of 25 hours, recorded digitally on magnetic tape. A total of 27 analogue parameters and 5 discretes were recorded. A satisfactory replay was obtained using AAIB replay facilities.

The cockpit voice recorder (CVR) was a Fairchild A100, which has 30 minute duration using an 'endless loop' of tape. A satisfactory replay was again obtained using the AAIB replay facility. The tape had overwritten the take-off from Liverpool and recording began during preparations for the emergency landing.

Examination of the nose landing gear

The aircraft was subsequently recovered from the runway to a suitable hangar and the nose landing gear inspected. The ATP is fitted with a Dowty manufactured landing gear, very similar to the landing gear on the BAe 748 aircraft. The primary attachment of the nose landing gear to the aircraft is by means of a 'pintle-pin', also of Dowty manufacture, which engages in bearing housings in the nose structure, either side of the oleo. The pintle-pin is inserted from the right hand side of the aircraft and is secured in the left hand bearing housing by a retaining bolt which passes through the pin and the housing. A baulk device, of BAe manufacture, is fitted within the end of the pintle-pin, and is designed to prevent assembly of the retaining bolt if it was incorrectly located across the end of the pin, or in the slots which clear the bolts in the bearing housing (see Figure 1). On this aircraft the pintle-pin had migrated out of the left hand bearing housing (Figures 2 and 3) and there was evidence that after this had occurred it had then moved downwards causing the wheels to be displaced to the right. The retaining bolt was in place, undamaged, and was secured with its castellated nut and split pin; however there was evidence that it had been fitted across the end of the pintle-pin, instead of through the holes in the end of the latter. The baulk device was damaged in that the lug was broken off and the baulk was pushed down inside the pintle pin (Figure 4). It had therefore not performed its intended function.

Technical records

Examination of the maintenance records showed that the aircraft had been released to service following an E10 check on the 13th of April 1992. At that time the aircraft had completed 4673 airframe cycles. At the time of the accident it had accumulated a total of 4718 cycles. The Technical Log contained the following entry on the 15 April 1992: "Nosewheel steering - handle feels unloaded throughout a high degree of movement and steering less responsive." In response to this entry the steering cables were

checked and found serviceable. The problem was carried forward for further investigation and the aircraft returned to service. The job cards for the E10 check also showed that the nose landing gear had been changed at that time. This was to permit the embodiment of a modification which replaced the oleo with one of a later modification standard.

Fitting of the nose landing gear

The nose landing gear change during the E10 check was signed-off by a Licenced Aircraft Engineer, acting as Shift Supervisor. The task was carried out by two fitters. Neither the Shift Supervisor nor the fitters were familiar with the task; this was the first occasion that a nose landing gear had been changed on this operator's ATP fleet. The BAe ATP Maintenance Manual contained descriptive guidance for the task, but did not include any cautions or warnings. The Shift Supervisor was assisted by the Deputy Base Engineer who had been involved in similar work on an ATP belonging to another operator. In addition, the airline's Base Engineer was reported to have been present for some of the time.

With the aircraft on jacks, the pintle-pin was withdrawn and the nose landing gear removed. The pintle pin was examined. It was observed by the Deputy Base Engineer to be in good condition and to have the baulk device correctly fitted. He therefore suggested to the Shift Supervisor that the same pin be re-used as this would avoid removing and re-fitting the baulk device. This was agreed and the two fitters positioned the replacement landing gear under the aircraft ready for installation. BAe have since advised that a support trolley is specified for this task, but no such device was used. Some difficulty was experienced in re-fitting the pintle-pin due to imperfect alignment of the nose gear with the bearing housings. A 'drift' was used to tap it fully 'home' and the position was confirmed by viewing the end of the pin in the right hand bearing housing. It was concluded that the pin was fully inserted but was rotationally misaligned, since the retaining bolt could not be fitted. The pin cannot easily be rotated once in position, so the Deputy Base Engineer advised that, following a short break, the pin should be withdrawn, aligned and re-inserted. He then left the scene. Following the break, the Shift Supervisor observed some of this work but was concurrently engaged in supervising other tasks on the same aircraft. The fitters withdrew the pintle-pin and observed no damage at that time, however they had been under the aircraft during the first attempt at installation and were unclear as to the purpose and function of the baulk device. They marked the pin so as to assist the alignment and re-inserted it. Since the landing gear was now correctly positioned, the pin was inserted without difficulty and was tapped home until it sounded 'solid'. The retaining bolt was then inserted without difficulty, its nut fitted and secured with a split pin. None of this work was observed by the Shift Supervisor. On his return to the nose area of the aircraft, the fitters advised him that the task was complete. The Shift Supervisor then inspected the area, especially noting that the pintle-pin was in position and that the

retaining bolt was in place and locked correctly. Since the pintle-pin appeared to be in place, he believed that the baulk device had ensured that the retaining bolt had passed correctly through the holes in the pintle-pin. The Shift Supervisor then signed the job off, apart from the function checks which were left for the next shift. During the next shift, the function checks were carried out and although another problem associated with the nose landing gear arose, no problem with the pintle assembly was noted. Prior to gear retraction, a close inspection of the pintle area was made and no abnormalities were found. It should be noted that the end of a correctly installed pintle-pin should be flush with the right hand bearing housing, and no protrusion is acceptable. This was not stated in the Maintenance Manual and in fact the pin must have protruded by between about 0.1 and 0.8 inches. However, viewing of this protrusion must be done through a small access panel, looking 'end-on' at the pin, and may therefore be difficult.

Maintenance documentation and operational experience.

The baulk device fitted to the ATP is identical to that fitted to the BAe 748 except that it is somewhat shorter. Its geometry is such that, to fit the retaining bolt, the pintle-pin must be either correctly positioned, or at least 1.8 inches out of position. The baulk was fitted to the 748 by BAe modification action following instances where the retaining bolt had been fitted across the slots at the end of the pin, instead of through the holes. This would have permitted the pin to migrate, as had occurred in this incident. A BAe 748 Service Bulletin had been issued which fully addressed this problem, and the 748 Maintenance Manual reflected this information, however none of this was contained in the ATP Maintenance Manual. As the airline had not previously operated the BAe 748 type, there was no internal expertise which might have countered this deficiency.

Certification of "escape devices" (slides)

The BAe ATP was certificated in accordance with Joint Aviation Requirements (JARs) and British Civil Airworthiness Requirements (BCARs). The respective requirements for escape devices are almost identical. JAR 25.809(f) states, in part:

> "Each aeroplane emergency exit.....more than 6 ft. from the ground.....must have an approved means to assist the occupants in descending to the ground as follows:....."

Sub paragraph (1)(iii) then states:

"It must be of such length after full deployment that the lower end is self supporting on the ground and provide safe evacuation of occupants to the ground after collapse of one or more legs of the landing gear."

The certification demonstration of the slide was conducted by the slide manufacturer using a 'mockup' of part of the fuselage surrounding the rear door. The mockup could be elevated to represent various sill heights. The slide was jointly certificated by the FAA, CAA and the French DGAC. As part of this investigation, the certification demonstration was repeated at normal sill height and at a sill height representative of that caused by a collapsed nose landing gear. The slide reached the ground in both cases with satisfactory geometry, requiring just a little pressure at the maximum sill height to deflect it to the ground (Figure 6). This was considered to be in accordance with the requirements and was judged satisfactory.

BAe. corrective actions

Nose landing gear - Within four days of this accident, BAe issued ATP Service Information Leaflet 32/3 to all operators. This advised that an incident had occurred and contained detailed information on the fitting of the pintle-pin . It stated, in part:

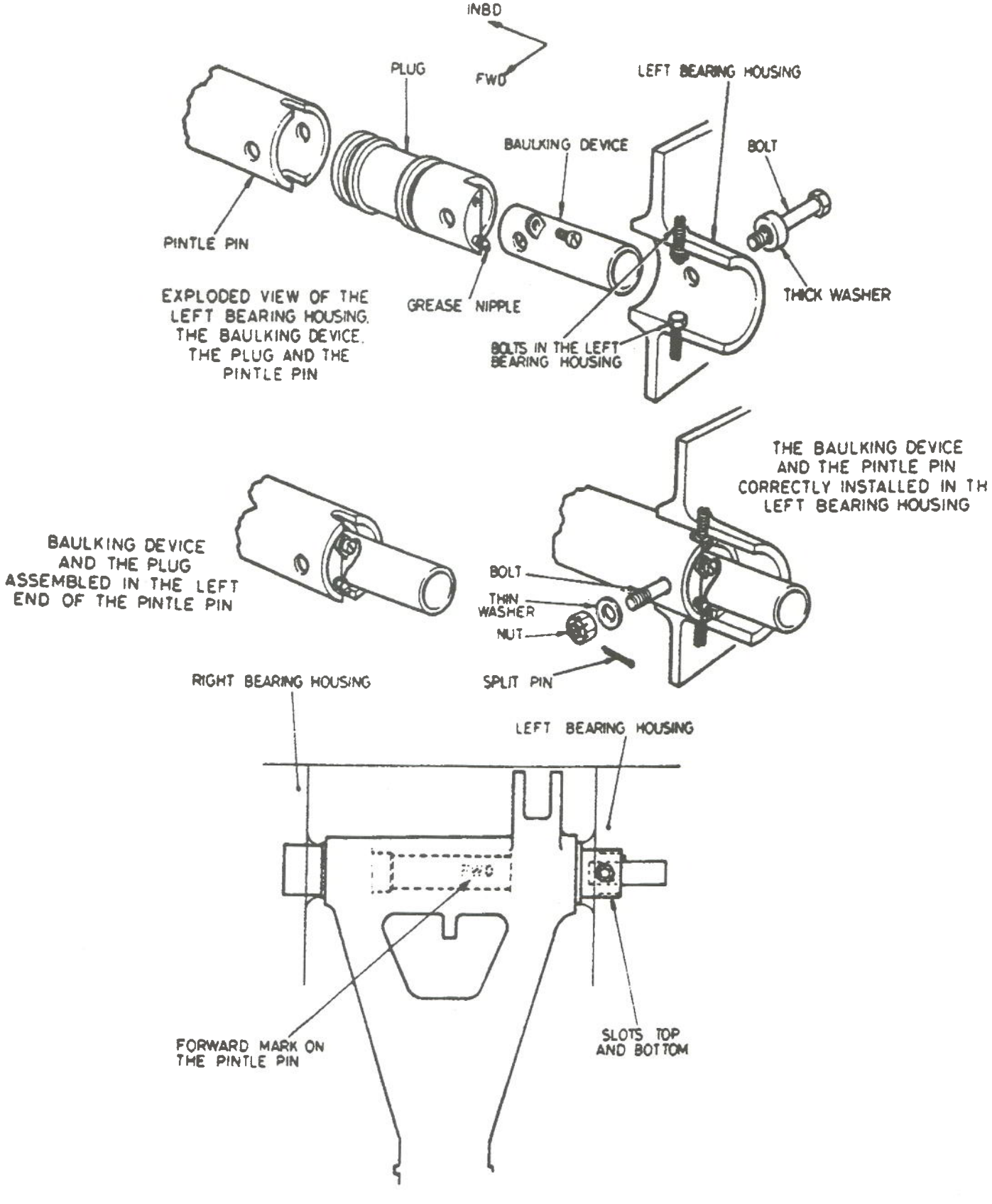
CAUTION

IF THE NOSE LANDING GEAR IS NOT CORRECTLY ALIGNED THE BAULKING DEVICE CAN CATCH ON THE BOLTS IN THE LEFT BEARING HOUSING. IF IT IS NOT CORRECTLY ALIGNED AND TOO MUCH FORCE IS USED:-

- THE BAULKING DEVICE CAN BE DAMAGED.
- THE BAULKING DEVICE CAN BE PUSHED INTO THE PINTLE PIN WHERE IT WILL HAVE NO EFFECT.

The same document contained detailed information which was intended to enable operators to confirm the correct position of the pintle-pin and to ensure that the baulk device remains undamaged after assembly. Additionally, BAe has completed a review of the ATP Maintenance Manual, Revision 35 issued to all ATP operators on 30th June 1992, to ensure that BAe 748 experience where relevant is reflected.

Slides - The discrepancies between the slide certification demonstration and the actual deployment of the slide on G-PEEL are reported to be 'complex'. The resolution of this aspect will be monitored and related information will be included in a supplementary AAIB Bulletin.



EXTRACT FROM BAe ATP SIL 32/3

FIGURE 1

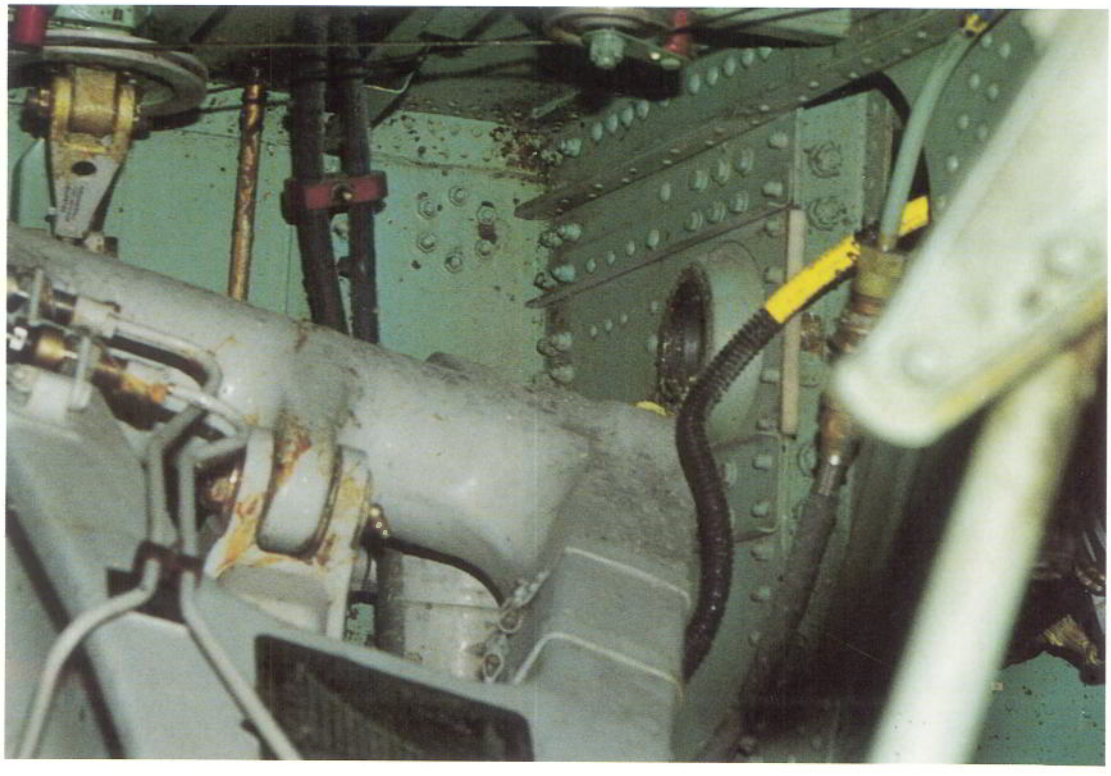


FIGURE 2 - VIEW OF NOSE LANDING GEAR LOOKING AFT WITH THE PINTLE PIN MIGRATED OUT OF THE LEFT BEARING HOUSING

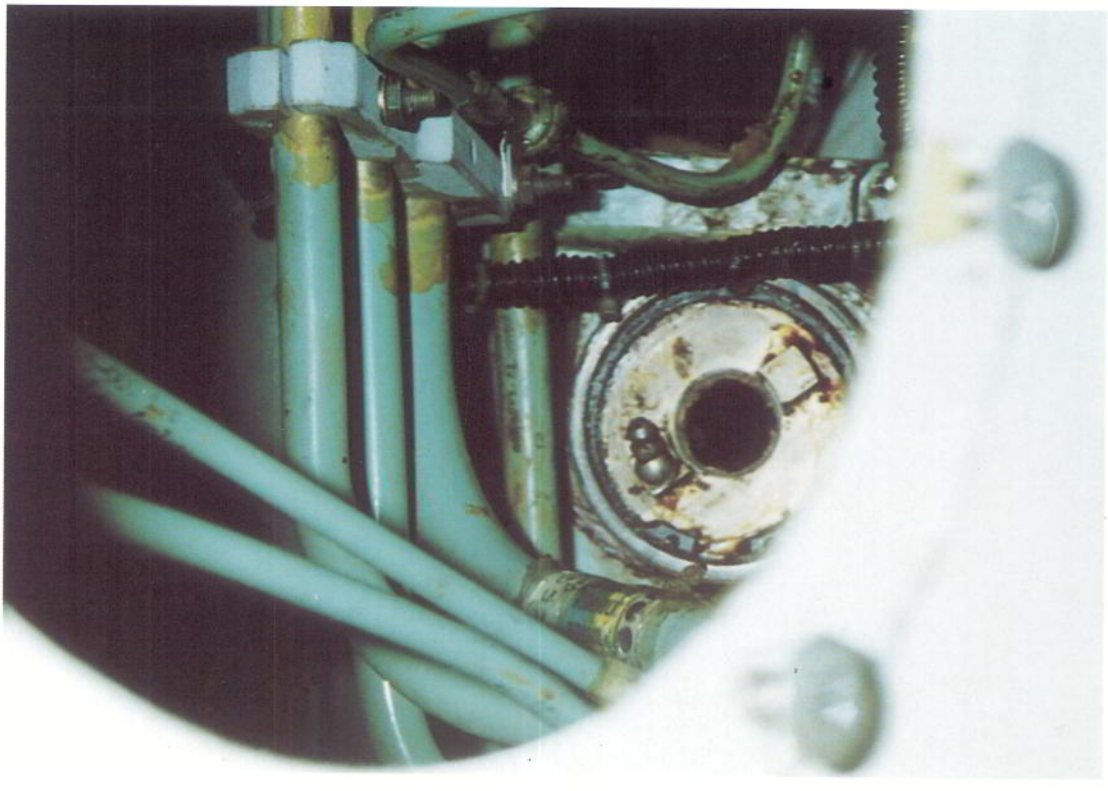


FIGURE 3 - VIEW ON THE RIGHT HAND END OF THE PINTLE PIN AS SEEN AT THE SKIN ACCESS PANEL. THE PIN IS APPROXIMATELY 2 INCHES OUT OF POSITION

FIGURE 4 - LEFT.
THE BAULK DEVICE PUSHED INTO THE PINTLE PIN, AS FOUND

FIGURE 5 - BELOW.
G-PEEL AFTER THE ACCIDENT, WITH THE REAR BAGGAGE DOOR SLIDE DEPLOYED AND APPROX. 3 FEET CLEAR OF THE GROUND

FIGURE 6 - THE SLIDE FROM G-PEEL FITTED TO THE MOCKUP AND DEPLOYED AT MAXIMUM SILL HEIGHT, I.E. NOSE GEAR COLLAPSED.