AAIU Report No. 2000/012
AAIU File No. 2000/0025
Published 07 September 2000

Aircraft Type and Registration:	HS. 748 Series 2A. G-BVOV
No. and Type of Engines:	Two Dart engines Type 534-2
Aircraft Serial Number:	1777
Year of Manufacture:	1980
Date and Time (UTC):	28 April 200020.47 hours
Location:	Dublin Airport
Type of Flight:	Cargo flight
Persons on Board:	Pilot and Copilot
Injuries:	Nil
Nature of Damage:	Nose Wheel Collapsed. Damage to nose wheel doors. Skin damage in nose wheel area. Damage to all propeller blades necessitating their removal and removal of engines for shock load tests.
Commanders Licence:	Commercial Air Transport Pilots Licence
Commanders Age:	59 years
Commanders Flying Experience:	6000 hours, of which 1000 hrs on type
Information Source	Watch Manager, Dublin Airport AAIU Field Investigation.

Synopsis

The incident was notified to the Air Accident Investigation Unit (AAIU) by the Watch Manager, Dublin Airport at 21.15 hours on the 28 April 2000.
Flight JEM910 was about to taxi on to Runway 10 for take off on a flight to Liverpool when the aircraft lurched to starboard. When the crew tried to bring the aircraft back to the taxiway centreline, the nose strut collapsed rearward under the fuselage and the nose of the aircraft struck the ground. The Captain then ordered the First Officer to declare a Mayday call.

1 Factual Information

1.1 History of the Flight

The aircraft pushback from Stand 9 was normal. The aircraft was taxied to the holding point at RWY 10 via the taxiway B7. As the aircraft negotiated the final turn off to the holding point the Captain commented on a clunking noise from the nose gear trunion. This noise was not unusual in an aircraft of this age but was nonetheless noticeable. The Captain stopped at the runway hold for some seconds and when he released the brakes the aircraft moved to the right. He applied full left tiller(nose wheel steering) but with no effect. He stopped the aircraft, increased power on the starboard engine and released the right brake. The aircraft again moved right against considerable right engine power and then the nose wheel leg collapsed.

The Captain said he immediately shut down the engines and feathered the propellers as the blades hit the taxiway surface in rotation. Fearing that there might be an engine fire the Captain ordered the first Officer to put out a Mayday call. Runway 28/10 was then closed until further notice. The airport emergency services arrived on the scene promptly.

The AAIU investigators inspected the aircraft in situ, removed the CVR and interviewed the crew. Airport lifting equipment was brought to the scene and with the aid of a 4-wheel bogey the aircraft was brought back to the terminal area.
The runway was reopened at 05.55 hours
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1.2 Injuries to persons.

There were no injuries to any persons as a result of this incident
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1.3 Damage to the Aircraft.

Damage to the blade tips of all propellers, these being bent rearwards. Starboard bushing housing damaged and torn from it's mounting. Skin damage to fuselage in nose wheel well area and to all nose wheel doors. Damage to nose strut attachment pin.
Both engines were removed and shock load tested. These test results necessitated extensive repairs.

1.3.1 Aircraft Information.

The Operator used a maintenance organisation in the UK, about 50 minutes flight time from their base in Liverpool. A fleet maintenance contract had been in place with this organisation since April 1999. Prior to this (since Nov 1998) they had held a contract to maintain one of the fleet of BAe 748 aircraft. Since early 1998 they had been carrying out maintenance on the fleet through a maintenance agreement with a third party. On 3rd April 2000 a "C" check was completed at 18438 airframe hours, 28635 landings, and the aircraft released to service. During the inspection some corrosion

had been noted on stringers in the vicinity of frame 216F and between frame 180F to 198F. Repair would also be necessary to the boom angle on the lower aft face at Station 252F (nose wheel well). This repair would necessitate the removal of the nose undercarriage leg. This work was to be carried out as soon as spares became available. The aircraft completed a further 15.56 flight hours in service and on the 8th April 2000 was ferry flown to the maintenance organisation in order to complete the above non-scheduled work. During this work the nose undercarriage leg was removed and replaced on completion of the repairs in the nose wheel well. The mechanic said that he installed the nose landing gear on the 26thApril i.a.w. the Maintenance Manual Section 32-20-01. The aircraft inspector confirmed this and said, "*no abnormalities or difficulties were noticed"*. On inspection he said that the baulking device (see Fig.1) appeared to be correct.
The aircraft operator said that the aircraft records showed that the nose undercarriage leg had been in place for at least five years prior to its removal for the corrosion repair. The work was completed on 27th April 2000 and at 19.29 hours on that day the aircraft was flown back to its base at Liverpool.
On the 28th April 2000 there were three flights and three further landings, the final landing being made at Dublin at 04.33 hours. The total flight time in service since maintenance was conducted was 1.59 hours.

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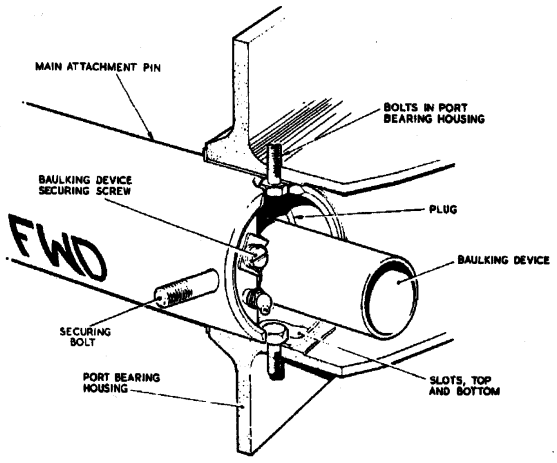
1.3.2 Additional Aircraft Information

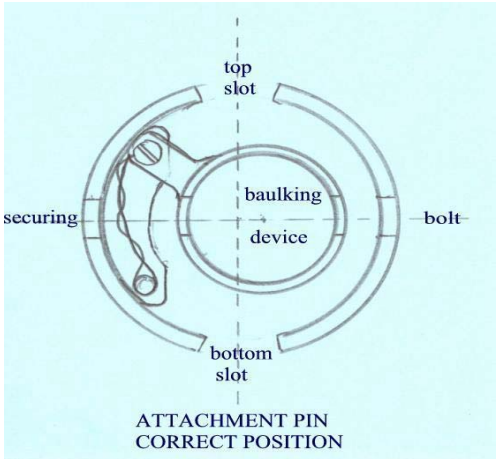


The nose strut of the BAe 748 is attached to the fuselage through a nose undercarriage attachment pin *(left*). This pin is inserted through an opening in the starboard side of the front fuselage. It is secured on the port side using a securing bolt, which secures the pin through holes in the port bushing housing. The port bushing is secured to the housing using two bolts. The attachment pin incorporates slots to facilitate the bolt heads. The pin also incorporates an internal greasing plug and the greasing plug receives a baulking device incorporated by Mandatory Modification 4046 (S.B. 32/45). The baulking device, <u>when fitted properly</u>, should ensure that the holes in the attachment pin, port bearing housing and baulking device all line up in order to receive the securing bolt. In this way it would be impossible to insert the attachment pin and secure it to the bush housing using the slots intended to facilitate the bearing housing bolts. If, however, the baulking device is excluded, it is possible to fit the attachment pin at 90 degrees from its correct position and attempt to secure the pin with the securing bolt running through the attachment pin slots. In service the attachment pin would then work its way out of the housing. The starboard bearing housing would then take all forces transmitted through the nose leg, pulling the housing from its securing structure. (*see Fig.1 for complete breakdown of assembly*)

1.4 Inspection of aircraft and nose undercarriage.

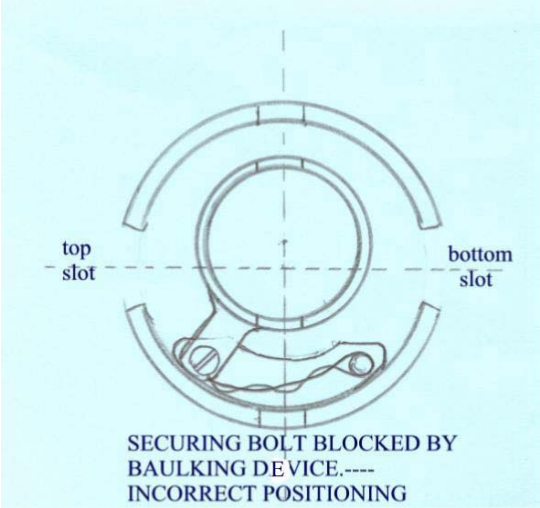
The nose undercarriage strut was found pushed rearwards, with the whole of the strut exposed beneath the fuselage. The attachment pin was found attached to the starboard side of the strut but had come away from the port side such that the end of the pin was visible with the slots at about 90 degrees to what would be their normal position when the pin is attached to the port bearing housing.
When the strut collapsed the starboard housing had been ripped from its structure. The strut was attached to the aircraft by the nose wheel steering control mechanism.
Two objects were found on the ground nearby, viz;- a sliver of metal 12cms long and an hydraulic blank. Neither of these was identified as having come from the nose strut itself.
On removal of the strut from the aircraft, further examination revealed that the baulking device, complete with the securing bolt, remained in the port bearing housing. The attachment pin, which had been removed from the strut, was then examined. It was found that the greasing plug had rotated therein so as to block the passage of the securing bolt into and through the holes in the attachment pin. The lug on the baulking device used to secure that device to the plug had broken off and remained with the plug.

1.4.1 Detailed examination of the attachment pin



ATTACHMENT PIN
CORRECT POSITION

(a) The attachment pin was found with the face marked "FWD"(forward) facing downwards. The holes in the pin were therefore in the vertical rather than in the horizontal.
(b) If the pin had been fitted in this way the slots would have been in a position to receive the securing bolt.
(c) The greasing plug was found moved in the attachment pin such that the hole in the plug could not line up with the hole in the pin.
(d) It can be concluded that the securing bolt had not been located through the plug.
(e) If the holes in the pin, plug and baulking device had been lined up prior to fitting and inserted into the port bearing housing such that the slots were horizontal the baulking device would not allow the securing pin to be fitted.
(f) There is a possibility that if the lug on the baulking device had broken off such that the device and the plug were no longer attached then the baulking device could be free to rotate during fitting.
(g) As the slot diameter is greater than the securing bolt diameter there is a possibility that the holes in the baulking device and the slots in the pin would line up to receive the securing bolt.
(h) The baulking device would then be secure but the pin, and with it the plug, would be free to migrate out of the port housing.



1.5 System Failure History

The design of the nose undercarriage landing gear of the BAe 748 aircraft was also incorporated into the newer BAe ATP aircraft. The manufacturers of these aircraft informed the investigators that since 1992 there have now been a total of 4 other occurrences of NLG failure due to misfitting of the attachment pin. Details of these are:

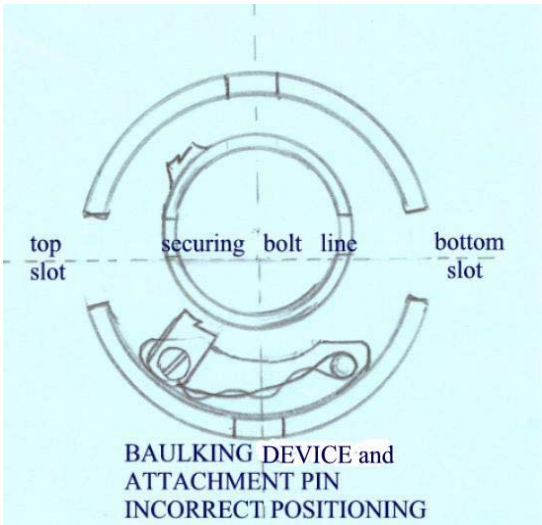
Date	A/C	Reg	Location	Occurrence
19-4-92	ATP	G-PEEL	Liverpool	NLG failed to retract on take off, collapsed on landing, pintle pin baulk not fitted during NLG refitment.
3-2-98	748	9N-AEH	Kathmandu	NLG collapsed on landing, pintle pin baulk not fitted.
6-4-98	ATP	EC-GSH	Palma	NLG failed to retract on take off, collapsed on landing, pintle pin baulk not fitted during NLG refitment.
6-4-98	748	C-FTTW	Sandy Lake Ontario	NLG collapsed on landing, pintle pin baulk not fitted.

Note: - Pintle pin = Attachment pin

Modification 4046 was introduced by Service Bulletin 32/45 dated June 18th 1973. This modification introduced the baulking device "to ensure the nose leg to aircraft attachment pin is installed correctly". The reason given for the introduction of the modification was "to prevent the nose landing gear leg attachment pin being fitted incorrectly during the installation of the nose landing gear leg assembly to the aircraft".
In July 1983 the manufacturers introduced in Service Bulletin 32/71 as "one off" "inspection of the nose undercarriage main attachment pin to ensure correct installation".
This checked that the nose undercarriage attachment pin securing bolt was not inserted through the slots in the attachment pin and that the baulking device was securely attached to the greasing plug. Having confirmed this to be the case, an instruction was given to paint the letters "FWD" on the forward position of the attachment pin in line with the retaining bolt holes. This was to be used as an aid in the future fitting of the nose leg.
In April 1999 the appropriate chapter for the removal and installation of the nose landing gear leg was amended. It indicated that when the leg attachment pin was to be replaced that the old baulking device should be retained for use with the replacement pin. It also instructed the ground staff to "ignore any hand painted markings on new or refurbished attachment pins". Incorrect FWD markings were to be removed and replaced in accordance with Service Bulletin 32/71. The security of attachment and

wirelocking of the baulking device to the greasing plug should be checked and also that the greasing plug is correctly assembled in the main attachment pin.

2. Analysis



BAULKING DEVICE and
ATTACHMENT PIN
INCORRECT POSITIONING

The technicians who removed and replaced the nose gear leg said that they reassembled the strut, attachment pin, baulking device and greasing plug in the way that they found it.
Examination has shown that only the baulking device was secured by the bolt in the port housing. The attachment pin complete with greasing plug was free to migrate out of this housing. The securing bolt did not go through the hole in the greasing plug. It has to be concluded that the attachment pin was fitted with the slots horizontal and with the securing pin inserted through these slots.
The screw retaining the baulking device to the greasing plug was in place and secure. However, the lug had broken off the baulking device. If the lug was attached prior to fitting of the attachment pin with the letters FWD facing down as found, then it would have been impossible for the securing bolt to go through the baulking device. It has to be concluded therefore that the lug on the baulking device had broken off and remained with the plug prior to reassembly of the nose. The baulking device was therefore free to rotate in the greasing plug. It is conceivable that the securing bolt then passed through the baulking device and the slots in the attachment pin, allowing the attachment pin, complete with greasing plug, to migrate out of the port housing.
If the strut, attachment pin, baulking device and greasing plug had been fitted in the way found prior to the nose gear removal, as stated, then it is unlikely to have remained in place during five years of operation.

3. Conclusions

3.1 Two Service Bulletins, in addition to the amendment of the maintenance manual dated April 1st 1999 in relation to the removal and replacement of the nose gear have failed to guarantee, with reasonable certainty, that the gear attachment pin has been fitted properly.

3.2 The ground personnel who fitted the nose gear following work in the wheel well, overlooked instructions in all of the above documents issued by the aircraft manufacturer.

3.3 This incident could have been far more serious had the nose gear collapsed on landing.

3.4 It is doubtful whether this same design incorporating a baulking system should have been carried forward to the more modern ATP aircraft.

3.5 The laws of probability would indicate that there are other aircraft in service where the baulking device, if fitted, is not fulfilling its purpose.

4. Safety Recommendations

4.1 In the short term, Service Bulletin 32/71 should be reissued by the aircraft manufacturer, British Aerospace. It should be requested that, following a survey of all Bae748 aircraft, that feedback on the survey be returned to the manufacturer together with the aircraft serial number and registration number. (SR 36 of 2000)

4.2 British Aerospace should issue instructions that when nose gear fitting takes place two separate duplicate inspections should take place to ensure:-

(a) verification that the slots are correctly positioned and
(b) that the securing bolt passes through the bolt holes in the attachment pin. (SR 37 of 2000)

4.3 The recommendations at 4.1 and 4.2 should be applied to the British Aerospace ATP aircraft. However, the aircraft manufacturers should give consideration to improving the modification design in order to make installation of the nose gear more reliable. (SR 38 of 2000)

NOTE: POST INCIDENT ACTIONS:- The maintenance organisation involved are engaging in a survey of other BAe 748 aircraft to check that the baulking device is fitted and fulfilling its purpose. At going to press three aircraft had been examined. One of these had failed the examination.

All of the above recommendations have been accepted by the aircraft manufacturer. In addition, a feasibility study into redesigning the attachment pin locking arrangement is being carried out for the ATP aircraft.

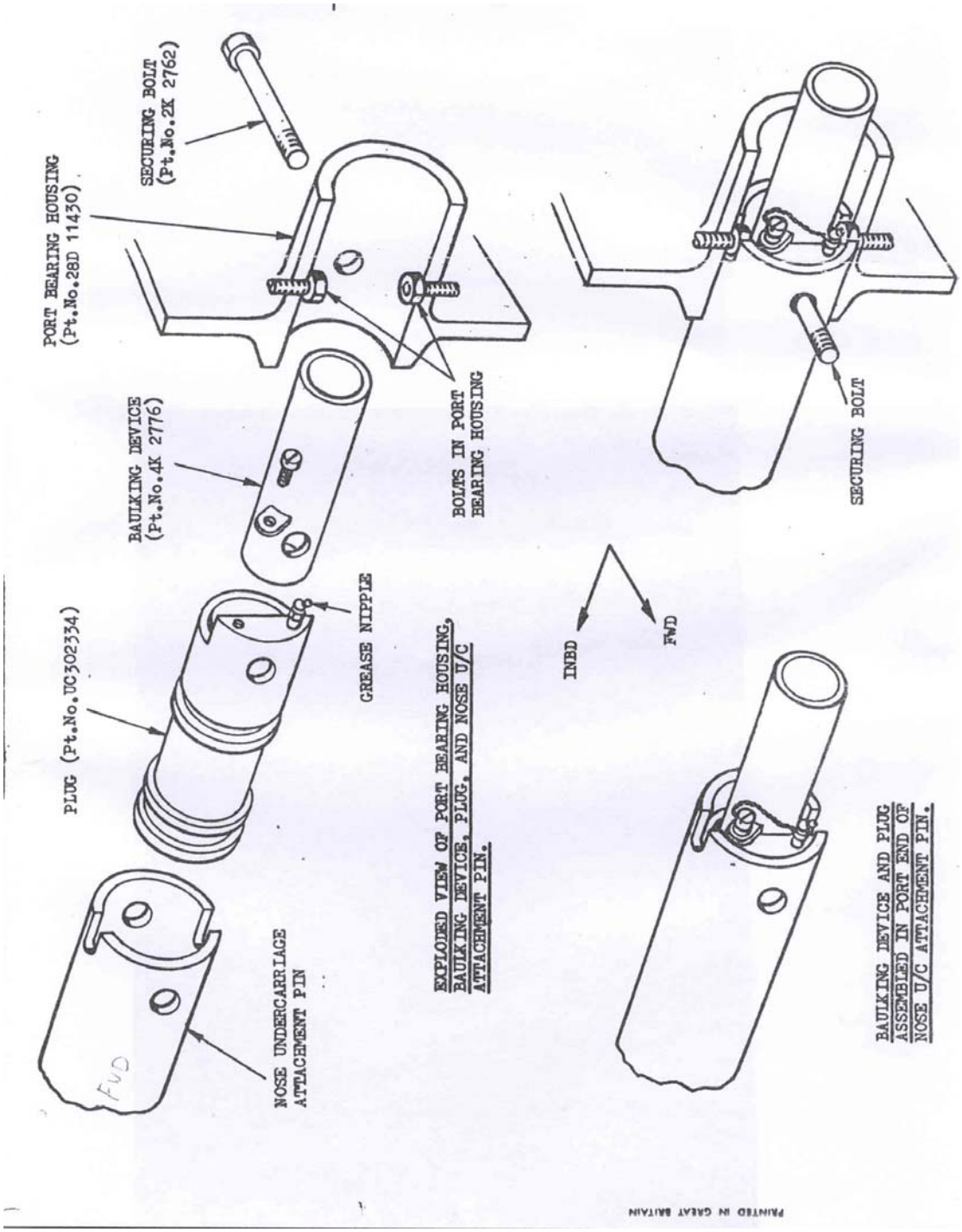
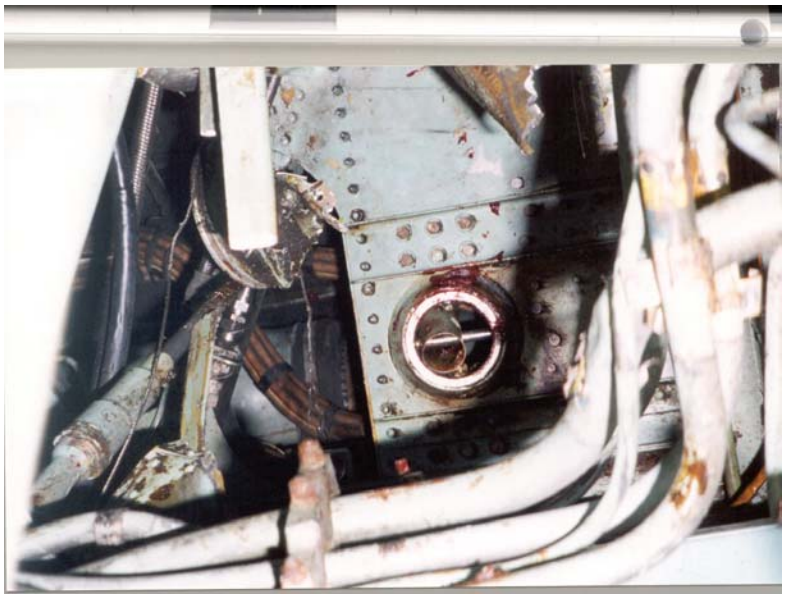

PORT BEARING HOUSING
(Pt.No.28D 11430)
SECURING BOLT
(Pt.No.2K 2762)
BAULKING DEVICE
(Pt.No.4K 2776)
BOLTS IN PORT
BEARING HOUSING
PLUG (Pt.No.UC302334)
GREASE NIPPLE
NOSE UNDERCARRIAGE
ATTACHMENT PIN
FWD
EXPLODED VIEW OF PORT BEARING HOUSING,
BAULKING DEVICE, PLUG, AND NOSE U/C
ATTACHMENT PIN.
INBD
FWD
SECURING BOLT
BAULKING DEVICE AND PLUG
ASSEMBLED IN PORT END OF
NOSE U/C ATTACHMENT PIN.
PRINTED IN GREAT BRITAIN

FIG.1

FIG.2

Attachment Pin- following the incident

Attachment Pin – following collapse of nose undercarriage



Securing Bolt in Baulking Device as found by investigators