BAE ATP, G-MANJ

AAIB Bulletin No: 3/2001

Ref: EW/C2000/05/02 - Category: 1.1

Aircraft Type and Registration:	BAE ATP, G-MANJ
No & Type of Engines:	2 Pratt & Whitney Canada PW-126 turboprop engines
Year of Manufacture:	1987
Date & Time (UTC):	16 May 2000 at 2004 hrs
Location:	Liverpool Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 4 - Passengers - 44
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Damage to left propeller, engine nacelle, wingtip, flap and tailplane
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	4,150 hours (of which 2,972 were on type) Last 90 days - 105 hours Last 28 days - 42 hours
Information Source:	AAIB Field Investigation

History of the flight

The crew, consisting of 2 flight deck and 2 cabin crew members, came on duty at 1240 hrs to operate two return flights from Manchester to Belfast. The first flight to Belfast and return was flown without incident. The crew requested clearance for their second flight to Belfast, from the Manchester ground controller, at 1633 hrs and were given no delay for a 'Wallasey 1R' Standard Instrument Departure (SID) with an assigned squawk of 5127. At 1657 hrs the crew requested push back and start clearance and by 1704 hrs the aircraft was at the hold for Runway 24R awaiting take-off clearance. At 1707 hrs, the crew were cleared for take off and were given the surface wind of 200°/04 kt.

As the aircraft passed 400 feet on departure, the crew made contact with Area Control Manchester West Sector on 128.050 MHz, confirming that they were on a 'Wallasey 1R' departure climbing to 5,000 feet. They added that they were going to, 'have to do an after take off check and we might

need to return. There's no emergency'. The controller asked if they wished to maintain 5,000 feet. The crew replied that they would and continued with the SID to Wallasey. At 1716 hrs the crew were instructed to contact Manchester Radar on 133.050 MHz, where the controller informed them that they had been transferred to his frequency as it had 'spare capacity....and was the problem serious?'. The crew replied; 'NO IT'S THE LEFT GEAR WON'T COME UP....WE'LL KEEP YOU ADVISED'. Four minutes later the crew transmitted, 'WE'RE DECLARING A PAN PAN AT THIS STAGE. WE WOULD LIKE TO MAINTAIN 5,000 AND JOIN INBOUND TO WALLASEY....THERE'S NO IMMEDIATE DANGER TO THE AIRCRAFT BUT WE DO ONLY HAVE TWO UNDERCARRIAGE LOCKED DOWN HAVING HAD ONE FAIL TO INDICATE UP AFTER TAKE OFF". The crew continued, "WE'RE ONLY INDICATING TWO LOCKED DOWN THE LEFT IS UNSAFE AND WE HAVE CHECKLISTS TO WORK OUT; WE'VE GOT A LOT OF FUEL ON BOARD AND WE'D LIKE TO HOLD AT WALLASEY AND CONTACT THE COMPANY AND SORT THE CHECKLISTS OUT BEFORE WE DECIDE WHERE WE'RE GOING TO TAKE THE AIRCRAFT TO LAND". The controller confirmed that they could do as they had requested and that the frequency in use was for their sole use. After several minutes the crew asked the controller to have available the actual weather for both Manchester and Liverpool as they would be their landing airfield options.

The first officer had been the pilot flying (PF) and, after the normal take off, the landing gear had been selected up but a red unsafe light indicated that the left main landing gear (MLG) was not locked up. The commander had instructed the first officer to continue the SID climbing to 5,000 feet, engage the autopilot and hold at the Wallasey VOR. He had also informed the No 1 cabin crew member (No 1) of the situation and that the cabin service should not be carried out. He also advised the passengers.

The initial checklist consulted by the crew was titled, 'Unable to raise landing gear' (Checklist card 36). The commander stated however, that he considered, after discussion with the first officer, that this checklist was only for use if the landing gear selector could not be moved to the up position and therefore he considered it inappropriate to continue with that checklist. The landing gear was then selected down so that the crew could begin their analysis of the situation from a known starting point and establish the exact nature of the problem. The landing gear position lights were then confirmed as a left main red with right main and nose leg greens. The No 1 was then asked to examine the landing gear mechanical indicators, installed outside the cabin on the engine nacelles, to confirm the main landing gear positions. She confirmed that the left MLG was not locked down. The commander then consulted the checklist cards to determine which landing gear checklists were appropriate.

By 1738 hrs the crew had received the weather details for both Manchester and Liverpool, which were both suitable for an approach. The crew however stated that they would hold for at least two hours in the vicinity of the Wallasey VOR, action the checklist and, if needed, burn off excess fuel before commencing, what they now believed would inevitably be, an approach for an emergency landing. The passengers were re-apprised of the situation and the cabin service was started but without the service of alcoholic beverages. After consultations with the company and paying due regard to the weather conditions and emergency capabilities of the airports, the crew had decided by 1835 hrs that they would land at Liverpool.

The crew had three checklist cards to consult; cards 34, 34A and 35. Card 34 dealt with, 'abnormal and emergency lowering of landing gear'. Card 34A covered, 'emergency landing gear lowering with landing gear changeover lever ineffective', and card 35 covered, 'landing with landing gear not fully locked down'.

The actions on card 34 were initiated but operation of the landing gear changeover lever caused the right MLG indicator to change from green to red. This concerned the crew somewhat so they

reversed their actions to recover the right main leg green indication. After consultation with the company and examination of the ATP Flight Manual (FM) however, the crew realised that the checklist (card 34) had indeed to be completed. Card 34 checklist actions were therefore initiated for a second time. The commander took control of the aircraft, the first officer entered the passenger cabin and operated the mechanical up-lock releases. Upon his return to the flight deck, the aircraft was accelerated to 175 kt and, after a suitable passenger briefing, manoeuvred in an attempt to force-down the left main landing gear leg. During the checklist actions the No 1 had viewed the area of the left MLG from ahead of and behind the wing. She had reported that the left MLG was not visible but the forward gear bay doors were open slightly. The completion of card 34 checklist items resulted in no change to the situation.

The commander now continued by actioning the checklist on card 35. The No 1 was briefed on the use of emergency exits and passengers seated adjacent to the window exits were briefed, by the No 1, on their operation. The time available to prepare the cabin and fully brief the passengers was more than adequate.

At 1920 hrs the Manchester controller transferred the aircraft to Liverpool Approach for a weather update. The weather in the vicinity of the Wallasey hold by this time had deteriorated so the crew, with the assistance of the Liverpool controller, moved their manoeuvring area to the northwest of Wallasey. At 1934 hrs the commander advised ATC that he expected to make an approach in 10 minutes time. At 1944 hrs however, another aircraft from the same company, also making an approach to Liverpool, reported that it was, 'quite turbulent on the approach with heavy rain going through'. The crew of that aircraft suggested that the emergency aircraft hold for a further 10 minutes. By 1950 hrs the Liverpool controller advised that the local weather was improving to the west of the airfield and that the worst of the weather was to the south and east. At 1954 hrs the crew transmitted that they were ready for an approach. The Liverpool controller acknowledged this and vectored the aircraft for a localiser DME approach to Runway 09. At 1959 hrs the crew were cleared to land, given the surface wind as 200°/12 kt and transferred to the tower frequency. The commander took control, with the flight director and No1 auto-pilot system engaged, with approximately 15 nm to touchdown. During the later stages of the approach he took over manually and just before touchdown the auto-ignition was deselected.

The aircraft landed at 2003:30 hrs. After touchdown right roll control was applied gradually to the maximum. As the airspeed reduced further however, the left wing settled gently onto the runway. Directional control was applied via the nose wheel steering and finally the right main wheel brake.

The later stages of the approach and the touchdown were filmed by the Liverpool based police helicopter. The video showed the aircraft touching down in the centre of the runway before settling gently onto its left wing. As the wing came into contact with the surface a large number of sparks emanated from the trailing edge of the flaps and to a lesser extent from the left outer tailplane and a brief flash fire was seen in the area of the Left MLG bay. These sparks continued but ceased as the aircraft came to rest, as did the fire.

After the aircraft stopped both pilots opened their direct vision (DV) windows and checked for signs of an external fire. There was none so the commander ordered an evacuation 'using the forward main door and both rear doors'. The crew then turned off the batteries and left the flight deck. A few remaining passengers were still evacuating via the forward door but soon they had all exited so the cabin crew, followed in turn by the first officer and commander, evacuated the aircraft. There were no injuries to the crew or passengers.

The emergency services, which had plenty of time to prepare and position themselves for the emergency landing, were on the scene almost immediately.

Flight recorders

The aircraft was fitted with a Plessey PV 1584 FDR and a Fairchild A100 CVR. Both recorders were replayed satisfactorily by the AAIB. The aircraft touched down gently with a normal acceleration peak of 1.18g, at 89 kt IAS and on a heading of 090°M. Six seconds later both engine torques reduced to zero. The aircraft began to roll to the left, settling onto the left engine nacelle with a roll attitude of -10.5° nine seconds after touchdown. The aircraft also began to yaw to the right. Eighteen seconds after touchdown the FDR stopped. The aircraft was at 61 kt IAS, on a heading of 105°M.

The CVR recorded the final 30 minutes of information, which covered the period of the approach and landing, but not the initial problem at gear retraction, and subsequent crew response. The CVR stopped 1 minute and 32 seconds after touchdown, as the crew evacuated, the aircraft was shut down and the battery switched off. The FDR takes electrical power from No1 Generator; therefore, as the engines were shut down whilst the aircraft was still moving, the generators went off-line and the FDR stopped. The CVR continued to run whilst there was still battery power available.

Description of landing gear extension/retraction mechanism

The ATP has a conventional tricycle landing gear and retraction/extension is achieved using hydraulic power. A detailed description may be found in the AAIB Bulletin 9/98, page 1 (accident to BAe ATP, G-BUUP). Since this accident bears many features in common with the accident to G-MANJ, readers should refer to the above whilst this account will concentrate on the areas directly relevant to this investigation. In particular, the way in which the forward main landing gear (MLG) doors are actuated is described in much detail with comprehensive illustrations.

As can be seen from Appendix 1 and Bulletin 9/98 in more detail, during the retraction cycle the forward doors are opened directly by movement of the MLG pintle, which starts to move down the A-frame to which the door actuating rods are connected. However, as the leg starts to retract further, the A-frame disconnects from pintle movement and a spring pot takes the A-frame into the doors fully-open condition. As the landing gear approaches the UP position, a hook fitting on the front of the leg engages in a roller in the A-frame and further movement of the landing gear pulls the A-frame up and hence closes the doors. The uplock roller, which forms part of the hook fitting, then engages in the uplock hook on the roof of the bay and the retraction cycle is complete.

It can be appreciated that if the A-frame is, for some reason, not correctly positioned by the spring pot as the fork fitting comes to meet it, the roller on the A-frame can fail to engage in the hook and instead contact the forward face of the fitting. This will have two effects: firstly the doors will start to close slightly earlier than normal and, because clearance between the doors and the spinning tyres is minimal, the tyres will contact the inside of the doors. The second effect is that the uplock roller will fail to engage the uplock hook, causing a failure of the leg to lock in the up position. Experience of G-BUUP suggested that the interference between the tyres and the doors prevents the doors opening on a subsequent DOWN selection, as there is insufficient mechanical advantage on the extension/retraction jack to overcome the resistance. Emergency selection, which is a free-fall mechanism, would also therefore have no effect.

Also of note are the large angular and rotational movements experienced by the door actuating rods during an open/close cycle. Appendix 2 shows that the rod attachment swivel bearings on the doors and A-frame can pivot about a lateral axis. In addition the rod itself has a rose-bearing at one end (eye-end) and a mechanism, described as a 'threaded bearing,' at the other (fork fitting). This allows the fork fitting to twist relative to the rod and is provided with a grease nipple to ensure smooth operation. Since the rod would be free to rotate (and hence tighten or undo the threaded bearing) by virtue of the swivel bearing on the A-frame, an anti-rotation plate is fitted at the eye-end which allows limited rotation of the rod but prevents full rotation. The original rods supplied by BAE Systems used a jam-nut to lock the thread of the eye end and wire-locking was used to prevent slackening of the jam-nut. A later version, made by a sub-contractor, used a tab-washer to perform this latter function.

On-site examination

The aircraft was examined by the AAIB on the night of the accident. It had come to rest on the runway heading but with the left nacelle resting on the shoulder of the runway and the left wing over the grass. The left MLG and doors appeared to be in the 'up-and-locked' condition, with consequent severe abrasion damage, particularly to the aft pair of doors. All six blades of the left propeller had heavy damage due to runway contact and a considerable span of the left flap lower skin had been ground away. In addition there was heavy abrasion of the outboard left tailplane, which had not been a feature of the accident to G-BUUP. This was because the latter was fitted with the 'short' nose landing gear whilst G-MANJ had the 'long' nose landing gear which resulted in a more tail-down attitude.

The aircraft was lifted using airbags inboard of the left nacelle. The left MLG did not move during the operation and crow-bars were used to pry open the forward doors. It was observed that there was interference between the tyres and the doors, as had occurred with the accident to G-BUUP, and considerable resistance was encountered. Just before the doors were forced fully open, it was possible to see that the roller on the forward door actuating 'A' frame was not engaged in the hook fitting but was impinging on the forward face, again as in G-BUUP. Once the doors had been opened sufficiently, the left MLG was able to free-fall down. It was not however possible to lock it down due to heavy abrasion damage to the reaction link and downlock housing: the top of the oleo leg had also been ground away, releasing hydraulic fluid and causing the flash fire seen on videos and photographs during the landing. The forward door actuating rods were disconnected at the fork fittings (door) ends to enable inspection of the mechanism and bruise marks on the forward face of the fork fitting could be seen where the 'A' frame roller had contacted it in an incorrect location.

The decision was made to remove the aircraft from the runway and perform a detailed inspection the following morning. The inability to lock the left MLG down meant that the left wing had to be supported on a lorry as the aircraft was towed into a vacant hangar.

Off-site examination

In the hangar, with the aircraft on jacks, an inspection showed that it should be possible, using the aircraft's electrical auxiliary hydraulic pump, to perform powered retractions and extensions of the left MLG. The final lock-down of the MLG could not be achieved as noted above but several normal extension/retraction cycles were achieved, with the hook fitting successfully engaging the roller on the 'A' frame. It should be noted that, these tests were conducted with the rear and forward doors disconnected so that the mechanism could be observed during operation. A test was also conducted with the forward doors connected, which again was normal.

On completion of the tests, examination of the undamaged right MLG showed that the actuating rods were free to move in rotation as designed, due to the threaded bearings. On the left MLG, the rods also moved freely but, on the outboard rod, this rotary movement was being accommodated by the eye-end fitting (which should have been locked with a nut and locking wire), and not by the threaded bearing. The jam nut *appeared* to be tight against the rod and the locking wire was intact, but it had lost torque and the eye-end was able to turn. The threaded bearing appeared to have seized, with one or two threads visible outside the rod.

After some discussion, it was decided to investigate the effect of re-locking the eye-end and re-installing the rod. Initially, a powered retraction cycle functioned correctly, but it was found that the lock-nut had slackened-off again and was allowing the eye-end to rotate. The test was repeated after the jam nut was tightened, with the rods attached and the doors closed (access through the open rear doors). This time the retraction appeared to proceed normally until the 'A' Frame approached the fully depressed (doors open) position. It was apparent that it did not move fully down and, whilst held in this position, the main leg hook fitting contacted the 'A' frame roller on its forward face, instead of between the forks, and started to close the doors onto the tyres, ie the scenario observed after the accident. It was also apparent that the spring pot tension attempting to lower the 'A' frame was being resisted by the anti-rotation plate, which was hard-up against the frame and being distorted. This was because the actuating rod, now effectively locked in torsion at both ends, had forced the swivel bearing in the 'A' frame to try to accommodate all the required motion itself. When the anti-rotation stop contacted the frame, the resistance was sufficient to prevent the spring pot from completing the required travel of the 'A' frame.

The rod was removed from the aircraft. As there was no obvious reason for the seizure of the threaded bearing, it was assumed that it was probably due to a combination of corrosion and lack of lubrication. BAE Systems issued All-Operators Message (AOM) No 00/014J on 18 May 2000, which essentially called for inspection and re-lubrication of the rods.

Detailed examination of the actuating rod

Visual examination of the actuating rod showed that the eye-end fitting was not 'in-safety' (ie there was insufficient thread engagement in the body of the rod). Although there were one or two threads showing at the fork end (threaded bearing), it was felt that the reason for the lack of movement could be that the thread had tightened-up to the point where the end of the fitting had contacted the first cross-rivet. Sectioning the rod showed this to be the case (Appendix 3): the fork fitting had tightened-up and had produced a 'pre-load' against the rivet. Contrary to the initial assumption about the cause, the threaded bearing was found to be in a well-lubricated and clean condition.

At the eye-end fitting, only about 6 mm of the thread remained in the rod. No assessment of the condition of the locking method could be achieved because the locking wire had been removed and the nut re-tightened as part of the testing in the hangar at Liverpool. It was, however, now clear that the jam-nut had not prevented the eye-end fitting from unscrewing itself from the rod, whilst the threaded bearing on the fork-end was doing the opposite - thus the overall length of the assembly remained roughly the same. This process had continued until the threaded bearing bottomed on the rivet and the jam-nut tightened on the eye-end. The rod was now locked in torsion at both ends and unable to accommodate the required motion of the 'A' frame during the retraction cycle.

Testing of a similar rod

The operator supplied a similar door actuating rod from their spares store. This rod was as-supplied by the manufacturer, with the jam-nut tightened and the wire-locking fitted. It was found that the jam-nut torque could be relaxed without breaking the lock wire and that the eye end was then free to undo. The wire-locking seemed to ensure that the lock nut remained in close proximity to the rod and thus any motion towards screwing the eye end back into the rod resulted in a lock. The migration of the eye end could therefore only be towards the 'undo' direction.

The manufacturer has indicated that the wire-locking on this rod as-supplied, 'was there to ensure that all parts of the assembly remain together in transit; as a result it may not be done up as tightly as it should be when installed'.

Maintenance manual information

The subject actuating rod had been fitted to G-MANJ on 2 November 1998, when the original item was found to be 'worn at screw thread'. It is understood to have been a new item when fitted. The ATP Maintenance Manual chapter 52-80-00, covers the procedure to replace and then adjust the forward door actuating rods. The actual replacement is routine and then Subtask 52-80-00-220-305 requires, 'Adjust the strut which operates the door (Ref. Step 3.G. (11).' Step 3.G (11) states:-

b) At the door operating strut, at the end nearest the door:

1 Remove the split pin, the nut, the washer and the bolt (Ref. Fig 505 Detail B). Discard the split pin.

2 Remove the lock wire and loosen the lock nuts.

3 Turn the eye-end to adjust the length of the operating strut as necessary.

4 Tighten the lock-nut.

c) Connect the operating struts to the door with the bolts, the washers and the nuts.

The above instructions require careful reading to avoid ambiguity. Although 3 above indicates that the eye-end should be used to adjust the length, it is one of four steps preceded by, "*At the door operating strut, at the end nearest the door"* and the figure referred-to does not depict the eye-end of the rod at all. The text is also somewhat incorrect, inasmuch as the eye-end *per se* cannot be turned through a complete revolution; the rod itself requires to be turned with the eye-end stationary. This is presumably the (unstated) reason why the threaded bearing end is disconnected first, because any rotation of the rod to adjust the engaged thread length of the eye-end, would be nullified by an opposite effect at the other if it remained connected. Indeed, in considering the mechanism, it would appear to be more than reasonable to make modest adjustments purely at the threaded bearing thus obviating the requirement to break-down the locking at the eye-end. Adopting such a method would, however, require specification of minimum and maximum numbers of visible threads (or dimensions) to ensure that it can still function as a bearing. It was not possible to determine whether the locking of the eye-end had been disturbed when the rod was fitted.

Conclusions

The failure of the left main landing gear to extend was caused by the inability of the extension mechanism to overcome a condition of interference between the tyres and the forward MLG doors. As with the accident involving G-BUUP in August 1997, this condition had arisen because the 'A' frame, which controls motion of the forward doors, was not correctly positioned as the hook fitting on the oleo leg contacted it to close the doors. The 'A' frame roller did not engage in the hook and the forward face of the fitting pushed the roller upwards, effectively closing the doors before the wheels were fully retracted.

The investigation of the incident to G-BUUP concluded that the incorrect location of the 'A' frame was probably due to contamination of the spring pot, which controls its position at this phase of the retraction cycle. Accordingly, revised methods and periodicity were mandated for lubrication of the system. However, in this investigation, there was no evidence that problems with lubrication or contamination were responsible but rather that failure of a eye-end thread locking method led to a restriction of movement in the mechanism. In analysing how the jam-nut did not prevent the eye-end from unscrewing from the rod there are clearly several questions. The most fundamental is whether the manufacturer's locking had been disturbed during fitment of the rod. It would appear improbable that a new rod, taken from stores, would fit precisely without the need for any adjustment to rig the doors. Explicitly following the instructions in the Maintenance Manual would require remaking of the eye-end locking after adjustment, but the mechanic may have found it possible to accommodate the adjustment at the threaded bearing end, leaving the original locking intact.

The question of *who* was responsible for the failure of the locking should be considered less important than the fact that it can fail at all. Tests using a new rod showed that it was possible to release the torque on the jam-nut without breaking the manufacturer's locking wire. If this happens then the eye-end is free to unscrew and the presence of the wire merely keeps the lock nut in close proximity to the rod end, such that any motion towards screwing the eye-end back in will result in a locked condition.

Subsequent airworthiness actions

Once it was realised that the apparent seizure of the threaded bearing was not related to a lack of lubrication, BAE Systems issued Mandatory Service Bulletin (MSB) ATP-32-100 on 24 May, which contained guidance on the detection and subsequent prevention of bottoming of the threaded bearing in the light of the new explanation. The manufacturer then embarked on a review of the locking methods of both rods which had been manufactured by themselves and also a later, alternative, component supplied by a sub-contractor which used a tab washer instead of locking wire to secure the jam nut. It was felt that neither locking method was fully effective and a modification to both was introduced by optional SB ATP-32-101, which employed a split-pin method. Embodiment of the modification was 'Highly Recommended' by BAE Systems.

Following a review by the aircraft manufacturer of the Maintenance Manual instructions on the 'procedure to replace and then adjust the forward door actuating rods', they have been substantially rewritten. The enhanced guidance was embodied at Revision 63, issued on 15 October 2000, and is applicable to all ATPs. As well as resolving ambiguities, it gives clear details of required thread lengths, not only in the section in question, but also in those covering Operating Mechanism Lubrication (52-80-00-301) and Landing Gear Doors - Removal Installation (52-80-00-401).

In addition, the manufacturer commenced a design review of the MLG system, which suggested that the mechanism by which the main landing gear had been prevented from lowering, in both the

cases of G-BUUP and G-MANJ may have been not only that of friction between the tyres and the doors but one of geometry of the mechanism. It was realised that, in a normally-functioning system, initial downward movement of the leg, following release of the uplock, starts to move the 'A' frame and hence the doors. This initial movement occurs because there is sufficient clearance between the tyres and the doors. In the abnormal condition described in this bulletin, the hard tyre/door contact prevented the initial movement of the 'A' frame and hence opening of the doors, in what was described as 'a geometric closed-loop' situation.

The same design review concluded that the MLG door mechanism should be modified such that mis-aligned 'A' frame/hook fitting contact would not be permitted to continue through to the point where the tyres contact the doors. The proposed modification, under development by the manufacturer, seeks to introduce a baulk mechanism on the 'A' frame and the oleo leg, so that, if mis-contact occurs for any reason, further movement of the leg towards UP is physically prevented. This should manifest itself to the crew as a failure to lock the affected MLG up, but allow a normal DOWN re-selection. Successful testing of the modification has now taken place and it is intended that its embodiment will be Mandatory but allow easement of the extra maintenance tasks introduced by MSB ATP-32-100 if the revised eye-end locking modification (SB32-101) is also carried-out.

In view of the above the following recommendation is made:-

Recommendation 2000-66

It is recommended that the CAA, on completion by BAE Systems of the development and testing of the modification to introduce a baulk mechanism on the 'A' frame and the oleo leg, so that, if mis-contact occurs for any reason, further movement of the leg towards UP is physically prevented but a normal DOWN re-selection is achievable, make the implementation of that modification mandatory.

Emergency and abnormal checklist

After the accident in August 1997 the manufacturer carried out amendment action on Card 35 and Card 36 of the checklist. Furthermore, as the checklist overall did not comply with the new, 'Guidelines for the Design and Presentation of Emergency and Abnormal Checklists', published in Civil Aviation Publication (CAP) 676 (dated September 1997) the AAIB made recommendation (98-53) that:

> British Aerospace (Regional Aircraft) Ltd review the content and presentation of the ATP Emergency and Abnormal Checklist with a view to revising this Checklist in accordance with the guidelines published in CAP 676.

The manufacturer agreed with this recommendation but examination of the checklist used during this accident revealed that no changes had been made in the light of the previous recommendation. Since the accident to G-MANJ, BAE Systems have revised the ATP Emergency and Abnormal Checklist in accordance with the intent of Recommendation 98-53.