

# **Boeing 747-121, N739PA: Appendix F**

**Aircraft Accident Report No 2/90 (EW/C1094)**

**Report on the accident to Boeing 747-121, N739PA at Lockerbie, Dumfriesshire, Scotland on 21 December 1988**

## **APPENDIX F**

### **BAGGAGE CONTAINER EXAMINATION, RECONSTRUCTION AND RELATIONSHIP TO THE AIRCRAFT STRUCTURE**

#### **1. Introduction**

During the wreckage recovery operation it became apparent that some items, identified as parts of baggage containers, exhibited blast damage. It was confirmed by forensic scientists at the Royal Armaments Research and Development Establishment (RARDE), after detailed physical and chemical examination, that these items showed conclusive evidence of a detonating high performance plastic explosive. It was therefore decided to segregate identifiable container parts and reconstruct any that showed evidence from the effect of Improvised Explosive Device (IED). It was evident, from the main wreckage layout that the IED had been located in the forward cargo hold and, although all baggage container wreckage was examined, only items from the forward hold showing the relevant characteristics were considered for the reconstruction. This Appendix documents the reconstruction of two particular containers and, from their position within the forward fuselage, defines the location of the IED.

#### **2 Container Arrangement**

Information supplied by Pan Am showed that this aircraft had been loaded with 12 baggage containers and two cargo pallets in the forward hold located as shown in Figure F-1. Three containers were recorded as being of the glass fibre reinforced plastic type (those at positions 11L, 13L and 21L) with the remaining 9 being of metal construction.

#### **3. Container Description**

All the baggage containers installed in the forward cargo hold were of the LD3 type (lower deck container, half width - cargo) and designated with the codes AVE, for those constructed from aluminum alloy, and AVA or AVN for those constructed from fibreglass. Each container was specifically identified with a four digit serial number followed by the letters PA and this nine digit identifier was present at the top of three sides of each container in black letters/numbers approximately 5 inches tall. Detail drawings and photographs of a typical metal container are shown in Figure F-2. Each container was essentially a 5 feet cube with a 17 inch extension over its full length to the left of the access aperture. In order to fit within the section of the lower fuselage this extension had a sloping face at its base joining the edge of the container floor to the left vertical sidewall at a position some 20 inches above the floor. The access aperture on the AVE type container was covered by a blue reinforced plastic curtain, fixed to the container at its top edge, braced by two wires and central and lower edge cross bars which engaged with the aperture structure. The strength of this type of container superstructure was provided by the various extruded

section edge members, attached to a robust floor panel, with a thin aluminum skin providing baggage containment and weatherproofing.

#### **4. Container Identification**

Discrimination between forward and rear cargo hold containers was relatively straightforward as the rear cargo hold wreckage was almost entirely confined to the town of Lockerbie and was characteristically different from that from the forward hold, in that it was generally severely crushed and covered in mud. The forward hold debris, by comparison, was mostly recovered from the southern wreckage trail some distance from Lockerbie and had mainly been torn into relatively large sections.

All immediately identifiable parts of the forward cargo containers were segregated into areas designated by their serial numbers and items not identified at that stage were collected into piles of similar parts for later assessment. As a result of this two containers, one metal and one fibreglass, were identified as exhibiting damage likely to have been caused by the IED. From the Pan Am records the metal container of these two had been positioned at position 14L, and the fibreglass at position 21L (adjacent positions, 4th and 5th from the front of the forward cargo hold on the left side). The serial numbers of these containers were respectively AVE 4041 PA and AVN 7511 PA.

#### **5. Container Reconstruction**

Those parts which could be positively identified as being from containers AVE 4041 PA and AVN 7511 PA were assembled onto one of three wooden frameworks; one each for the floor and superstructure of container 4041, and one for the superstructure of container 7511. Figures F-3 to F-9 show the reconstruction of container 4041 and Figure F-10 shows the reconstructed forward face of container 7511. Approximately 85% of container 4041 was identified, the main missing sections being the aft half of the sloping face skin and all of the curtain. Two items were included which could not be fracture or tear matched to container 4041, however, they showed the particular type of blast damage exhibited only by items from this container.

While this work was in progress a buckled section of skin from container 4041 was found by an AAIB Inspector to contain, trapped within its folds, an item which was subsequently identified by forensic scientists at the Royal Armaments Research and Development Establishment (RARDE) as belonging to a specific type of radio-cassette player and that this had been fitted with an improvised explosive device.

Examination of all other component parts of the remaining containers from the front and rear cargo holds did not reveal any evidence of blast damage similar to that found on containers 4041 and 7511.

#### **6. Wreckage Distribution**

Those items which were positively identified as parts of container 4041 or 7511, and for which a grid reference was available, were found to have fallen close to the southern edge of the southern wreckage trail. This indicated that one of the very early events in the aircraft break-up sequence was the blast damage to, and ejection of, parts of these two containers.

#### **7. Fuselage Reconstruction**

In order to gain a better understanding of the failure sequence, that part of the aircraft's fuselage encompassing the forward cargo hold was reconstructed at AAIB Farnborough. After all

available blast damaged pieces of structure had been added, the floor of container 4041 was installed as near to its original position as the deformation of the wreckage would allow and this is shown in Figure F-11. The presence of this floor panel in the fuselage greatly assisted the three-dimensional assessment of the IED location. Witness marks between this floor and the aircraft structure, tie down rail, roller rail and relative areas of blast damage left no doubt that container 4041 had been located at position 14L at the time of detonation.

## **8. Analysis**

The general character of damage that could be seen on the reconstructions of containers 4041 and 7511 was not of a type seen on the wreckage of any of the other containers examined. In particular, the reconstruction of the floor of container 4041 revealed an area of severe distortion, tearing and blackening localised in its aft outboard quarter which, together with the results of the forensic examination of items from this part of the container, left no doubt that the IED had detonated within this container.

Within container 4041 the lack of direct blast damage (of the type seen on the outboard floor edge member and lower portions of the aft face structural members) on most of the floor panel in the heavily distorted area suggested that this had been protected by, presumably, a piece of luggage. The downward heaving of the floor in this area was sufficient to stretch the floor material, far enough to be cut by cargo bay sub structure, and distort the adjacent fuselage frames. This supported the view that the item of baggage containing the IED had been positioned fairly close to the floor but not actually placed upon it. The installation of the floor of container 4041 into the fuselage reconstruction (Figure F-11) showed the blast to have been centered almost directly above frame 700 and that its main effects had not only been directed mostly downwards and outboard but also rearwards. The blast effects on the aircraft skin were onto stringer 39L but centered at station 710 (Figure F-12). Downwards crushing at the top, and rearwards distortion of frame 700 was apparent as well as rearwards distortion of frame 720.

With the two container reconstructions placed together it became apparent that a relatively mild blast had exited container 4041 through the rear lower face to the left of the curtain and impinged at an angle on the forward face of container 7511. This had punched a hole, Figure F-10, approximately 8 inches square some 10 inches up from its base and removed the surface of this face inboard from the hole for some 50 inches. Radiating out from the hole were areas of sooting, and other black deposits, extending to the top of the container. No signs were present of any similar damage on other external or internal faces of container 7511 or the immediately adjacent containers 14R and 21R.

The above assessment of the directions of distortion, comparison of damage to both containers, and the related airframe damage adjacent to the container position, enabled the most probable lateral and vertical location of the IED to be established as shown in Figure F-13, centered longitudinally on station 700.

## **9. Conclusions**

Throughout the general examination of the aircraft wreckage, direct evidence of blast damage was exhibited on the airframe only in the area bounded, approximately, by stations 700 and 720 and stringers 38L and 40L. Blast damage was found only on pieces of containers 4042 and 7511, the relative location and character of which left no doubt that it was directly associated with airframe damage. Thus, these two containers had been loaded in positions 14L and 21L as recorded on the Pan Am cargo loading documents. There was also no doubt that the IED had been located within

container 14L, specifically in its aft outboard quarter as indicated in Figure F-13, centered on station 700.

Blast damage to the forward face of container 7511 was as a direct result of hot gases/fragments escaping from the aft face of container 4041. No evidence was seen to suggest that more than one IED had detonated on Flight PA103.