

WRECKAGE INFORMATION

1. Fuselage

The fuselage was found inverted at the main wreckage with severe impact damage and fire damage (Figure 1). The crown of the fuselage was crushed downward for the entire length (nose to tail). The pilot and co-pilot's windows were cracked and the side windows were pulled out and were lying outside the cockpit. There was no evidence of any bird strike or foreign object damage on the cockpit windows. The right side of the fuselage suffered slight impact damage just aft of the R1 entry door. The skin at this location was torn in the vertical direction (Figure 2).

The remaining fuselage on the right side was intact and suffered no impact damage. There was evidence of heavy external soot and fire damage on the skin and right wing fairing just forward of the right wing front spar. The lower wing fairing aft of the right main landing gear wheel well exhibited severe scrape/grind marks. These scrape marks were at 30 degrees angle (nose left orientation).

About a 10-foot section of the right wing upper and lower skins with front and rear spars remained attached to the fuselage (Figure 3). The trapezoid fitting which connects the fixed and folding retractable side brace of the right main landing gear remained attached to the fuselage. This fitting suffered no fire damage and was fractured in tension at the brace connection. The fractured surface exhibited overload features. This fracture surface area was cut from the fitting for detailed metallurgical examination. The right main landing gear had separated from the wing and fuselage point and was found near the aft right side of the fuselage under the right horizontal stabilizer (Figure 4).

The left fuselage suffered crushing damage just aft and forward of the L1 entry door. A large section of the fuselage common to L2 door from Station 735 to Station 1059 was pushed out (Figure 5). The remaining portion of the fuselage remained intact with minor impact damage. The aft section of fuselage suffered external fire damage and soot damage on left and right sides.

2. Wings

2.1. Left wing

The left wing remained attached to the fuselage and was found at the main wreckage (Figure 6). The inboard section of the wing exhibited evidence of sooting. There was evidence of scrape marks on the upper wing skin in a span-wise direction outboard of no.1 engine location. The leading edge at the inboard section was slightly damaged and suffered fire damage. The leading edge at the no.1 engine location was crushed aft and slightly upwards. The inboard slats remained attached to the wing and were found in extended position (approximately 30 degrees position). The leading edge outboard of the no.1 engine suffered severe impact and fire damage at various locations. The slats outboard of the no. 1 engine remained attached to the wing and were in the extended position. The outboard end of the slat suffered fire damage. The wing structure outboard from Station 855 suffered severe fire damage with the structure exhibiting melting. The front and the rear spars of the outboard section suffered severe fire damage and had sagged. The wing tip suffered severe fire damage. The outboard aileron and the wing-lets were consumed by fire. The spoilers remained intact with no apparent damage.

The inboard flap and the inboard aileron remained attached to the wing structure. There was evidence of slight scrape marks on the upper surface of the flap. The outboard flap remained attached with minimum damage. The left main landing gear remained attached to the attachment fitting on the wing. There was no damage to the attachment fitting.

2.2. Right Wing

The right wing fractured between the no. 3 engine nacelle and the right side fuselage at Station 163 on the leading edge and Station 197 at the rear spar (Figure 3). About a 15-foot section of the front spar and a six-foot section of the rear spar remained attached to the fuselage. The upper and the lower skins

between the front and the rear spar of the inboard section remained attached to the fuselage and exhibited upwards bending. About a six-foot section of the outboard front spar separated from the upper skin near the fractured end and the spar cap was cracked. The remaining nine-foot section remained attached to the upper skin and exhibited no bending. The stringers between the front and rear spar exhibited upward bending. The fractured surface exhibited overload features. There was evidence of slight fire damage and soot damage on the front spar and associated structure. Some of the fractured surfaces were sooted. The soot/fire damage was not very significant as compared to the outboard section of the wing.

The wing outboard from the fracture was in one section and was found about 300 feet from the nose of the airplane in the main wreckage (Figure 7). The upper skin exhibited sooting from the fracture to Station 772 and was consumed by fire from Station 772 to the tip. There was a crack of about 30 inches long at the middle of the upper skin in a span-wise direction. The fractured surface on this crack was sooted. The upper skin was bulged upward 12 inches forward of the rear spar on the upper skin and the side rib. The upper skin bulge was 38x46 inches in area and bulged up for about two inches. The leading edge suffered severe impact damage and fire damage. The inboard slat was detached and recovered at the site. The middle and outboard slats suffered severe fire damage and remained attached to the leading edge. The leading edge from the fracture to Station 538 suffered fire damage. The inboard end of the leading edge suffered severe impact damage and was dented at various locations. The leading edge outboard of Station 538 was consumed by fire. There was no evidence of heavy scrape marks on the upper skin. Only light scrape marks were observed at the inboard end on the upper skin in a fore and aft direction. The wing tip suffered severe fire damage on the upper skin. The strobe lens reflector and the case with the bulb remained intact and suffered fire damage. There was no evidence of any scrape marks on the wing tip structure on the lower skin. The right wing lower skin was intact from the inboard fracture location to the tip and suffered severe fire damage. There was no evidence of any heavy scrape marks on the lower skin.

The inboard fractured end of the lower skin exhibited severe scrape marks and grinding on the edge of the skin at a 45-degree angle.

The inboard flap was missing and was found on the left side of the runway in the vicinity of the main wreckage. The inboard aileron and the outboard flap suffered severe fire damage and were separated from the wing. These control surfaces were found at close proximity to the right wing. The outboard aileron was consumed by fire along with the outboard section of the wing.

The engine pylon forward attachment fitting (tombstone fitting) that attached to the engine pylon remained attached to the front spar and was fractured across the middle. The fractured end exhibited evidence of bending aft. The forward wing pylon mount fitting was pulled downward at the forward end and was slightly bent inboard. The aft pylon mount fitting remained attached to the lower skin with no bending. The aft pylon mount remained attached to the lower skin and was slightly bent aft. All the fasteners on the aft mount bulkhead sheared.

The forward and aft main landing gear attach fitting suffered severe damage. The aft lug of the forward mount fractured between 4 o'clock to 10 o'clock position (view looking forward - see Figure 8). The fractured surface exhibited soot accumulation and slight discoloration. The forward mount was cracked and exhibited impact damage in an upward direction. The forward mount shear pin was sheared off and a portion of the shear pin remained with the forward lug (Figure 9). The remaining piece was attached to the landing gear. The fractured surface on the shear pin was heavily sooted. The aft mount was fractured, and both the lugs along with a large piece of fitting remained attached to the landing gear including the shear pin (Figure 10). The entire area of the main landing gear fitting and fractured surfaces exhibited evidence of sooting. The piece of the head-end of the main landing gear actuator remained attached to the fitting.

3. Landing Gears

3.1. Right Main Landing Gear

The right main landing gear was separated from its mount. The forward shear pin was sheared off from the forward mount and half of the shear pin remained in the forward lug of the forward mount. This section of the shear pin was pushed out and exhibited severe soot damage on the fracture surface. The remaining portion of the shear pin remained on the forward lug of the landing gear and exhibited some bending. The fractured surface on this portion exhibited surface rust and the fractured surfaces could not be examined. The aft lug of the forward mount fractured between the 4 o'clock and 10 o'clock positions. This section of the lug fractured into two pieces and was found on the runway between the touchdown point and the main wreckage. The mating fractured surface on the wing forward mount aft lug exhibited some discoloration but the mating fractured surface of the lug that was found on the runway did not exhibit any discoloration. All surfaces on the aft lug exhibited evidence of overload features. There was no evidence of fire or soot on the pieces of lug found on the runway. The forward fitting that remained attached to the landing gear fitting suffered soot damage. The forward mount fractured in the middle and exhibited impact damage in an upward direction (Figure 8).

The landing gear fitting between the forward and aft mount fractured and a portion of the fitting was missing. This section was attached to the landing gear with the aft pin still in place. This piece also exhibited impact damage between the forward and aft mount. The landing gear fitting between the forward and aft mounts suffered severe soot damage and the soot was evident on the fracture surfaces.

The right main landing gear strut remained intact and was fully extended at the main wreckage site. The strut was deflated later for safe handling. The folding side brace remained attached to the gear. The upper rib of the folding side brace was fractured and twisted near the end that attached to the fuselage. A small

section of the fixed brace remained attached to the trapezoidal fitting along with the folding side brace (Figure 11). The trapezoidal fitting fractured from the trapezoidal panel that attached to the fuselage (Figure 12). The trapezoidal panel pillow block remained attached to the fixed and folding brace. The fractured surface exhibited evidence of overload features. There was no evidence of fire damage or soot damage to the right main landing gear.

The truck beam suffered impact damage and was cracked at the aft stop location on the upper surface. The forward stop exhibited severe impact damage on the upper surface. All four tyres remained attached to the truck beam. The outboard tyres remained inflated and the pressures in the tyres were 200 psi each. The inboard tyres were deflated. The inboard side-wall of the inboard tyres exhibited severe scuff marks generally in radial direction. There was no evidence of any fire damage to the landing gear tyres.

3.2. Centre Landing Gear

The centre landing gear fractured at the bottom of the cylinder (oleo) near the axle (Figure 13). The fractured surface exhibited overload features with a 45-degree shear lip and was severely rusted. The wheel truck with tyres was found on the runway near the main wreckage. There was evidence of heavy impact damage on the right hydraulic brake reservoir that attached on the wheel. The heavy impact mark was a 3/8-inch wide indentation and ranged up to 1/2 inch deep. There was no evidence of any fire damage or soot damage to the centre gear truck assembly. Only one tyre was inflated and did not exhibit any scuff mark on the inner or outer side. The other tyre was deflated and suffered severe sharp cuts on its side.

The strut remained attached to the fuselage with the inner cylinder (oleo) compressed all the way in. The lower end of the strut exhibited grinding consistent with runway contact. These grind marks was approximately at 45 degrees with respect to airplane centreline and about 30 degrees nose left. These grind marks covered about 50% of the circumferential surface. The body gear remained attached to the fuselage. There was no evidence of any damage to the

gear-to-fuselage attachment point. There was no evidence of any fire damage on the centre landing gear.

A small section of the base of the oleo (lower cylinder) of about five inches long with torque link was separated from the centre gear. The fractured surfaces on both sides exhibited overload and were rusted.

3.3. Left Main Landing Gear

The left main landing gear remained attached to the wing and fuselage with its attachment point. There was no evidence of any impact damage or fire damage to the left main landing gear. The gear cylinder was extended and the gear was in the lock position with the folding and fixed side braces intact. The tyres remained attached to the truck beam assembly and suffered no damage.

3.4. Nose Landing Gear

The nose landing gear remained attached to the nose fuselage with minimum structural damage. The strut was in an extended position. The right tyre separated from the hub and was found near the main wreckage. The tyre exhibited heavy cut damage in the bead area of the tyre. The hub fractured circumferentially. The left tyre remained attached to the axle and was scuffed on the inboard side-wall. There was no evidence of fire damage to the nose landing gear.

4. Engine Pylons

4.1. No. 1 Engine Pylon

The no. 1 engine remained attached to the left wing at its forward attachment point. The forward attachment point is the tombstone fitting and remained fully attached to the upper and lower spar of the pylon. This tombstone fitting was bent forward about 60 degrees. The pylon separated at the rear mount fitting. The fitting fractured in the middle of the lug. The fractured surface exhibited evidence

of overload failure. There was no evidence of any fire damage to the pylon-wing attachment structure.

4.2. No. 2 Engine Pylon

The no.2 engine pylon was separated from the empennage and was found intact. The front portion of the inlet duct was separated from the engine and the vertical stabilizer broke off at the manufacturing joint on the top of the pylon.

4.3. Engine No. 3 Pylon

The no. 3 engine separated from the wing at its pylon attachment points and was found in the grassy area near the right wing (Figure 14). The front (tombstone fitting) pylon mount fractured about 24 inches from the upper wing skin. This fitting suffered severe fire damage and the web and the cap was bent aft at the fractured end. The tombstone fitting was attached to the wing front spar and pulled out of the pylon about five inches below the pylon upper spar. The upper spar that the front links were attached, was broken out of the pylon and attached to the wing mount. A large section of the tombstone fitting remained with the engine pylon. The web and the cap were bent forward with slight twisting. The rear engine mount and bulkhead separated from the pylon in one piece and remained attached to the wing. The rear engine mount separated from the left and right pylon skin and all the fasteners were pulled out of the skin. The upper spar cap at the outboard side of the pylon was bent in a "U" shape and the web/ skin separated from the cap indicating that the pylon was experiencing loads in the inboard direction. The upper spar cap at the inboard side remained attached to the web with no noticeable bending. The inboard pylon skin was bent inboard.

5. Empennage

The right horizontal stabilizer remained attached to the empennage with severe impact damage (Figure 4). The section outboard of Station 292 was bent down. The inboard section remained attached to the empennage. The right stabilizer suffered soot damage on the leading edge, upper and lower skins. The leading edge and lower skin exhibited

severe scrape marks and these scrape marks were on top of the sooted leading edge and skin. The scrape marks were in three distinct directions. One set of scrape marks near the leading edge ran in span-wise direction. The second set was about 30 degrees anti-clockwise from the span-wise direction (view looking down), while the third one was about 70 degrees anti-clockwise from the span-wise direction (view looking down). There were other scrape marks in various directions. These scrape marks are indication of runway contact. The leading edge of the stabilizer was dented and crushed at various locations. The outboard end of the leading edge was crushed aft. The inboard and outboard elevators remained attached to the horizontal stabilizer and suffered severe fire damage.

The left horizontal stabilizer fractured at Station 290 (Figure 15). The inboard section remained attached to the empennage with upper skin. This section exhibited upward bending. The lower skin was fractured at the root in a jagged fracture pattern. The front spar and the associated structure at the fractured location were bent aft. The upper and lower skin suffered soot damage. The inboard elevator remained attached with no impact damage but exhibited severe soot damage. The outboard elevator fractured at Station 290. There was no scrape marks observed on the inboard section of the horizontal stabilizer.

The vertical stabilizer right skin fractured approximately at Station 525 and at Station 426 on the left side (Figure 16). The left skin and the associated structure were bent to the left. The front spar fractured at Station 525 and the lower section of the front spar web was missing. The front spar at the fracture was bent slightly to the left. The rear spar fractured at Station 525 and was bent aft. The second fracture on the rear spar was at Station 444. At this location the spar was bent aft. The left skin from Station 525 was still attached to the upper vertical stabilizer but the right skin was missing. The upper forward and aft rudders remained attached to the vertical. The lower forward and aft rudders fractured at approximately Station 426. The rudder section below this station suffered severe fire damage. A portion of the lower vertical stabilizer (lower from Station 426) remained with the lower rudder and suffered fire damage. The vertical stabilizer fractured at the base just above the no.2 engine. The rear spar and aft centre spar fractured about 10 inches above the base and was bent aft. The forward centre and

front spar attachment point fractured six inches above the base and exhibited no bending. All the fractured surfaces exhibited evidence of overload.

6. Powerplants

The accident aircraft was powered by three Pratt & Whitney model PW4460 engines. All three engines were found at the crash site. None of the engines displayed signs of engine fire or non-contained events. All of the engine cowling and nacelle hardware was found forward of the aircraft touchdown area. The Full Authority Digital Engine Control (FADEC) was removed from each engine for analysis of engine fault information by the FADEC manufacturer. No further engine disassembly was required for investigation.

6.1. No. 1 engine; s/n: 723907 (Figure 17)

After the accident, no. 1 engine remained attached to the pylon structure. The engine and pylon had separated from the left wing at the front and rear pylon mounts. The engine was inverted, along with the wing, with the 12 o'clock position of the fan case resting on the ground. The inlet structure was separated from the engine forward of A-flange. The fan rotor and fan blades were intact. Fifteen of the fan blades were slightly bent opposite the direction of rotation. The other 21 fan blades were not significantly bent while two fan blades were slightly bent in the direction of rotation. The fan case showed signs of fan blade tip contact with the fan case attrition material. The Low Pressure Compressor (LPC) inlet vanes were intact and did not show signs of distress. No significant damage was found to the LPC blades and vanes that could be seen from the LPC inlet. The fan exit guide vanes were intact. The fan cowl doors were separated from the nacelle. The thrust reverser doors were found in the stowed position. The rear stages of the low-pressure turbine were intact and showed no indication of distress. No indication of engine failure or debris was found in the turbine exhaust case. The exhaust nozzle and tail cone remained intact and were not significantly distressed. There were no indications of any scrape marks on the engine nacelle.

6.2. No. 2 engine; s/n: 723968 (Figure 18)

After the accident, no. 2 engine remained attached to the inlet and engine mounting structure. The engine, inlet, and mounting structure separated from the aircraft along the diverter structure of the vertical stabilizer. The inlet duct was breached radially inward and forward of the fan face. Debris was found in the inlet duct in front of the fan face. The fan rotor and fan blades were intact. Foreign object impact damage was observed on the fan blades in the form of nicks and local deformations of the fan blade leading edges. The inlet, fan section, LPC, and bypass air surfaces were thinly covered in soot, consistent with the external, post-accident fire. No damage beyond slight foreign object damage was observed on the LPC inlet vanes or blades. The fan exit guide vanes remained intact. The fan cowl doors were separated from the fan case, one of which was found on the side of the runway. The bypass and core cowl doors remained on the engine and showed impact damage from external directions. The thrust reverser doors were found in the stowed position. No indication of engine distress was found on the 6th stage LPC blades or in the turbine exhaust case. The exhaust tail cone and nozzle remained attached to the engine.

6.3. No. 3 engine; s/n: 723952 (Figure 19)

After the accident, no. 3 engine remained attached to the pylon structure. The engine and pylon structure was separated from the right wing at both the front and rear pylon mounts. The engine mounts did not exhibit any signs of distress. The inlet duct separated from the engine immediately forward of A-flange. The inlet exhibited abrasion marks at the 6 o'clock position. The fan case separated from the engine at C-flange, just behind the fan exit guide vane outer platform mounts. The separated fan case structure showed no signs of non-containment. Engine externals mounted near the 6 o'clock position of the fan case exhibited abrasion marks. The fan containment belt, yellow in color, displayed heavy fraying in the 6 o'clock region. Fragments of the belt material were found on the runway. The fan hub was intact and contained all 38 fan blade attachments. Three fan blades

were fractured at roughly 50% span while 25 fan blades were fractured at the part-span shroud location. The remaining 10 fan blades were of full length and bent opposite the direction of fan rotation. The LPC shroud was intact, with the 1st stage LPC stators showing signs of foreign object damage. Ground debris was found throughout the bypass ducts and the LPC.

The upper intermediate case struts were deformed rearward, while the lower struts were crushed into the engine core cowl. The outer structure of the bypass duct, including the thrust reverser, was collapsed radially inward on both the left and right sides of the nacelle. Scuff marks consisting of gray paint were found at the 10 & 11 o'clock positions. Two pieces were removed for further examination. The right thrust reverser door was in the stowed position. The left thrust reverser door was separated from the engine, along with the thrust reverser cascades. The thrust reverser cascades were in place on the right side of the engine. The lowest external region of the thrust reverser doors exhibited two distinct patterns of abrasion or grinding. One of the patterns of abrasion was oriented roughly along the engine centreline in the fore to aft direction. The second pattern of abrasion was oriented approximately 35 degrees right of engine centreline, also in the fore to aft direction. The 6th stage low-pressure turbine blades showed no signs of distress. The lower third of the turbine exhaust case was crushed radially inward at T-flange; however, P-flange was only slightly deformed. No engine debris was found in the turbine exhaust case. The exhaust nozzle was separated from T-flange. The exhaust tail cone suffered radial impact at the 6 o'clock position, but remained attached to the turbine exhaust case.

GENERAL COMMENTS

All station numbers are approximate

Conventional sign orientation with the aeroplane on gear

No evidence of any inflight collision or fire



Main Wreckage (Figure 1)



Right-hand Forward Fuselage (Figure 2)



Right Wing Root Section (Figure 3)



Right Main Landing Gear and Right Horizontal Stabilizer (Figure 4)



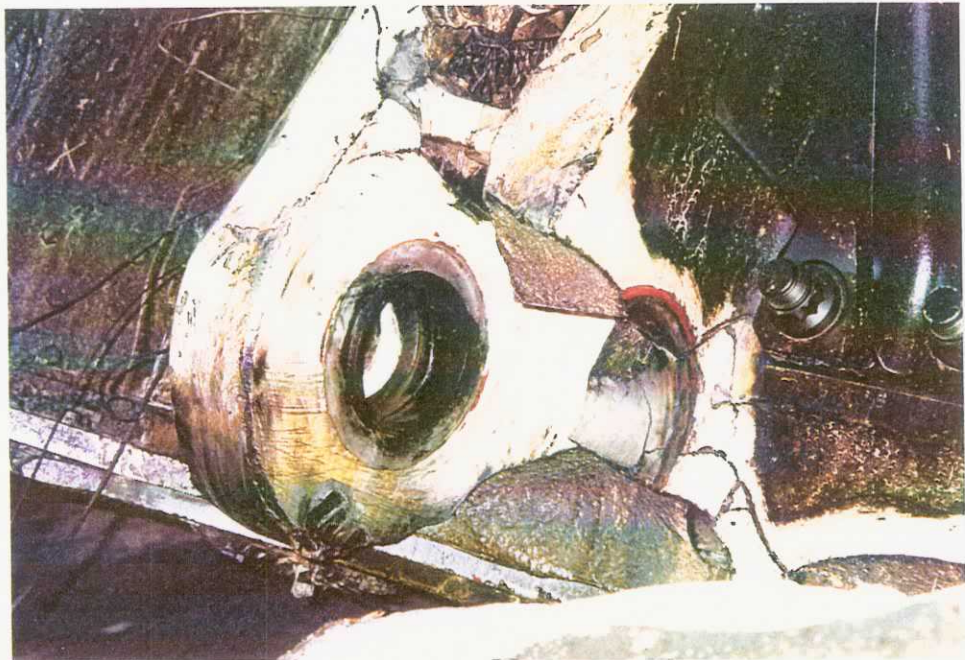
Left Forward Fuselage (Figure 5)



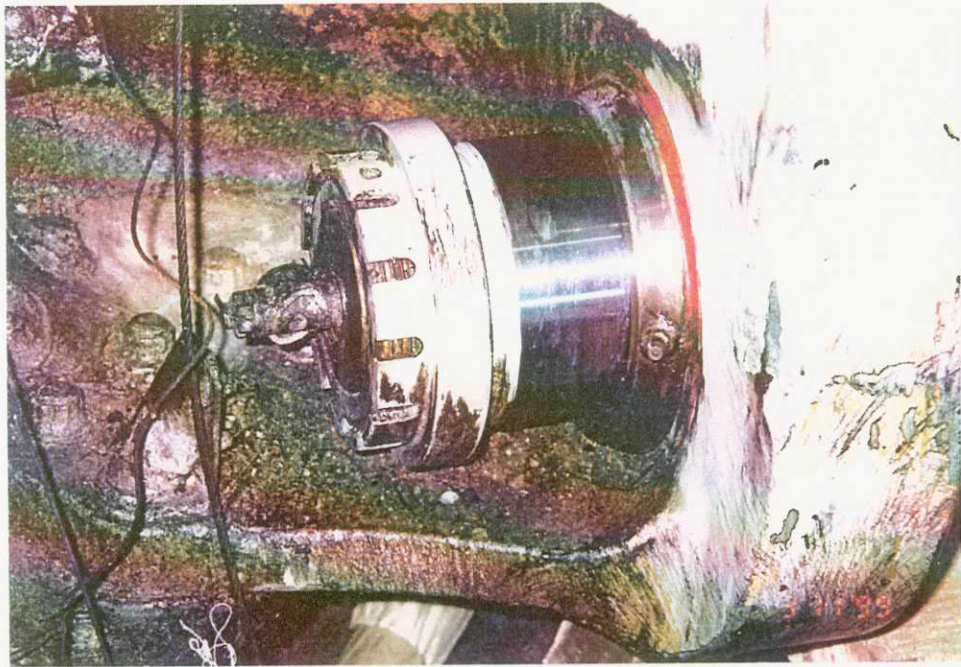
Left Wing (Figure 6)



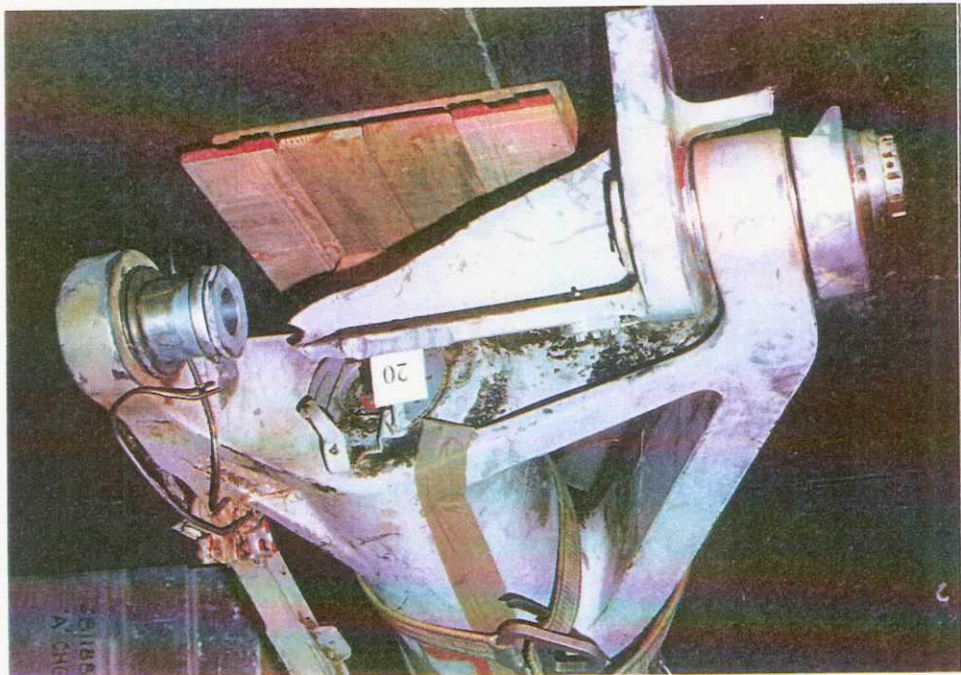
Right Wing Detached from Main Fuselage (Figure 7)



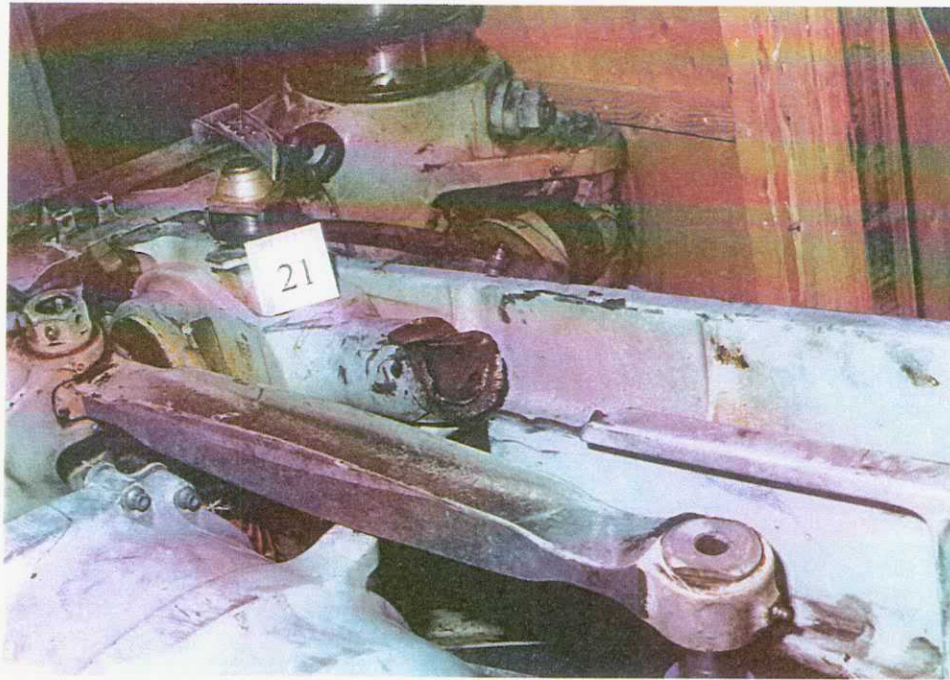
Right Main Landing Gear (RMLG) Forward Attachment Fitting (Figure 8)



Forward Shear Pin (Trunnion Bolt) (Figure 9)



**Fractured RMLG Aft Attachment Fitting with Aft Shear Pin (Trunnion Bolt)
(Figure 10)**



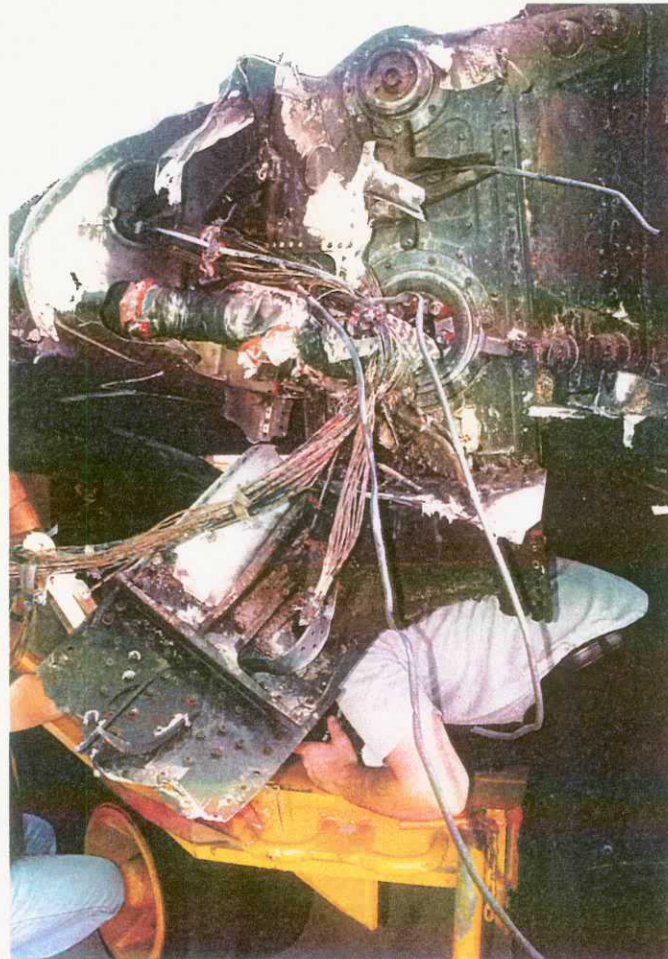
Fractured Fixed Side-Brace (Figure 11)



Fractured Trapezoidal Panel (Figure 12)



Fractured Center Landing Gear Oleo (Figure 13)



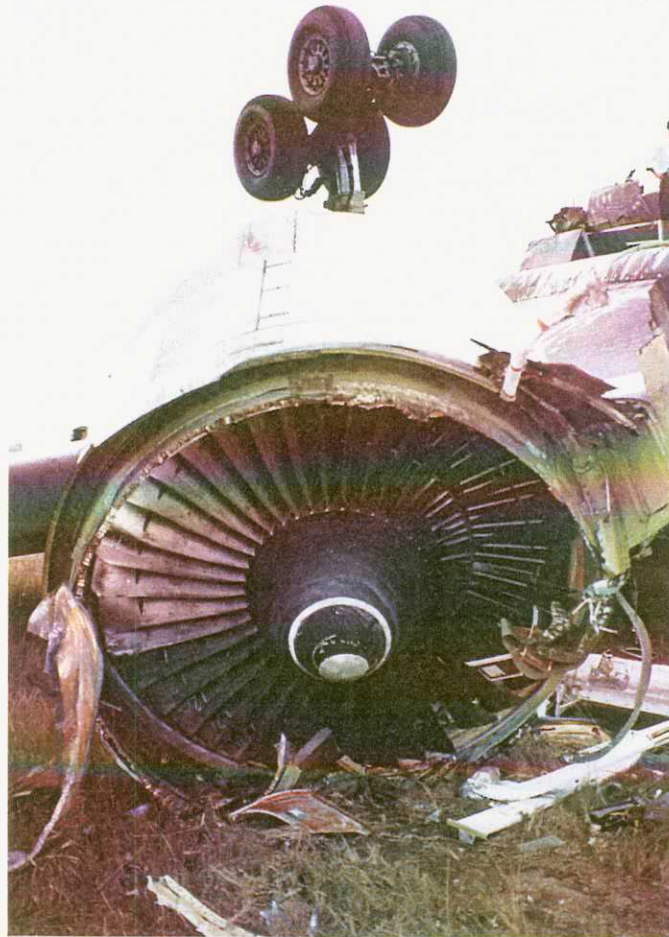
No. 3 Engine Pylon to Wing Forward Attachment Structure (Figure 14)



Left Horizontal Stabilizer (Figure 15)



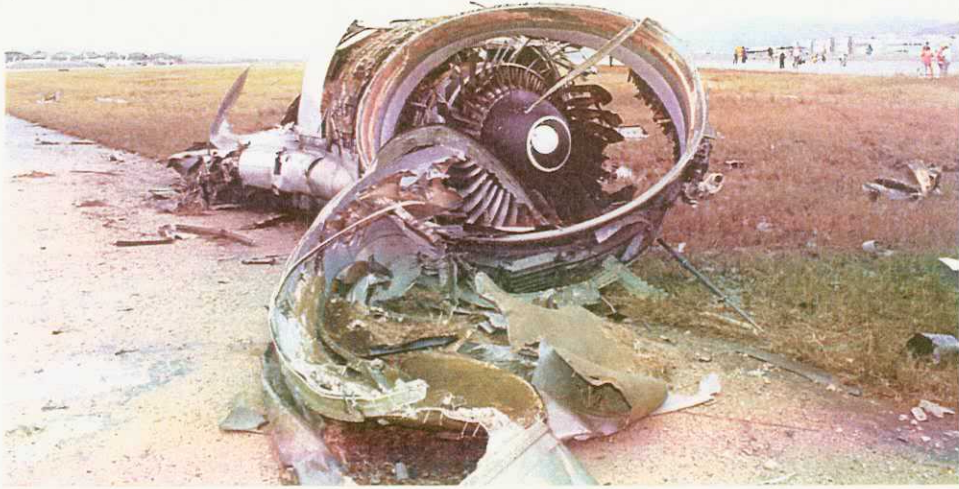
Vertical Stabilizer (Figure 16)



No.1 Engine (Figure 17)



No.2 Engine (Figure 18)



No.3 Engine (Figure 19)