NATIONAL TRANSPORTATION SAFETY BOARD
NORTHWEST REGIONAL OFFICE
SEATTLE, WA 98188

MAY 21,1998

MAINTENANCE GROUP CHAIRMAN'S FACTUAL REPORT ADDENDUM

A. ACCIDENT: DCA-96-MA-070

Location: East Moriches, New York

Date: July 17, 1996

Time: 2031 Eastern Daylight Time

Airplane: **Boeing** 747-131, N93119

B. GROUP IDENTIFICATION

Chairman:	Debra J. Eckrote	National Transportation Safety Board (NTSB) Seattle, WA
Members:		
	Jerry Kohlbrecher	Trans World Airlines (TWA) Kansas City, MO
	Fred Liddell	International Association of Machinists (IAM) Kansas City, MO
	Jim Orchard	Federal Aviation Administration (FAA) Kansas City, MO
	James H. Connell	Boeing Commercial Airplane Group Kansas City, MO
	Raymond T. Stettner	Air Line Pilots Association (ALPA) O'Fallon, MO

C. SUMMARY

On July 17. 1996. at 2031 eastern daylight time. a Boeing 747-131. N93119, crashed into tlie Atlantic Ocean, about 8 iniles south of East Moriches. New York. shortly after take off froiii John F. Kennedy International Airport (JFK). The airplane was being operated on an instrument flight rules (IFR) flight plan under the provisions of Title 14. Code of Federal Regulations (CFR). Part 121. on a regularly scheduled flight to Charles De Gaulle International Airport (CDG). Paris France. as Trans World Airlines (TWA) Flight 800. The airplane was destroyed. and all 230 people on board were killed.

D. DETAILS OF CONTINUED INVESTIGATION

Tlie Maintenance Group reconvened on February 24. 1998 through February 27. 1998, and March 16, 1998, through March 18, 1998. to continue the review of the maintenance records back to January 1986. Records reviewed were: the Aircraft Maintenance Logs, scheduled maintenance non-routine work cards. Engineering Maintenance Liaison Records (TWA Engineering repair records), and Airworthiness Directives to include applicable Service Bulletins and Modification Orders.

TWA retains the Aircraft Maintenance Logs for a period of 30 months Aircraft Maiiitcnancc Logs older than 30 months are subsequently destroyed Aircraft Maintenance Logs available for coiitiiiiucd review dated back to December 1992 Tlic Maintenance Group reviewed tlic logs from December 1992 to July 1994 Records review information for July 1994 to July 1996 can bc found in the Maintenance Group Factual Report dated October 8. 1997

During tlic review of the Aircraft Maintenance Logs. specific entries were identified in tlie areas of fucliiig discrepancies. volumetric shutoffs. fuel flow discrepancies. and electrical discrepancies

TWA retains the Check "C" routine and non-routine work cards for 10 years Tlic review of the non-routine work cards began at tlic 2A - Check "C" dated June 3. 1986, and continued through tlic last 3E - Check "C" dated November 6. 1995 During this review, tlie non-routine work cards were reviewed to identify the discrepancy and work accomplishments from fuselage stations 340 to 1,300 Specific write-ups were identified for electrical discrepancies, fuel tank. fuel gauging and fueliiig discrepancies. and metal nork in close proximity to wire bundles

TWA retains tlic Check "D" (OP16) routine and non-routine work cards for 25 years Tlic review of tlic non-routine work cards began uitli tlie November 19. 1988, check Additional Operation (OP) checks were also reviewed that dated back to the OP-3F on February 8. 1986, and continued through tlic OP-3B check dated December 16, 1991 Tlic last OP 16 prior to tlic accident was completed on December 11 1992 Tlie same specific write-ups continued to be identified froiii fuselage stations 340 to 1,300

TWA's procedures for retaining the Engineering Maintenance Liaison Records (EMLR) have changed over the past several years. Prior to 1991. the records were attaclied to tlic applicable noii-routine work card and logged in tlic Engineering Department. After 1991, the EMLR was also included in an aircraft file. Tlic review of the EMLR's from 1986 identified the major structural modifications that were perforincd on the airplane from fuselage stations 340 to 1.300.

The entire list of the applicable Airworthiness Directives (AD) dating from the early 1970's were reviewed to identify the AD's that mandated structural repairs from fuselage stations 340 to 1,300. Several AD's were identified. After further review of the AD's, the list was further refined to identify those AD's that mandated structural repairs in close proximity to wire bundles. The AD's also identified the applicable Service Bulletins which described the work to be performed. TWA then created

Modification Orders (MO) to direct and schedule the accomplishment of the AD. Further text will identify the AD, SB, MO, and summarize the work accomplished from the work cards.

AIRCRAFT MAINTENANCE LOG

DECEMBER 1992

On December 17, 1992, the center wing tank fuel quantity indlcator read 80.7, while the dipstick showed 77.7. The item was deferred until December 18, 1992. The center wing tank wing indicator was found stuck at 70.0. The indicator was replaced and both the wing and cockpit center tank indicators corresponded to the other tanks and totalizer. The system was tested and signed off as "normal."

JANUARY 1993

On January 1, 1993, the red wheel well fire detection light overhead would not dim. The item was deferred and corrected the same day. An operations check was found "normal" per this configuration of aircraft The placard was then removed.

On January 7, 1993, the number one fuel tank indicator was intermittent at the fueling panel. The item was deferred until January 9, 1993. The number one main fuel quantity wing indicator was replaced and calibrated. The system checked okay and the placard was removed.

On January 7, 1993, the number one reserve fuel tank indicator was intermittent at the fueling panel. The item was deferred until January 9, 1993. The number one reserve fuel quantity wing repeater indicator was replaced and calibrated. The system checked okay and the placard was removed.

On January 7, 1993, the number one fuel quantity gauge read full scale high in the cockpit. The item was deferred until January 9, 1993. The number one main fuel quantity repeater indicator was replaced and calibrated. The system was checked okay and the placard was removed.

On January 18, 1993, the captain's map light was inoperative. The wiring was checked and an open was found from D2349 to D1807 plug. The wire was spliced from the rheostat to the map light. An operational check was "normal."

FEBRUARY 1993

On February 14, 1993, the number one and number four reserve volumetric shut off and was inoperative. The fuse was pulled to fuel the aircraft. The fuse was reinstalled after fueling. The item was deferred On February 20, 1993, the volumetric shut-off compensator probe was checked with MD-2 and was okay The volumetric shut-off was checked for the number one and four reserve with a volumetric tester. The system checked okay and the placard was removed.

On February 14, 1993, during cruise flight, the number one reserve fuel gauge reading went to 1,350 pounds when 3,350 pounds was the correct reading. There was no trim change. The indicator was replaced with no help. The item was deferred. On February 15, 1993, the *tank* was checked with MD-2. All capacitance and resistance checked okay. The indlcator was checked with MD-2 and checked okay The placard was removed.

On February 15, 1993, the flight engineer's seat power cord was noted as not properly routed. The cord was rerouted.

On February 18, 1993, a water leak was in the B and C galley - C zone. The floor was wet at the last row ambassador center (rows 15 and 16) causing a short in the stereo and lights. The drain was unclogged, the water drain circuit breakers were reseated and operations checked okay.

On February **20,** another write-up for a water leak in the B and C galleys. Leak goes back into front of C zone. The item was deferred. The drain operation was checked and found okay. The filter (water) was leak checked and found okay. **A** check for a water leak around the C galley and for a potable water leak was performed No water leaks could be found.

MARCH 1993

On March 14, 1993, the number four fuel flow gauge read **high.** The fuel flow indicator was replaced.

APRIL 1993

On April *2,* 1993, the number one main fuel tank wing and cockpit indlcator was inoperative. The item was deferred and the aircraft was fueled using the **dip** stick. On April 3, 1993, the cockpit indicator was replaced and calibrated.

On April 4, 1993, the number one fuel volumetric shut off, and was inoperative. The item was deferred and write-ups continued to April 6.

On April 20, 1993, the number one main tank was entered to correct fuel quantity discrepancies Tests were conducted and probe and compensator readings were found low. The fuel quantity probes in the tank were checked **and** they were found within maintenance manual limits. Five broken studs and one rounded bolt out of the sandwich plug on the number one main fuel tank were removed. The compensator reading was high at **57** pf. The probe reading was low at 9 12 pf. All of the readings were from the cockpit and required further testing. The readings were found normal for a dry tank. The fuel totalizer was tested and found "normal."

On April 23, 1993, during fueling, the number two main tank volumetric shutoff closed the fueling valve at 75.9 indicated. while the number three main tank continued fueling to 81.3. The item was deferred with a note stating that all fueling valves do close. The number two volumetric was adjusted. the number three volumetric shutoff point was checked and found "normal."

MAY 1993

On May 8, 1993, the left surge tank protection (STP) did not test. The item was deferred. On May 16, 1993, the system was found to not discharge. EQ-1045 tested normal except for the power system light did not illuminate. Other readings checked okay. The STP was intermittent. The system would test by rapidly depressing the STP test button. A detector was installed with no help. Trouble-shooting procedures were performed per MM 26-31-00 page 103. All checks were normal. The detector assembly was replaced after charging the new unit - no help. The STP system module was tested on AOG - p/n 282-7139, 36860/82250. On May 18, 1993, a broken wire was replacedbetween #2 PDU and #1 engine pylon. The system tested normal.

On May 12, 1993, the pilot and F/E number four fuel flow indlcator read high. Other indications were normal, however, the fuel-used indicator was high. Fuel flow was 11.7. The fuel flow module was reseated and a bite check was performed on the fuel flow module per MM 73-01-00. All checked okay,

On May 20, 1993, The C galley, number four outboard plug had a short. The cable was replaced and the operations check was "normal."

On May 27, 1993, the pilot's number four fuel flow gauge fluctuated. It was normal for the first one hour and thirty minutes, then it became intermittent. The fuel flow indicator connector was cleaned. The system then checked "normal."

On May 27, 1993, both the F/E and pilot's fuel flow indicators increased intermittently after five hours of flight The other parameters were "normal." The fuel quantity decrease was "normal." The fuel flow power supply was replaced and the operations check was "normal."

JUNE 1993

On June 4, 1993, the number three engine fuel flow indicator intermittently read full scale high at both the pilot's and F/E position. The fuel flow amplifier was reseated. A bite check was performed and the operations check was "normal."

On June 8, 1993, the number three engine fuel flow indicator still intermittently read full scale high at both pilot's and F/E stations. The item was deferred. The number three engine fuel flow transmitter was removed and replaced. The operations check was "normal."

On June 12, 1993, the F/E number four engine fuel flow was higher (11.8)than the other engines (5.3). A cross check with fuel-used indicator and quantity decrease indicator was performed. The fuel flow and the other engine parameters were normal. Pulling and resetting the circuit breakers was no help. Same problem with number three. The fuel flow power supply was replaced. A bite check was "normal."

On June 27, 1993, the number four fuel flow periodically read high on the F/E panel and forward instrument panel. The fuel-used indicated a high flow rate. All other engine instruments read normal. The fuel tank quantity indicated that the fuel flow was normal. The F/E and forward fuel flow indicators were replaced. Operations checked "normal."

June 29, 1993, the number four reserve fuel gauge read 3.3 when the tank was empty. The item was deferred. The number four indicator was calibrated and the volumetric shutoff was checked. Operations checked "normal."

JULY 1993

No specific write-ups were identified for this month.

AUGUST 1993

No specific write-ups were identified for this month.

SEPTEMBER 1993

On September 1, 1993, the left hand STP would not test. The item was deferred. On September 5, 1993, the indicator was checked with no system-fired indication. The indicator was replaced with no help. On September 8, 1993, all of the reservoir indicators and the detector were replaced. An operations check was "normal."

On September 1, 1993, the number four fuel flow tape fluctuated. The number four fuel flow tape indicator was reseated and the operation checked okay.

On September 10, 1993, the left hand STP discharged. The item was deferred. Trouble-shooting found that four each reservoirs, initiators and detectors were needed.

On September 14, 1993, the left hand orange and left hand test light failed to illuminate in the STP test unit. Fuel was drained from the left hand fuel tank surge tank. The item was deferred with a note that parts were required and that the stock was depleted.

On September 15, 1993, a damaged wire harness was removed on the right wing at the leading edge flap drive unit. The wires at the three right connector DM 882 were inspected and found okay for service. The wire bundle was re-wrapped. Meggered wires and shook wiring down on DM882 pins 12, 7, and 9 A low resistance was found on pin 9 wire. The 3R leading edge flap driver card YA3A06 in leading edge flap display logic module was replaced. The A-2 card in aural warning control module was replaced Operations check was "normal."

On September 28, 1993, the fuel flow and fuel-used indicators fluctuated. The fuel flow transmitter was replaced. Operations check was good during the engine run-up.

OCTOBER 1993

No specific write-ups were identified for this month

NOVEMBER 1993

On September 4, 1993, the number four fuel flow indicator occasionally motorized to full scale on pilot and F/E indicators The item was deferred On September 6, 1993, the operation checked "normal `` The transmitter was suspected as both indicators fluctuated On September 6, 1993, the flight crew indicated that the number four fuel flow operated "normal ''

DECEMBER 1993

On December 7, 1993, the flight engineer seat ran over the power cord and "sparks flew." Maintenance made an airworthy repair by splicing the cord and properly stowing.

On December 12, 1993, the brake temperature indicator, left wing - left front, read off scale high. The overheat light was illuminated and sometimes unreliable. The item was deferred. On December 20, 1993, the connector was replaced at the temperature sensor for the right body left rear system. The system tested okay.

On December 27, 1993, the fuselage upper lap joint B24 position per M47ADK8 was accomplished

JANUARY 1994

On January 15, 1994, the right STP test light failed to illuminate during test. The item was deferred. On January 23, 1994, the right detector was replaced. Shook wiring, no defects occurred. Operations checked okay.

FEBRUARY 1994

On February 3, 1994, the number three fuel flow indicator at the F/E position continued to motorize 0-10 pounds. The item was deferred. On February 4, 1994, the fuel flow indicator was removed and replaced,

On February 7, 1994, the pilot's number four fuel flow tape fluctuated intermittently. The condition disappeared for a time during the flight, then re-occurred. The item was deferred. The number four engine fuel flow transmitter was replaced. Operations checked okay.

On February 7, 1994, the circuit breaker for the pilot's background light popped on taxi to the hangar. A chafed wire on the socket was repaired and the wire was repositioned.

On February 14, 1994, the forward panel and F/E number three engine fuel flow was higher than the other engines by 600 pounds at FL 390. A cross check with the fuel-used indicator and quantity decrease confirmed a high fuel flow. Other indicators were normal. The item was deferred. The fuel flow power supply was replaced. A bite check of all four fuel flows checked okay.

On February 16, 1994, the number three fuel flow indicator and the fuel used on the pilot's and F/E panel read high. The fuel flow indicator fluctuated at all times. A bite check of the fuel flow amplifier was performed. Systems checked "normal."

On February 17, 1994, the pilot's number three fuel flow indicator fluctuated. Read from normal to high and back again. The number three engme fuel flow transmitter was replaced. During the run-up, all were okay.

On February 18, 1994, the pilot's and F/E number three fuel flow indicator and fuel used read high. Read approximately 1,000 pounds higher than the other gauges. The fuel flow amplifier was replaced.

On February 28, 1994, the right STP would not test. The item was deferred. On March 4, 1994, the detector, indicator, four each initiators, four each reservoirs and o-rings were replaced. Each were tested and inspected. Operations checked "normal."

MARCH 1994

On March 9, 1994, the right hand STP would not test. The item was deferred. Due to history with the STP system, wiring checks with a megger were performed. Shook wiring of all leading edge right hand wiring. No faults were found.

APRIL 1994

On April 1, 1994, accomplished AD 92-27-12, Checked P6 Panel Wire Bundle. No non-routine maintenance was generated.

On April 7, 1994, the number four fuel flow indicator (F/E and Pilot) intermittently motorized and was very slow to indicate flow during engine start. Deferred - no changes made.

On April 29, 1994, the fuel quantity indicator at the F/E panel had two discrepancies with the indicators at the left wing fueling panel. Center tank - F/E panel 9.3, left wing 9.7. Number three main F/E panel - 80.5, left wing - 81.5. Checked cockpit, under wing and drip stick for center tank and number three main tank All were found within limits.

On April 30, 1994, the number three main under-wing fuel quantity indicator read 10,000 pounds high Cockpit indicator read normal. The item was deferred. The number three wing fueling indicator was replaced. Calibrated per MM 28-41-00. Operations checked "normal."

MAY 1994

On May 15, 1994, on completion of fueling, found center tank indicator in cockpit read 2,000 pounds low, while the wing was okay. The item was deferred. On May 17, 1994, the indicator was removed and replaced. The indicator was calibrated, and the operations checked normal.

On May 24, 1994, the left hand potable water tank upper polar cap center area separated from the polar cap attachment ring area. Extensive write-ups to accomplish the tasks to repair the damage were made. (See Potable Water Tank Damage Summary).

JUNE 1994

On June 4, 1994, the F/E number four fuel flow indicator was inoperative with warning flag not in view Fuel-used indicator was normal. The F/E number four fuel flow indicator was replaced. Operations check normal.

On June 15, 1994, the center wing section cavity drain inspection was accomplished for AD 89-12-07

On June 29, 1994, the number four fuel used indicator was inoperative - stuck at "0000" - resets backwards. Would not go forward. The number four fuel used indicator was replaced.

JULY 1994

On July 2, 1994, the scavenge pump low pressure light illuminated with 2,100 pounds of fuel remaining. The center tank was sumped and the scavenge pump operation checked okay.

POTABLE WATER TANK DAMAGE SUMMARY

On May 24, 1994, during scheduled ground maintenance at New York (JFK) to perform a cabin seating reconfiguration and removal of comfort class - Zones "C", "D", and "E", the left hand potable water tank upper polar cap center area separated from the polar cap attachment ring area. The cap separated in a circular pattern approximately two-inches smaller than the polar cap outside diameter. As a result of the cap separation, the area above and around the potable water tanks were damaged. An Aircraft Service, Landing Gear/Tire Pressure Check, Auxiliary Maintenance Check, and an Emergency Light Check were also accomplished during this time frame.

The following text identifies the damage, and the work accomplished to repair the damage,

Non-Routine Maintenance Records for the Potable Water Tank Damage

Water compressor pressure switch and connector, plus three feet of wiring were removed from the aircraft for testing. The water compressor pressure switch was installed and the connector was replaced.

The water system pressure relief valve was removed from the aircraft for testing and a new pressure relief valve was installed.

Damaged ceiling panels and floor panels were removed. Inspection department was called to check the area above the ceiling panels and the floor area.

The damaged water tank and the second water tank, along with the insulation from the bulkhead aft of the water tanks, were removed. Inspection department was advised to inspect the area and sign-off. Serviceable water tanks were then installed.

Seat rows 19-22 seats 4, 5, 6, and 7. Damage to numerous PSU cable connectors which were replaced. Baggage restraint bars damaged and replaced. Floor panels damaged and new panels for seat 20-4, and 21-4 were made. Ceiling panels on the left and right sides of the seat assemblies were damaged and replaced. Several PSU's and trim panels were damaged and replaced. Four clamp support brackets for antenna wires in the ceiling overhead were damaged and replaced. One attach bracket was broken and

replaced. Three support straps for 6 inches of the air duct was broken and the duct was disconnected and replaced. Work required the inspection department to inspect and sign-off when the repairs were completed.

Left side water tank area damage - All side support rods were broken and replaced. At station 1,000 bulkhead, right lower, right upper and left upper support rod fittings were bent on the bulkhead. The fittings were returned to original shape with no cracks evident. The vertical support bracket and attach rods were broken away. The vertical attach rods and support bracket were replaced.

At station 980, the floor beam above the left tank broke away from the center body liner to LBL 44 The damaged area was removed and repaired.

The floor track broke away from station 980 to 984 at LBL 12. The damaged floor track was removed and the damage was repaired per Structural Repair Manual (SRM) 53-10-05.

The ceiling support angle in the forward cargo was bent from station 960 to 980 at LBL 24. The damaged support angle was removed and the damaged section was repaired per SRM 51-40-05.

The floor angle support was bent and cracked at station 984 from LBL 12 to LBL 32. The damaged angle was removed and repaired per SRM 51-10-07.

The pressurization lines above the water tanks were removed for metal work and then re-installed

Above the right side water tank, the fill and overflow valve was damaged, the bracket was broken and three each lines were damaged. The items were removed and replaced.

The fill valve for the water service had a loose fitting where the control cable goes through the bottom of the fuselage. The jam nut was tightened.

The drain and distribution lines at the bottom of both tanks were broken and distorted. The lines were replaced.

The left hand tank quantity transmitter was broken. A new transmitter was installed

The water tank compressor outlet hose was kinked. The hose was replaced.

The water tank air filter bracket pulled thru the fastener at floor beam station 900. The bracket was replaced.

The forward and aft distribution lines were kinked at the fitting below the tank. Both were replaced

The belly of the forward cargo at station 980-1,000 was cleaned of water, dirt, and debris

The forward water service drain valve bracket was broken below the right hand tank. A new drain valve bracket was installed.

Disconnected three ground wires at station 980 above and forward of water tank for metal repair. The wires were reconnected after the metal repair was completed.

Wire bundles forward and aft of station 970 were removed from the support clamps for metal repair (forward and above water tank area). The bundles were secured after the repairs were completed.

The wire bundles for the water tank air compressor were disconnected just forward of the compressor The wire bundle was reconnected, plugged and secured after the metal repairs were completed.

All CB's were reset in P-14 panel for the water tank air compressor and all water heaters after the metal repairs were completed.

The top section of the floor beams in the center of the box beam were torn and cracked at station 780 between bays three and four in the forward cargo compartment. Repairs were made per SRM 51-40-03

The potable water quantity transmitter connector DT465 had broken wires, W552-M636-22 and W552-M642-22. The wires were re-spliced at the connector.

The left side water compressor switch and connector DS25 1 were replaced. A new section of wires was spliced to the existing wires W552-M626-22 and W552-M628-22.

New heater elements were installed on the water supply lines from the water tank to station 760 on the left side. New blow-out panels were installed.

The side-wall upper left side panels were removed and then replaced to gain access to water line at station 700 and aft.

Row 21 had been removed to **gain** access for potable water tank repair

Potable water system compressor seems to try and run with CB pulled. The C839 CB was replaced and operation checked normal.

All work associated with the potable water tank damage was completed on 5/31/94.

TESTING RESULTS

The water relief valve p/n: D524TP6D45 and the air compressor shut-off pressure switch p/n: IG216 were removed and tested.

The testing results for the relief valve indicated that the "cracking pressure" as received was 53 PSIG. Specifications indicate 46 PSIG +/- 6. The "reseating pressure" as received was 51 PSIG. Specifications indicate 41 PSIG +/- 5. Findings of the test indicated that the jam nut which "locks in" the relief valve adjustment was loose, allowing the deflector cap to rotate, possibly altering the relief pressure setting. The deflector cap was rotated one full turn and re-tested. The cracking pressure was then in excess of 170 PSIG.

The testing results for the pressure switch indicated that the "contacts open" pressure as received was 33 PSIG. Specifications indicate 31 PSIG +/- 1. The "contacts closed" pressure as received was 26 PSIG. Specifications indicate 26 PSIG +/- 1.

The findings of the test indicated that the microswitch actuation plunger and the pressure actuation diaphragm plunger were corroded.

As a result of this failure, on May 31, 1994, Boeing recommended that TWA use a new relief valve p/n: RV05-361. TWA issued Modification Order M071W91. Boeing Alert Service Bulletin 747-38A2105, dated October 27, 1994, was issued to all users **of** 747 airplanes, line positions 1 through 1013 to replace the water/waste - potable water system pressurization - pressure relief valve at the earliest opportunity On June 23, 1995, AD 95-11-03 became effective.

CHECK C NON-ROUTINE WORK CARD REVIEW

CHECK 2A, JUNE 3. 1986

During this check, AD 86-02-53 - Inspection of the Fuselage Skin Lap Splice S-23, BS 240 to 400 **was** accomplished. Also during this check, AD 86-09-07 - External visual inspection of the lower longitudinal lap joint areas for corrosion was accomplished. In order to accomplish AD 86-09-07, wires to the forward drain mast had to be removed. After the work was completed. the wires were reinstalled.

CHECK 3C, JANUARY 7. 1987

Soft spots in the flooring in the aisle between seats 91-2 and 8 through 93-2 and 8 were found. The flooring was reinforced.

CHECK 3D, FEBRUARY **21, 1987**

Metal on the forward cargo compartment flooring was broken and bent up on the left hand side at station **705,** next to the drive wheel. A doubler strap was installed.

CHECK 4C, JUNE **20. 1987**

The decompression panel cage was not secured under the center of seat **16** - 1, 3. The decompression panel was secured.

CHECK 4D. JULY **24, 1987**

The **STP** system was placarded inoperative on the right side of the F/E panel. The work card indicates that the problem was corrected referencing form W139.

CHECK 5B, SEPTEMBER 30. **1987**

A deferred item indicating that the number one reserve fuel quantity indicator was inaccurate during flight was checked. The F3, F4, **F5,** and F6 probes were replaced. The cockpit and wing indicator were calibrated and a volumetric shutoff adjustment and test were performed. The fuel tank entry record was completed.

The left hand side guide-support brace located at station **720** in the froward cargo area was cracked. The support brace was replaced.

CHECK 5C, OCTOBER **29. 1987**

Modification Order (MO) M47AD50 was accomplished. This MO was written to accomplish AD **86-18-**01, to detect cracking of the **body** frame structure in the lower lobe (Sections **42** and **46)** of the fuselage

CHECK 7C, SEPTEMBER **28, 1988**

An electrical arc at the cannon plug for the single service carts in the Galley "C" cart three and four were found. Two new cords were needed. The old cords were removed and replaced.

CHECK 10C, JUNE 11. **1990**

A deferred item indicated that the center tank fuel quantity indicator was inoperative. The press-to-test would not work and the indicator read **29,000** with the tank empty The cockpit center wing fuel quantity indicator was replaced. The cockpit, wing, totalizer, and volumetric indicators were all calibrated. Operations checked "normal."

CHECK 1A, DECEMBER 25, **1991**

The stand-off bracket was not secured for the wire bundle adjacent to the enplaning control box at the forward cargo door. The stand-off bracket was installed and the wire bundle was repositioned and secured.

CHECK 2E, OCTOBER 14, 1994

The number three hydraulic quantity gauge was inoperative. The wiring was shorted and intermittent around the ADP. The indcator and transmitter were replaced with no help. The old wiring was removed **A** new harness was built up and routed in.

CHECK 3E, NOVEMBER 6. 1995

During this check, AD 89-12-07 - Overwing Center Section Cavity Drain Inspection was completed Floor panels were removed to expose station 1240 drain cavity at the canted bulkhead.

CHECK D AND OPERATIONS CHECKS NON-ROUTINE WORK CARD REVIEW

OPERATION 3F, FEBRUARY 8, 1986

The forward cargo compartment fitting between the upper front spar chord and cabin floor track was cracked at station 1,000, LBL 9. A new fitting was installed.

The interior of **P14** and P15 power panels needed to have the duct cleaned out, including the back side of the circuit breakers. The panels were cleaned.

The exposed areas of all E1, E2, and E3 equipment shelves, wire bundles and terminal strips needed to be cleaned at *aft* end of the shelves.

Clean as necessary, the dirt and lint from the wiring outboard of the F/E panel in the cockpit

Clean as necessary metal shavings from the interior of the P-6 panel. The shavings were vacuumed out

Right hand body gear wheel well. Remove metal shavings and debris from forward outboard side of wheel well at station 1,350 to 1,394 above the large casting.

ESCAPE LIGHT PATH MODIFICATION, MAY 8. 1986

In the forward E&E compartment, the right hand sidewall at the former ring just above the floor level wire bundle was not clamped below the P15 main power center. The clamp **was** replaced and the bundle secured.

Location - Zone A, left hand side. Floor panel number 24 (upper deck station 480) was removed then reinstalled after metal work was accomplished.

Location - Zone A, repair to a crack at cut-out of doubler in left hand bulkhead station 440, floor level, per Engineering Maintenance Record (EMLR) 53087.

OPERATION 1, APRIL 17. 1987

A cracked stringer at station 420 on the right side at S24 was replaced

A former flange on the left hand side at station 460 was cracked approximately eight inches in length at the skin fasteners between stringer **26L** and stringer 27L. **A** doubler and angle were installed.

Stringer 27 at the number one entry door from stations 440 to 460 on the left side was cracked. The stringer was replaced.

The exposed areas of E1, E2, and E3 shelves were dirty and had loose hardware and metal cuttings laying on them. The loose debris was brushed away and then blown with air.

The relay box above the L-1 door was removed for metal and installation work. A P-87 box was installed.

At the P15 interior location, two tie-wraps located inside the wire bundle at the forward section of the circuit breaker panel section were taped. The tie-wraps were removed and the bundle was secured.

Wiring was unclamped and removed to gain access to the E&E compartment service light in the ceiling area, inboard of the P-14 circuit breaker panel to provide access for metal work. The wiring was secured after the metal work was complete.

Loose wiring was found in the wire bundle (throughout) inside the auxiliary power unit number one generator at P14. The wire bundle was properly secured.

Three wires in the W402 wire bundle in the cockpit P4 area needed to be secured

At the flight engineer's P4 panel for the number two hydraulic quantity indlcator, the number two wire bundle was loose in the wire bundle connector restrainer. The number three wire bundle in this same area was not attached to the connector's wire bundle restrainer. New restrainers were installed for both

Black electrical tape was found wrapped around the hydraulic quantity indlcator number four wire bundle and connector. The tape was removed. The wiring was repaired and protected.

In the forward E&E compartment, two wire bundle stand-offs at station 420 had broken loose on the left hand side under the P14 main power center. The wire bundles were remounted on new bundle stand-offs

The exposed areas of the E6 and E9 shelves were dirty with metal cuttings on the terminal blocks below the edge of E6. The terminal strips at both shelves were dirty. The area was brushed off and blown with air.

The wire bundles on the right side of E6 and on the left and right side of E9 shelves were unclamped The bundles were clamped as required.

In the forward E&E compartment, metal shavings and debris were removed from the area outboard and forward of the left hand cargo compartment to the E&E access door.

OPERATION 16 (D CHECK). NOVEMBER 19. 1988

Permanent repairs were made to a skin dent at station 496 and stringer 14L. Dye penetrant check found no cracks to the stringer. Reference EMLR 57051.

The canted bulkhead at station 1241 was cleaned to the rear spar and left and right sides to fuselage skin.

The area under all of the removed floor panels was cleaned in zone B

The tracks and structure below the floor under and 20 inches around lavatories H, J, K, and L and Galleys A, B, C, D, and E were cleaned.

Several entries were made indicating that floor panels in zones **A** and B were removed in order to complete "metal work." The floor panel number followed by the approximately station location is identified **as** follows:

Panel Number	Station Location	Panel Number	Station Location
21	360 center	78	660 center
22	360 left	79	660 center
27	410 left	85	760 right
29	420 right	95	800 right
30	420 right	111	900 right
31	420 right	112	900 center
32	420 left	113	900 center
49	480 left	115	950 right
69	640 center	153	1265 left
70	640 center		

The wall panel forward of the 1L door was removed for "metal work."

The floor beam cap was bent and torn in the forward cargo area at station 780, RBL 5, LBL 5. **A** new beam was made and installed.

The floor beam in the upper deck chord was found corroded at station 480 under the number seven chair track. **A** new top beam cap was installed to the existing splice per EMLR 58365.

The floor beam web had a gouge and crack at station 500, RBL4 at the lower forward side (above electric standoff). The crack was stop-drilled and a doubler was installed.

The floor beam web was cracked and oil-canning at station 520, RBL 46, and bent at RBL 29. The area was repaired per maintenance manual instructions.

The floor beam cap was damaged at station 900, RBL 11. The area was repaired per maintenance manual instructions

The inner costal was cracked at station 440, LBL 55. The inner costal was repaired

In order to perform "electrical work," the left hand side panel at station 740 to 780 was removed

OPERATION 3B. NOVEMBER 9, 1989

The aft crease beam web was cracked one and three quarters of *an* inch at stringer 5R, station 980. The cracked web was removed. **A** new web was fabricated and reinstalled.

OPERATION **3A.** OCTOBER 8. 1990

Corrosion was found at approximately station 1,241, LBL 57 on the canted pressure deck. The damaged web was cut out and repairs were made. In addition, **a** doubler was cut on the outboard cut line. **An** additional doubler, one gage heavier of the same material was required.

All loose debris below the floor in **tlie** forward cargo area was vacuumed out

All loosc hardware and shavings between stringer 38L to 42L at stations 700 to 1,000 were vacuumed up

Tlic lcft hand side former frame ucb number 14EL stringcr at station 440 cutout was crackcd approximately one inch The crack was stop drilled and tlic area was tested A new rcpair was installed

OPERATION 3B, DECEMBER 16. 1991

The wiring on the rear of the cockpit fuel quantity pancl iiccdcd to bc repositioned and tied correctly in the ccntcr area of tlic panel.

The wires from tlic forward drain mast on panel 191 S nccdcd to bc removed to assist in the removal of the pancl

ENGINEERING MAINTENANCE LIAISON RECORDS (EMLR) REVIEW

Tlic EMLR dated July 16. 1992. dircctcd tlic removal of the external rcpair at station 489 to 502 and stringer L13 through 14 to inspect for damage to the cut-out for proper trim An open hole eddy currcnt inspcction of all the fastcncr holes was to bc completed **A** new doubler was to bc installed in accordancc with Structural Repair Manual (SRM) instructions

On May 13. 1996. a minor temporary rcpair was dircctcd to usc a temporary alternate ground for the number tlircc cnginc start valve duc to a problem with tlic csisting ground connection. Tlic wiring was lo bc rcstorcd to a normal conditions within tlircc days.

Additional EMLR rcfcrcnccs wcrc idcntificd with the appropriate non routine work card rcfcrcnce in the previous text

STRUCTURAL AIRWORTHINESS DIRECTIVES (AD)

The Airworthiness Dircctivc List was reviewed to determine tlic AD's that inandatcd inspcctions and rcpairs to the structure of the fusclagc that would impact wiring bundlcs in close proximity to the work accomplishments. Several structural AD's were idcntificd. and aftcr further review with tlic aid of an engineer from Bocing. tlie following AD's were identified as having the most impact in close proximity to the wire bundles.

AD 78-09-08. - Main Deck Pressure Web Inspection, effective May 16, 1978. This AD rcquircd a repetitive inspcction. AD 78-09-08 was superseded by AD 81-13-03, cffcctivc July 1. 1981. TWA gcncratcd scvcral Modification Orders (MO) to accomplish tlic repetitive mandates of the AD. and the one time and terminating action requirements. This AD mandated a visual inspection of the longitudinal floor beams. Webs or chords found crackcd were to be repaired or rcplaccd in accordancc with tlic instructions in Bocing Service Bulletin (SB) 747-53-2224.

TWA accomplished tlic terminating action proccdurcs on Dcccmbcr 7. 1984 as described in SB 747-53-2224. R3. SB 747-53-2176. R4; and SB 747-53-2183, R2

The inspcction affects wire bundles from stations 1.265 - 1,480 Part of tlic inspection **is** impacted by **AD** 90-06-06

AD 84-19-01 - Repetitive inspection to detect for cracks and prevent failure of the frame to tension tie joint structure. This AD was effective October 19, 1984. The mandate was accomplished in accordance with Boeing SB 747-53-2088. The SB identified frame to tension tie joint modifications to body station 760. TWA generated a MO which was last accomplished on N93119, on September 27, 1992.

AD 86-03-51, - 747 Section 41 structure inspection effective January 31, 1986, initial inspection accomplished on May 8, 1986; superseded by AD 86-23-06, effective December 15, 1986, initial inspection accomplished April 15, 1988, with several areas requiring repetitive inspections. AD 86-23-06 was superseded by AD 91-11-01, effective June 24, 1991, initial inspection accomplished on April 15, 1988, with several repetitive inspections in accordance with Boeing SB 747-53A2265. This inspection was to detect and repair body frame and other internal structure cracks, and possible adjacent skin cracks in the nose section 41.

The AD states "Installation of new and improved body frame structure in accordance with FAA approved procedures or Boeing SB 747-53-2272, dated January 12, 1987 (AD-86-23-06), is considered terminating action for the repetitive inspections required by this AD for the structure (considered to be stringers, clips and slun associated with the frame)."

SB 747-53-2272 - Fuselage Nose Section 41 Body Frame Structure Replacement and Reinforcement. Page 79, B. states "Fabricate a suitable work platform as required to protect any wire bundles disconnected in the upper deck area between Station 420 - 520."

TWA reports that a MO was written to direct and schedule the accomplishments of the SB, and that the platform structure was fabricated. The MO indicates that 17 - 747 aircraft, including N93119, were affected by this order.

The MO also references AD 90-06-06, which directs modifications in accordance with Boeing Doc. No D6-35999, dated March 1989, "Aging Airplane SB Structural Modification Program - Model 747."

AD 89-05-03, effective March 31, 1989, was superseded by AD 90-21-17, effective November 16, 1990, 747 Stringer 6 Lap Splice, Station 400-520, mandated compliance in accordance with Boeing Alert SB 747-53A2303.

AD 89-05-03 was complied with on October 11, 1989. Some sections of the MO had been complied with on November 9, 1989. Effective December 7, 1990, the MO was revised to add new inspection requirements as mandated by AD 90-21-17. The revised requirements had not been complied with and were not due until November 1997.

The MO indicated that accomplishment was required by 20,000 flight cycles as mandated by AD 90-06-06.

AD 90-06-06, 747 Structural Modification Program, effective April 17, 1990, mandates that modifications shall be done in accordance with Boeing Document No D6-35999, dated March 1989, "Aging Airplane Service Bulletin Structural Modification Program - Model 747."

The AD identifies several accomplishments to be completed within four to six years (depending upon the accomplishment), or prior to the accumulation of 20,000 flight cycles.

TWA has generated several MO's against this AD, of which, many have been accomplished. Several others remained open, as N93119 had not yet accumulated 20,000 cycles at the time of the accident.

Four of the accomplished MO impact stations 460 - 1,300

The first MO directed the replacement of an existing doubler with an improved one at the number one doorway, upper forward corner, and replaces a portion of the doorway skin. The modification was accomplished in accordance with Boeing SB 747-53-2181, on May 11, 1984, and met the requirements set forth in AD 90-06-06.

Non-routine work cards were generated indicating work was accomplished to grind out corrosion at the number one left entry door. Repairs were made to the number one right entry door to repair an old crack. Insulation was installed above the number one doors after the work was completed.

The second MO, which was accomplished by AD 83-11-02, on December 7, 1984, mandated the reinforcement of the beam webs and replaced the lower chord on the ten longitudinal floor beams between stations 1,265 and 1,480. This MO terminated the inspection program mandated by AD 90-06-06.

The third MO, which was accomplished by AD 89-21-09, on November 2, 1990, in accordance with Boeing SB 747-53-2289, mandated the inspection of the fuselage skin above the forward cabin doors for cracking. This MO terminated the inspection program mandated by AD 90-06-06.

Non-routine work cards were generated which described a crack that was found at the left side door. The crack was stopdrilled and the doubler was repaired. The P-87 panel above the door was installed after the metal work was completed.

Other non-routine work cards generated during this visit indicated that terminating action for part of the fourth MO was completed to the lap seam 39L at Stations 740 - 1,000.

After "metal work" was completed, wire bundles and the wire bundle tray was installed under the floor at station 1,241, LBL 70. The bundles were relocated to gain access to the canted bulkhead.

In the cockpit at the P7 panel, a wire bundle was repositioned due to rubbing on the AIDS circuit breaker panel. Spiral protective wrap was installed on the wire bundle.

The fourth MO was accomplished by AD 90-06-06, in accordance with Boeing SB 747-53-2267, at the 1992 "D" check. The MO mandated the inspection and modifications to the skin lap joints from stringer 34 and below for the pressurized length of the fuselage by opening up the lap, inspect for corrosion and cracks, enlarging the upper row of fasteners at most locations and reinstalling with faying surface sealant Modifications were completed for stations 250 - 1,000 on both the left and right sides. The MO states, "The 747 Aging Aircraft Structures Working Group determined this modification will be required on all early aircraft at a threshold of twenty years aircraft age. AD 90-06-06, effective April 17, 1990, requires accomplishment within 4 years."

Several non-routine work cards were generated indlcating corrosion and cracks were found. Repairs were accomplished in accordance with maintenance manual instructions.

Several non-routine work cards indicated that after "metal work" was complete. ducting and wire bundles were reattached Numerous wire bundle clamps were found deteriorated and had to be replaced

At station 920. the wire bundle was rubbing on the left side outboard end of the tension tie. The bundle was repositioned.

Several tension ties were found cracked between stations 800 - 900. Repairs were fabricated.

AD 85-17-05. effective September 26. 1985. 747 - Fuselage Skin Lap Splice, was initially coinplied with on February 8. 1986. AD 85-17-05, was superseded by AD 90-23-14, effective December 11. 1990. 747 - Stinger 6 Lap Splice Stations 340 - 400. The repetitive inspections were last complied with on September 19. 1994, and was accomplished in accordance with Boeing SB 747-53-2253.

Several non-routine work cards were generated and are identified under AD 90-06-06

AD 90-15-06. effective August 20, 1990, mandated inspections in the fuselage skin from body stations 1,000 to 1,480, was initially accomplished November 2. 1990. with subsequent repetitive inspections

Accomplishment of AD 94-12-09, effective July 13, 1994. terminated the requirements of AD 90-15-06 AD 94-12-09, inandated inspections at the upper lobe skin panel lap joints (stringers 23 and above) in accordance with Boeing SB 747-57-2307

TWA issued MO's to mandate and schedule the inspection and repairs Compliance for AD 90-15-06, was on December 29, 1993. as indicated on TWA form M47-AD-K8 Additional compliance requirements for repetitive inspections had been scheduled after the accident date

AD 92-27-12, effective January 8, 1993. accoinplished on January 11. 1993, and August 12. 1993, inandated a visual inspection to detect damage due to chafing of the wire bundles that extend between the P6 and P7 panels at station 400 with attention to wire bundles W418. W718, W998. and other bundles that cross over these bundles Any damage found was to be repaired in accordance with Boeing Standard Wiring Practices Document D6-54446

No non-routine maintenance was generated during the April 1991 scheduled maintenance.

PROTECTION OF WIRE BUNDLES

Part of the review of the records was to determine the impact that repairs may have had to the wire bundles. Both TWA and Boeing were asked to respond to what procedures and guidelines were in place to protect wire bundles when repair work was being accoinplished in close proximity to the bundles.

Boeing reported that they publish only general guidelines on the repair of wires. The guideline states that one must assess the existing condition, use good judgement and common sense during maintenance to prevent injury and damage to equipinent. Wire bundles and equipment should be moved to avoid unnecessary damage during any type of repair, this includes structural repairs involving sheet metal.

TWA developed a "Standard Overhaul Practices Manual" that was derived from the Boeing Documents. This manual is used by inaintenance personnel and describes the guidelines and practices for repair and replacement procedures for metal **work.** electrical work, inspection procedures. cleaning procedures. finishing procedures, installation procedures. specifications and materials. These issues are also discussed in classroom training sessions.

Boeing reports that most operators will cover the wire bundles with bubble wrap or a clean cloth taped to the bundle. Boeing also reports that instructions for the protection of wire bundles may be found in a Service Bulletin. Example: SB 747-53-2272 - Fuselage - Nose Section 41 Body Frame Structural Replacement and Reinforcement. Page 79, B. states 'Tabricate a suitable work platform as required to protect wire bundles disconnected in the upper deck area between STA 420-520."

TWA reported that they do not have a written policy or procedure concerning use of a protective covering over or around wire bundles when performing metal work in the area of the bundles. It is up to the mechanic to determine if protective coverings need to be used. It is also **up** to the mechanic if a bundle needs to be moved in order to perform a maintenance task. If a bundle is moved, a non-routine work card is generated to report the movement of the bundle, and then another card to report the replacement of the bundle after the work is accomplished. Inspectors are to inspect the work of the mechanic.

General housekeeping procedures are used. This clean-up is either performed by the mechanic or fleet service. What cleaning procedures are used depends upon the type of work. Chemicals, cloth, brushes, or vacuums could be used.

Debra J. Eckrote

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5/26/98