DOCKET NO. SA-510

EXHIBIT NO. 7F

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C.

ADDENDUM TO THE STRUCTURES GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

WRECKAGE RECONSTRUCTION DOCUMENTATION

Cynthia L. Keegan

National Transportation Safety Board
Office of Aviation Safety
Washington, D.C.

December 28, 1994

ADDENDUM TO THE STRUCTURES GROUP CHAIRMAN'S FACTUAL REPORT OF INVESTIGATION

WRECKAGE RECONSTRUCTION DOCUMENTATION

A. ACCIDENT : DCA-94-MA-076

LOCATION : Aliquippa, PA
DATE : September 8, 1994
TIME : 1904 Eastern Daylight Time (EDT)
AIRCRAFT : Boeing 737-3B7, N513AU

B. STRUCTURES GROUP

The Structures Group reconvened at the USAir AI Hangar (on the east side of Pittsburgh International Airport) between October 30, 1994, and November 11, 1994, to reconstruct the following areas of the Boeing 737-3B7 (B737-300) wreckage: body station (BS) 178 forward pressure bulkhead, floor beams, wheels/tires, wheel well, PATS auxiliary fuel tank, lateral control cables, and the black light inspection of selected sections of the airplane wreckage.

Chairman : Cynthia L. Keegan
National Transportation Safety Board
Washington, D.C.

SUB-GROUPS

BS 178 Forward Pressure Bulkhead

Member : Richard L. Grubb
Boeing Commercial Airplane Group (BCAG)
Wichita, KS

Member : Stephen A. Mikus
Boeing Commercial Airplane Group
Wichita, KS

Floor Beams

Member : Butch Wilson
National Transportation Safety Board
Washington, D.C.

Member : William P. Bush, Jr.
Boeing Commercial Airplane Group
Wichita, KS

Member : Fred Newport
Boeing Commercial Airplane Group
Wichita, KS

Member : Pat Davis
Boeing Commercial Airplane Group
Wichita, KS

Member : Constantine Kleissas
Air Line Pilots Association
Grasonville, MD

Member : Stephen J. Skupien
Air Line Pilots Association
New Boston, NH

Member : Jonathan Oberdick
US Air
Pittsburgh, PA

Wheel Well

Member : Deepak Joshi
National Transportation Safety Board
Washington, D.C.

Member : Gary Hammack
National Transportation Safety Board
Washington, D.C.

Member : Brian Oelke
Boeing Commercial Airplane Group
Seattle, WA

Member : Larry Appenfeller
BCAG
Wichita, KS

Member : Stephen Moss
Air Accidents Investigation Branch
Farnborough, England

Wheels and Tires

Member : Merritt Birky
National Transportation Safety Board
Washington, DC

Member : Chris Dubuque
Boeing Commercial Airplane Group
Seattle, WA

Member : Gregory L. Feldor
Michelin Tires
Troy, OH

Member : Dick Hill
Federal Aviation Administration
Atlantic City, NJ

Auxiliary Fuel Tank

Member : Harvey Patrick
PATS, Inc.
Columbia, MD

Member : Mark Borden
Boeing Commercial Airplane Group
Seattle, WA

Member : Ted Uhlenhop
Boeing Commercial Airplane Group
Seattle, WA

Member : Otis Staley
Federal Aviation Administration, FSDO 19
Coraopolis, PA 15108

Member : Herbert C. Adams
USAir
Pittsburgh, PA

Member : Scott Davis
Page Avjet
Orlando, FL

Control Cables

Member : David E. Rusho
Boeing Commercial Airplane Group
Seattle, WA

Member : Olney Anthony
International Association of Machinists and
Aerospace Workers (IAM)
Moon Township, PA

Member : David Supplee
International Association of Machinists and
Aerospace Workers
Tampa, FL

Member : Harry L Bruner, Jr.
Federal Aviation Administration, FSDO-19
Coraopolis, PA

Black Light Inspection

Member : Steve Younker
Boeing Commercial Airplane Group
Seattle, WA

Member : Tom Alge
General Electric
Cincinnati, OH

C. SUMMARY

The reconstruction of the above areas began by sorting through all of the retrieved airplane wreckage for identification of specific areas of structure. Full size blueprints where

spread out at various locations on the AI hangar floor and covered with plexiglass to protect the blueprint surface. The floor beam blueprints were located according to their structural orientation (from BS 277, aft of the cockpit, to BS 1016, at the aft lavatory) and spaced 20 inches apart. The structure was then located in it's correct position by matching it to the corresponding blueprint. One week into the reconstruction effort the group began to run short of identifiable structure to relocate, and, therefore, chose to accomplish a second sort of the retrieved airplane wreckage. The following is the results of the completed reconstructed areas and the total percentage and findings that resulted from this effort.

D. RECONSTRUCTION DOCUMENTATION

1.0 Body Station 178.0 Forward Pressure Bulkhead

Approximately 40 percent of the forward pressure bulkhead web and attached structure was identified. Dial calipers and .032 and .040 inch thick sheets of aluminum were utilized to assist with identification of the bulkhead structure. The majority of the relocated structure was identified on the right, lower side of the bulkhead with about one-third of the horse-shoe beam (cockpit/bulkhead horizontal beam at water line (WL) 234.0) on the right side identified. The horse-shoe beam was torsionally twisted and exhibited a static overload fracture. Eleven of the sixteen radome attachment fittings were recovered, with five relocated on the left side and six relocated on the right side of the bulkhead. Both elevator pulleys that attach to the lower half of the bulkhead were relocated on the left and right side of the bulkhead. About 20 percent of the right pulley was fractured and twisted but remained attached to the hat section that diagonally attaches to the forward pressure bulkhead web. The left pulley exhibited severe impact damage and contained portions of pinched elevator cable where the structure and pulley were deformed and damaged. A section of the radar wave guide remained attached to a large section of the structure relocated in the right lower quadrant of the forward pressure bulkhead, and exhibited sheared skin attachment rivets and postimpact fire damage of the beam cap at BL 5.7.

Several pieces of radome were identified, and part of the weather radar antenna dish was identified with pieces of the radome imbedded in it. Two adjoining pieces of the centerline strap (BL 0.0) were identified with one piece exhibiting fire damage and the adjoining piece containing no evidence of fire damage. There was no evidence of transition of fire damage on any of the relocated bulkhead structure, or indication of preimpact fire damage. All of the relocated structure exhibited static tensile overload fractures, and no evidence of corrosion or fatigue. The blacklight examination of the relocated forward pressure bulkhead revealed no evidence of organic matter such as bird remains.

2.0 Floor Beams

The identified and reconstructed floor beam structure varied at each station with a minimum of 5 percent relocated forward of the wing box and a maximum of approximately 95

percent relocated at the rear galley/lavatory. The overall floor beam reconstruction averaged approximately 50 percent. Other identified sections of floor beam included the forward galley No. 2 floor and seat track mounting, the aft galley No. 3 floor, a portion of the aft galley No. 6, and the aft lavatory B and C floor beams and floor panels. There were no sections of the forward galley No. 1 or lavatory A floor structure identified. The galley No. 2 floor panel was charred and the attached seat tracks exhibited fire and heat damage, however, the floor beams which support the galley No. 2 exhibited no signs of fire or heat damage. The lavatory C floor was charred and the attached forward and aft floor beams contained peeled paint and sooting resulting from heat and fire damage. The adjacent floor panel common to station 1016 also exhibited a small charred section at the outboard edge of the panel, however, the floor beam cap forward of the floor panel edge exhibited no fire damage. The aft hard point mount intercostal (common to lavatory C) that attaches between stations 1006 and 1016, was located to it's correct blueprint location, and the fracture surfaces matched adjacent structure. The mating structure exhibited severe fire and heat damage, however, the hard point intercostal showed no fire or heat damage and no evidence of transition fire damage over the mating fracture surfaces of the structure.

The following is a list of the reconstructed beams and the approximate amount of relocated structure at each station and the associated damage to the structure:

Station	%	Damage
277	25	One large piece from right butt line RBL 16 to RBL 42, exhibits fire damage and the upper chord attached to the web.
294.5	30	Four relocated pieces exhibiting fire damage with vertical stiffeners attached to the web and sections of lower chord attached to the web.
312	10	Three small pieces, exhibiting light fire damage and sections of upper and lower chord attached to the web.
328	15	Two mating pieces identified from RBL 42 to RBL 58 with no fire damage and common fracture of fasteners at the chord attachments.
344	45	Six separate relocated pieces of web with sections of upper and lower chord attached exhibiting fire damage to non-contiguous pieces.
360	80	Nine separate pieces including two sections of mating fractured webs between left butt line (LBL) 22 and LBL 1, with only one section exhibiting fire damage.

Station	%	Damage
380	5	Small sections of web with fractured upper and lower chords.
400	5-10	Three sections positively identified to this station, four other sections (about 20%) may locate to other stations with similar web design.
420	5-10	Three sections positively identified to this station, four other sections (about 5%) may locate to other stations with similar web design. Pulley bracket attached at RBL 6.
440	10-15	Two mating sections positively identified to this station, six other sections (about 10%) may locate to other stations with similar web design.
460	15	Three sections positively identified to this station, seven other sections (about 20%) may locate to other stations with similar web design.
480	15	Four sections positively identified at this station, four other sections (about 20%) may locate to other stations with similar web design.
500	20-25	Four sections positively identified at this station, three other sections (about 10%) may locate to other stations with similar web design.
500A	20-25	Three sections positively identified at this station, three other sections (about 20%) may locate to other stations with similar web design.
500B	20	Three sections positively identified at this station, two other sections (about 5%) may locate to other stations with similar web design.
500C	15	Three sections positively identified at this station, five other sections (about 5%) may locate to other stations with similar web design. Pulley bracket remained attached.
500D	30	Five sections positively identified at this station, four other sections (about 15%) may locate to other stations with similar web design. Pulley bracket remained attached.

Station	%	Damage
520	45	Seven sections positively identified at this station. Fractures adjacent to fastener rows, and a deep/narrow notch in the floorbeam right rudder (RA) through hole at the 1 o'clock position. Two other sections (about 5%) may locate to other stations with similar web design.
727B	50	Eight fragmented sections identified with ninety percent of the lower chord separated from the web. Two of the sections may locate to other stations with similar web design.
727C	70	Eleven fragmented sections identified with 95 percent the upper and lower chord separated at the web. Five of the sections may locate to other stations with similar web design.
727D	70	Fourteen fragmented sections identified with the upper and lower chord separated from the web. Ten of the sections may locate to other stations with similar web design.
727E	60	Eleven fragmented sections identified. Two of the sections may locate to other stations with similar web design.
747	50	Eleven fragmented sections identified. Two of the sections may locate to other stations with similar web design. A deep/narrow downward notch in the floorbeam at left butt line (LBL) 12, cable through hole at the 6 o'clock position.
767	75	Thirteen fragmented sections identified. Five of the sections may locate to other stations with similar web design.
787	65	Fifteen fragmented sections identified. Eleven of the sections may locate to other stations with similar web design.
807	40	Twelve fragmented sections identified. Eleven of the sections may locate to other stations with similar web design. One-hundred percent of the upper and lower chords were fractured from the web fragments.
827	45-50	Eight fragmented sections identified. One-hundred percent of the upper and lower chords were fractured from the web fragments.

Station	%	Damage
847	70	Nine fragmented sections identified. A right elevator pulley and cable were found attached to a segment of web between RBL 8 and RBL 13. One-hundred percent of the upper and lower chords were fractured from the web fragments.
867	80	Eight fragmented sections identified with one-hundred percent of the upper and lower chords fractured from the web fragments.
887	70	Seven fragmented sections identified. The lower chord was completely fractured from the web, however, the upper chord remained attached from LBL 49 to the outboard beam to frame attachment.
907	93	Seven fragmented sections identified. One-hundred percent of the upper and lower chords were fractured from the web fragments. Web exhibits heat damage between LBL 48 and LBL 55.
927	80	Eight fragmented sections identified with one-hundred percent of the upper and lower chords fractured from the web fragments.
947.5	75	Six fragmented sections identified with one-hundred percent of the upper and lower chords fractured from the web fragments.
967	85	Four fragmented sections identified with one-hundred percent of the upper chord fractured from the web fragments, and the lower chord attached from the outboard frame to LBL 17.
986.5	97	Four fragmented sections identified with a section of beam containing a segment of frame and door sill attached.
1006	96	Floor beam extends forward to station 986.5 and contains the lavatory C floor panel that was chard from post-impact fire from LBL 10 to the outboard edge of the panel.
1016	95	The upper chord and web were fractured at the inboard edge of the LBL 5 tee stiffener and the left and right intercostals fractured at the clips.

2.1 Longitudinal Floor Beams

The longitudinal floor beams run fore and aft from BS 540 to BS 727B and consist of five beams that locate at right butt line (RBL) 45.57, RBL 24.82, left butt line (LBL) 0.07, LBL 24.82, and LBL 45.57. Approximately 10% of the total longitudinal beams were identified. The beam sections exhibited fractures typical of tensile overload and no evidence of fatigue or preimpact fire was found.

2.2 Stud Beams

The stud beams are one-piece aluminum beams running inboard and outboard from the RBL and LBL 45.57 longitudinal beams to the adjacent body frames from BS 540 to BS 663. There was approximately 10% of the stud beams identified. The beam segments were twisted and bent and exhibited some postimpact fire damage.

3.0 Rudder Control Cables

The identified rudder control cables consisted of 61% of the cable length for the right (RA) cable, and 22% of the cable length for the left (RB) cable. All four turnbuckles were identified and located aft of the aft pressure bulkhead. The RA cable aft terminal fitting was found attached to a broken portion of the aft quadrant with ten inches of cable attached. The upper turnbuckle was intact with 23.5 inches of cable extending to the aft quadrant and lower cable which was attached to the lower turnbuckle. The lower turnbuckle was fractured at its mid-point and the lower half had 65 inches of cable attached.

Two RA cable sections were found pinched between idler pulleys attached to sections of fragmented floor beams. One cable measured 236 inches and was attached to a section of floor beam web at BS 420 and extended 156 inches forward and 80 inches aft of BS 420, but moved freely through the idler pulley. The other cable measured 342 inches and was attached to a section of web at BS 767 and measured 60 inches forward and 282 inches aft of BS767, and was securely pinched between the deformed bracket and pulley.

The RB cable aft terminal fitting was found attached to a fractured section of the aft quadrant and measured 33 inches. The upper pulley was found crushed, trapping a 25 inch section of cable (with 11 inches extending below the pulley bracket). The upper turnbuckle was intact with 12.5 inches of upper cable and 14 inches of lower cable attached. The lower turnbuckle was fractured at the upper clip fitting and had 37 inches of lower cable attached. One RB cable was identified that passed through BS 690, 727, 727B and 727C and could be moved at the idler pulley deformed at BS 690. The fairlead grommets at BS 721 were intact.

Visual examination of all RA and RB cables revealed all broken cable ends resulting from tensile overload. The cables exhibited kinks about every 20 inches corresponding to the floor beam locations. Both RA and RB cable breakage at the turnbuckle locations exhibited multiple breaks. There was no evidence of preimpact failure of the rudder cables.

The RA and RB cable holes in the floor beams were inspected for wear and impact marks. Of the 38 total floor beams, 27 webs associated with the RB cable and 30 webs associated with the RA cable were identified with intact or partially intact cable through-holes in the beams. Except for the fairlead at BS 721, and grommets at BS 1006 and BS 1016, no grommets remained intact in the web through-holes.

Notches associated with the RA cable through-holes were identified looking forward at the following locations: the aft pressure bulkhead (in the 7 o'clock position), BS 907 (7 o'clock), BS 727C (1 o'clock), BS 520 (1 o'clock), BS 500C (2 o'clock), and BS 420 (12 o'clock). The RA associated web hole at the BS721 fairlead was also fractured at the cable through hole at the 12 o'clock position. Notches were also identified at several RB cable through holes. Body station 907 contained a notch in the 5 o'clock position, BS 727C exhibited a notch in the 10 o'clock position, and the aft pressure bulkhead exhibited a notch in the 7 o'clock position.

The upper and lower aft RB pulleys and brackets were identified, however, the upper and lower aft RA pulley and bracket were not identified. All cables that did not contain turnbuckles or identifiable structure were separated by the following designations: "short", "intermediate", "section 41", and "cables wrapped in the right main gear". The fractured cable ends were visually inspected and exhibited tensile overload separations. Some cables were sent to the NTSB materials laboratory for further examination.

The cables that were sent to NTSB laboratories were examined to determine if the fractured cable ends could be matched. None of the cable ends could be matched, however, a re-visit to the AI hangar by representatives of the NTSB, BCAG, USAir, and the IAM, on December 15, 1994, established a match of the RA cable (below the lower turnbuckle) with the fracture surface at the aft end of the RA body cable run. The matching of the fractured cables revealed that the strands were similar in length, however, there was a 21 inch overlap of the forward and aft RA cable runs previously located by the attached/pinched structure. There was no means, however, to determine if the cables had been pulled through the respective fairleads prior to being pinched by the structure; or, if they were in their original operating location, when the pinching occurred. The group concluded that the RA and RB cables were correctly identified and located, and the separations were consistent with overstress fractures.

3.1 Tail Section - Rudder Control Cables

Examination of the aft pressure bulkhead cable seals for the RA and RB cables revealed tension overload notches in the seals. Notches were also evident in the seal retainers on the aft side of the pressure bulkhead and on the forward side of the bulkhead at the feed through holes for the RA and RB cables. The notches were in the downward direction.

Examination of the belly section of the fuselage between BS 1016 and 1088 revealed a pulley and bracket for the RB cable attached to the structure aft of BS 1040 location. The bracket was compressed inside the pulley and the inboard lip of the pulley was sheared off. The fairlead aft of the pulley exhibited a tension overload notch at the inboard upper corner of the

fairlead bracket.

The crown area of the fuselage skin between the vertical stabilizer attach points exhibited intact cable feed-through holes. The micarta cable guide, which accommodates the RA cable, was sheared from its mount and the guide for the RB cable was cracked on the inboard, aft corner exhibiting tension overload of the cable. The lower surface of the structure also exhibited a hollowed scrape consistent with the overload tension downward pulling of the RB cable just aft of the cable feed-through.

The rudder control quadrant was found attached to it's mounting bracket, and separated from the vertical stabilizer. The input rod to the rudder PCU was fractured approximately two inches from the rod end, and the cable attach point was fractured from the quadrant on each end.

The lower end of the rudder tower shaft was sheared off above the lower crank at the rivet holes surrounding the circumference of the shaft. The quadrant input rod was sheared approximately 12 inches from the rod end. The upper portion of the tower shaft was intact in the vertical fin. The rod for the standby PCU remained attached with no signs of damage or binding, however, the rod for the main PCU was removed to facilitate the removal of the PCU by the Systems Group for further examination. Examination of the rudder control cables revealed no evidence of preimpact failure.

3.2 Aileron Bus Control Cables

Three additional aileron bus cables were identified as ABSA or ABSB cables (with turnbuckles intact) and a ABSB cable (without a turnbuckle). The cables exhibited fractures typical of tensile overload. One of the ABSA or ABSB cables containing a turnbuckle measured 40 inches long on one side of the turnbuckle and 15 inches on the other side. The section of ABSB cable measured 83 inches long. The ABSA or ABSB cable containing a turnbuckle measured 37 inches on one side of the turnbuckle, and 11 inches extending from the other side of the turnbuckle. The three aileron cables identified were from the left wing, and the identification of the two turnbuckles resulted in the identification of all aileron bus cable turnbuckles. Examination of the aileron control cables found no evidence of preimpact failure.

4.0 Wheel Well

4.1 Pressure Deck

The pressure deck is composed of a "bead" formed pressure web and stiffeners. The web and stiffeners are made of light gauge aluminum (.040 inches thick). The pressure deck is a horizontal deck that makes up the ceiling of the wheel well from BS 663 to BS 727B.

There were approximately 20 identifiable sections totaling about five percent of the pressure deck and ranging in size from 3 X 3 inches to 15 X 12 inches. The sections were wrinkled, twisted, and fractured at random locations. The Structures Group was unable to relocate the identified sections except for the main landing gear down lock view port and one of the two aileron shaft penetration fittings. There was no evidence of smoke or fire damage present on the sections.

4.2 Center Section - Rear Spar

The rear spar is composed of an upper and lower chord and a web constructed of aluminum. The spar is located at approximately BS 663 and spans approximately 141 inches wide between the left and right wing join areas, and stands about 22 inches high between the spar chords. Secondary structure is located below the lower chord and separates the air conditioning bays from the wheel well area. The secondary structure web is constructed of fiberglass.

The identifiable primary rear spar structure totaled approximately 40 percent. All of the fracture surfaces exhibited tensile overload separations. No fatigue failures were observed, and about 20 percent of the sections exhibited smoke and fire damage. The smoke and fire damage was localized on the left upper side of the rear spar and was consistent with postimpact fire damage. There were no tire spattering or rubber marks observed on the sections of spar except for a small rubber smearing on a section of spar at RBL 24.82.

4.3 Wheel Well Aft Bulkhead - BS 727

The BS727 bulkhead is composed of an upper and lower chord and a web constructed of aluminum. The bulkhead is located at BS 727B and spans approximately 130 inches wide, and stands about 50 inches high.

There were fifteen sections of identifiable structure totaling approximately 40 percent of the BS 727B bulkhead. The majority of the relocated structure was on the left side of the bulkhead from BL 0 to LBL 60. The remaining relocated structure was matched to the right side of the bulkhead. All of the fracture surfaces exhibited tensile overload separations. No fatigue failures were observed, and about 10 percent of the sections exhibited smoke and fire damage. The sections of bulkhead that exhibited smoke and fire damage showed no transitioning of the fire or soot consistent with a pre-impact fire. There were no tire spattering or rubber marks observed on the sections of spar except for a small area of black residue on a section of bulkhead at about LBL 27.00 and an adjacent stiffener at LBL 30.00.

5.0 PATS Auxiliary Fuel Tank

Approximately 85 percent of the auxiliary fuel tank's fuel control valve box components, and about 50 percent of the electrical control box and associated hardware were identified. The only components that could not be identified included one of the two bleed air check valves and

the bleed air pressure switch. The missing bleed air check valve is plumbed in series with the first check valve and operates as a redundancy backup, and the bleed air pressure switch controls the bleed air solenoid, which is disconnected when the tank is deactivated. The fuel control components that were located exhibited the following findings:

Vent Valves - Both vent valves were located. One of the two valve blade gates was verified in the "closed" position. The other valve's blade gate was separated from the valve body and it's position could not be verified. These valves are normally closed in flight, thereby, maintaining equal pressure with cabin pressure and equalization of pressure on the tank inner and outer walls.

Transfer Valve - Both transfer valves were identified in the "closed" position; "closed" is the normal position for a deactivated system where the fuel transfer would not be utilized.

Fuel Fill Valve - Found in the "closed" position. During deactivation of the auxiliary fuel tank the fuel fill valve is verified "closed" and it's corresponding circuit breaker is pulled and collared, to ensure the valve remains in the "fail safe/closed" position until the circuit breaker is reactivated.

10 PSI Relief Valve - Found intact and operation verified by pushing the poppet open with a wooden dowel. When force on the poppet was released/reduced, the spring returned the poppet to the "closed" position. The purpose of this valve is to port tank internal pressure to the airplane's center tank if auxiliary tank internal pressure exceeds 10 PSI.

Cabin Air Inlet Valve and Screen - These components were found intact with the screen clear and the valve functional.

Bleed Air Solenoid Valve - The bleed air solenoid valve body was located, however the coil, armature and plunger were missing from the valve body and could not be identified.

Valve Motors - All five of the valve motors had separated from the valve bodies and, therefore, the internal control box harnesses and associated valve motors could not be located and examined.

Bleed Air Check Valve - Only one of the two bleed air check valves was identified. The recovered check valve operated normally with proper sealing capability.

Bleed Air Filter - The filter was found and identified as a Purolator type PR-306 with element #51399. Examination of the filter element revealed a relatively clean element with a normally functioning control.

Fuel Control Valve Box (FCVB) Structure - Approximately 85 percent of the FCVB

were located and identified. The aft and side extrusions of the FCVB were identified, and approximately 20 percent of the bottom plate of the structure was located. The top cover and forward channel of the FCVB, however, could not be identified.

Electrical Control Box - The electrical control box components provide the control functions for the valve assemblies in the FCVB. The identifiable sections of the electrical control box sustained severe impact damaged, to the extent that it was barely recognizable.

Further examination and testing by representatives from the NTSB, BCAG, USAir, and the IAM, of several of the auxiliary fuel tank valves occurred at NTSB laboratories and at PATS, Inc. on December 14 and 15, 1994. The following findings are a result of pressure tests and internal examinations of the valves:

Cabin Air Inlet Valve - The cabin air inlet valve gate hinge was bent and contained small particles of dirt and debris, and the gate would not seal at the valve seat. However, there was a clean impression of where the gate seal had been seated previously.

10 PSI Pressure Relief Valve - The internal valve body of the pressure relief valve was contaminated with dirt and mud. The poppet valve seal and o'ring were clean and undamaged and the poppet spring exhibited no signs of distortion. The pressure and leak test revealed that the poppet valve opened at 9.0 PSI (the valve is certified to open at 10 PSI $\pm$ 1 PSI) and exhibited no indications of leakage.

Tank Air Inlet (Vent) Valve - The inlet valve poppet was contaminated with fine particles of dirt and a 1/2 X 3/8 inch shard of fuel tank structure was found inside the valve body. The valve o'ring and seal, however, were clean and undamaged, and the mating seat area was clean and undamaged. The pressure and leak test of the tank air inlet valve revealed that the valve opened at 2.0 PSI, as certified, and exhibited no indications of leakage.

Bleed Air Check Valve - Examination of the bleed air check valve revealed particles of dirt contamination on the poppet valve, however, the poppet seal and seat were clean and undamaged and the spring exhibited no signs of distortion. Testing of the bleed air check valve revealed that the valve opened at 2.2 PSI, and exhibited no indications of leakage. (The deactivation of the auxiliary fuel tank, results in the disconnection of the tank solenoid, and, therefore, removal of the pressure source to the bleed air check valve.)

Bleed Air Filter - Examination of the bleed air filter at the NTSB laboratories revealed that the safety wire had been cut (prior to this inspection) and the top of the valve was loosely secured to the valve body. Further inspection of the valve revealed that the filter was distorted and compressed inside the valve body and exhibited indentations on the top of the filter consistent with the misalignment of the filter inside the valve body, and the subsequent tightening of the valve cap. (Review of the inspection notes of the bleed air

filter at the AI hanger revealed no indication of distortion of the filter.) The filter exhibited no odor of fuel or evidence of contamination either externally and internally (determined by slicing the filter open).

Examination of the auxiliary fuel tank components revealed no abnormal operating characteristics and the valve positions were consistent with a deactivated fuel tank. In addition, there was no evidence of ignition, explosion, or corrosion throughout any of the fuel tank components or structure.

About 40 percent of the auxiliary fuel tank structure was identified and relocated with respect to a two dimensional layout of the tank. The relocated structure generally consisted of: portions of the upper panel (including a 5 inch portion of the forward upper seam), the center and lower portions of the forward panel, the lower and center portions of the aft panel, and the side angle panels. The only section of lower panel identified consisted of the sump drain doubler. The relocated tank support structure consisted of the compression beams located at the BS727 bulkhead. There were no identifiable sections of the tank lower base mount. No evidence was found of heat or fire damage on the identified tank support structure. A small section of forward tank panel exhibited fire damage, however, mating sections of tank structure contained no evidence of heat or fire damage. No other relocated tank structure displayed evidence of heat or fire damage.

Approximately 85 percent of the auxiliary tank fuel, transfer and vent hoses were identified. The hose end fittings remained intact with varying amounts of heat and fire damage. The section of fuel hose that extends over the wing center section to the BS 727 bulkhead exhibited severe postimpact heat and fire damage with only the end fittings and steel braid remaining intact. One side of the center section structure, where the hoses mount, exhibited severe charring and the other section, 4 feet away, exhibited no evidence of heat or fire damage. The hose assembly contained within the aircraft center tank exhibited heat exposure and burned hose rubber, however, the crossfeed line showed no charring. In addition, the hoses that extend from the BS 727 bulkhead to the top of the auxiliary fuel tank exhibited no signs of heat or fire damage.

6.0 Tires

The sorting of airplane structure during the reconstruction phase of the investigation was successful in locating portions of the left inboard tire which had not been identified in the Structures Group Chairman's Factual Report of Investigation. Examination of the remains of the left inboard tire revealed a section measuring approximately 12 X 28 inches. The section of tire contained markings consistent with a BF Goodrich brand, Michelin-manufactured tire. The section of tire exhibited such severe burning and fragmentation of the edges that it could not be determined if the fragmented edges were on a ply tear angle. In addition to the section of recovered tire, bead wires were found and identified for the left inboard tire. The bead wires exhibited small traces of burned rubber, however, the majority of the tire rubber had burned

from the wires.

An examination was conducted of the other main gear tires. The left outboard tire was identified as a BF Goodrich brand, Michelin-manufactured tire with serial number 3270N00702 visible on the sidewall of the tire. The tire remained mounted on the wheel and exhibited fire damage throughout the tire with the heaviest fire damage on the inboard (strut) side of the wheel. One of the burned edges of the tire (corresponding to the tread area of the tire) followed an angle similar to that of the plys. The extent of fire damage resulted in the inability to establish if the tire had been recapped without sectioning the tire.

The right inboard tire was identified as BF Goodrich brand tire, with serial number 3055N10033R1 visible on the rim. The tire remained installed on the wheel rim and contained no fire damage. There were numerous cuts and abrasions on the tire tread with some penetrating the casing of the tire. A rupture of the casing was found extending 4 inches in length, and exhibited ply damage consistent with the release of internal pressure.

The right outboard tire was identified as a BF Goodrich brand tire, with serial number 3167N00365R2 visible on the shoulder of the tire. The tire was dismounted from the wheel, and contained no fire damage on the casing. A 17 inch section of the tire was separated from the tire's crown area. The loose section exhibited minor fire damage, and had ply damage consistent with the release of internal pressure.

7.0 Blacklight Inspection

A blacklight inspection was conducted of relocated sections of the airplane structure. The objective of the inspection was to reveal any evidence of possible bird strike debris on relevant portions of the airplane structure. Sections of the airplane that were examined with the blacklight included the following areas: radome, 178 forward pressure bulkhead, left wing slats, cockpit flight control components (including the pilot's rudder pedals), and the leading edges of the vertical and horizontal stabilizers. There was no evidence of bird stains, remains, or odor on any of these areas. However, there was a small (10 inch spanwise X 5 inch chordwise) area that illuminated a stain on the outer surface of the outboard number 1 slat. The stained area contained a 3 X 5 inch white florescent swipe, in the upper external portion aft of the leading edge nose of the slat, oriented in the spanwise direction. The stain was adjacent to a section of fractured main slat track which was previously examined at the NTSB materials laboratory and found to be an overload fracture. Subsequently, a small piece (1/4 inch diameter) of the fluoresced debris was removed from the slat surface and another sample of fluoresced debris was removed from the adjacent interior slat cavity for further examination.

Both samples of fluoresced debris were sent to the Armed Forces Institute of Pathology (AFIP) for examination. The pieces of debris were examined using: stereo microscopy to evaluate the particles most likely to contain traces of blood or luminol, and to determine if there

was any blood present. Both processes of examination revealed a negative result for traces of blood. In addition, a negative result was also observed with the administering of Leuco-malachite Green on the debris specimens. The AFIP report of the examination of the debris specimens is included as an exhibit to this report.

On November 30, 1994, representatives from the NTSB, Boeing Commercial Airplane Group, AFIP and the IAM, visited the USAir AI hangar to reexamine the portion of the No. 1 slat containing the 3 X 5 inch swipe that had illuminated white florescent. The equipment used to examine the slat was an ultraviolet light of 365 nm, an Omnichrome Omniprint 1000, and a pathological blood kit. The swipe area was scanned and tested, and no organic remains were identified or detected. In addition, the group removed seven additional samples of debris from the No. 1 slat track, which were subsequently labeled and examined at the AFIP laboratories in Washington, D.C. The report of the examination of these samples is included as an exhibit to this report.

8.0 Air Accidents Investigation Branch (AAIB) Participation

Engineering staff of the AAIB from Farnborough, England with experience from the reconstruction of the PanAm Boeing 747 airplane crash in Lockerbie, Scotland, participated in the Structures Reconstruction Group. The AAIB representatives reported that the "destruction of the airframe was such that it was similar to that encountered with the impact of high speed military aircraft and extreme for that associated with civil aircraft accidents". They reported that, despite a dedicated effort by the Structures Group, the reconstruction work was severely hampered by a shortage of identifiable structure. A letter detailing the AAIB findings and conclusions regarding the reconstruction efforts of the USAir Flight 427 investigation is included as an exhibit to this report.

9.0 Federal Bureau of Investigation (FBI)

FBI explosives experts examined the airplane wreckage on December 19, and 20, 1994 for evidence of bomb or explosive materials. The examination included the detailed review of the previously documented reconstructed areas, and the various piles of unidentified structure. The FBI investigators reported that no evidence of bomb or explosive devices were observed during their examination of the wreckage. A report detailing the FBI's examination of the wreckage is included in an exhibit to this report.

Cynthia L. Keegan
Structures Group Chairman

12/29/94