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AIRCRAFT ACCIDENT REPORT
Trans World Airlines Flight 800
Part I
Consideration of Reasonable Probable Causes

Report on the accident to
Trans World Airlines Flight 800
Boeing 747-131, N93119
Near East Moriches, New York
July 17, 1996
by John Barry Smith,
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Part I: Consideration of Reasonable Probable Causes

Abstract and excerpts from Aircraft Accident Report NTSB/AAR-00/03. Abstract: This report explains the accident involving Trans World Airlines, Inc. flight 800, which experienced an in-flight breakup and then crashed into the Atlantic Ocean near East Moriches, New York, on July 17, 1996. The National Transportation Safety Board determines that the probable cause of the TWA flight 800 accident was an explosion of the center wing fuel tank (CWT), resulting from ignition of the flammable fuel/air mixture in the tank. The source of ignition energy for the explosion could not be determined with certainty, but, of the sources evaluated by the investigation, the most likely was a short circuit outside of the CWT that allowed excessive voltage to enter it through electrical wiring associated with the fuel quantity indication system.

Many witnesses in the area of the accident at the time that it occurred reported that they saw and/or heard an explosion, accompanied by a fireball over the ocean, and observed debris falling to the water. These witness reports and the widespread distribution of the wreckage indicated that TWA flight 800 had experienced a catastrophic in-flight structural breakup. In addition, a noise recorded on the CVR in the last few tenths of a second before the CVR recording stopped was similar to the last noises heard on CVR recordings from other airplanes that had experienced structural breakups (including fuel tank explosions). On the basis of this initial information, investigators considered several possible causes for TWA flight 800 in-flight structural breakup: a structural failure and decompression; detonation of a high-energy explosive device, such as a bomb exploding inside the airplane or a missile warhead exploding upon impact with the airplane; and a fuel/air explosion in the center wing fuel tank (CWT).

This Smith Trans World Airlines Flight 800 AAR states there are three reasonable alternatives to the CWT explosion explanation based on the previous similar accidents of United Airlines Flight 811, Air India Flight 182, and Pan Am Flight 103. Of the three reasonable alternatives, two can be ruled out with confidence: Missile strike and bomb explosion; and one ruled in: The shorted wiring/forward cargo door rupture/explosive decompression/inflight breakup explanation which closely matches the probable cause of the United Airlines Flight 811 accident. Since the discovered hazards of faulty wiring or switch and the hazard of nonplug cargo doors currently exist in the five hundred early model Boeing 747s in service, further official investigation is warranted and urgently needed.

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Glossary

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Acronyms and Abbreviations:

CASB, Canadian Aviation Safety Board, now TSB, Transportation Safety Board, of Canada
UK AAIB, United Kingdom Air Accidents Investigation Branch, Farnborough, U.K
NTSB USA, National Transportation Safety Board, United States of America
CVR, cockpit voice recorder
DFDR, digital flight data recorder
ATC, air traffic control
AAR, aircraft accident report
MEC, main equipment compartment
PSI, pounds per square inch
FOD, foreign object damage
IED, improvised explosive device
KTS, knots
TAS, true air speed
IAS, indicated air speed
AI, Air India
PA, Pan Am World Airways
UAL, United Airlines,
TWA, Trans World Airlines
JAL, Japan Air Lines
NAVAVNSAFECEN, Naval Aviation Safety Center
a.c. alternating current
AC advisory circular
AD airworthiness directive
ALPA Air Line Pilots Association
amp ampere
AOA angle-of-attack

APU auxiliary power unit
ARTCC air route traffic control center
ASR airport surveillance radar
ATC air traffic control
ATP airline transport pilot
CAM cockpit area microphone
CFR Code of Federal Regulations
c.g. center of gravity
CVR cockpit voice recorder
CWT center wing fuel tank
d.c. direct current
DNA deoxyribonucleic acid
E/E electrical/electronics
EME electromagnetic environment
EMI electromagnetic interference
EPR engine pressure ratio
F Fahrenheit
FAA Federal Aviation Administration
FARs Federal Aviation Regulations
FBI Federal Bureau of Investigation
FDR flight data recorder
FQIS fuel quantity indication system
GPS global positioning system
HF high frequency
Hg mercury
HIRF high-intensity radiated fields
Hz hertz (cycles per second)
JFK John F. Kennedy International Airport (New York, New York)
MHz megahertz
msl mean sea level
NASA National Aeronautics and Space Administration
NOAA National Oceanic and Atmospheric Administration
NPRM notice of proposed rulemaking
PETN pentaerythritol tetranitrate
P/N part number
psi (pressure expressed in) pounds per square inch
P&W Pratt & Whitney
RDX cyclotrimethylenetrinitramine
SB service bulletin
SDR service difficulty report
SL service letter
S/N serial number
STA body station
STC supplemental type certificate
TWA Trans World Airlines, Inc.
USAF U.S. Air Force
USCG U.S. Coast Guard

Glossary from NTSB AAR 00/03 for Trans World Airlines Flight 800:

Air conditioning pack: An assembly of air conditioning system components that reduces the temperature and pressure of hot bleed air that is then routed to

pressurized areas of the cockpit, cabin, and cargo compartments to provide environmental control (pressurization, ventilation, and temperature). The bleed air source can be any one or a combination of the following: engines, auxiliary power unit (APU), or ground air connections.
Air cycle machine (ACM): An assembly in the air conditioning system that includes components such as a fan and compressor. When partially cooled air from the heat exchangers requires additional cooling, the air is routed through the ACM expansion turbine for maximum cooling.
Alternating current (a.c.): An electric current that periodically changes in direction and constantly changes in magnitude. Ampere (amp): The basic unit of measurement of electric current flow. Arcing: Arcing is defined by Underwriters Laboratories, Inc., as a luminous discharge of electricity across an insulating medium. The electrical discharge of an arc can involve temperatures of several thousand degrees Celsius. Auto ignition: Spontaneous ignition of a fuel/air vapor when it is sufficiently elevated in temperature for ignition to occur without direct contact with an ignition source, such as a spark, arc, or hot surface or filament. Auto ignition is highly dependent upon many factors, including the size of the heated volume and container and other environmental conditions that affect fuel vapor. Existing research indicates that the auto ignition temperature for Jet A fuel/air vapor at sea level is about 460 Fahrenheit (F). Auto ignition temperature increases as the altitude increases. Ballistic coefficient: The weight of an object divided by the product of its drag coefficient multiplied by its area, used to determine the motion of an object in an atmospheric environment.
Bleed air: The hot pressurized air ducted from an airplane's engines, APU, or a ground source for use by other airplane systems (such as pressurization and air conditioning).
Body station (STA): A longitudinal point along an airplane's fuselage, identified numerically by its distance in inches from a reference point. In a classic 747, this point is 90 inches forward of the airplane's nose. Bomb: (as used in this report) An explosive device designed to release destructive material at high velocity upon detonation, as distinguished from a small explosive charge. Glossary of Terms 418 Aircraft Accident Report Bonding: Connecting components to maintain them at a common electric potential.
Boost pump: (as used in this report) A pump mounted in the wing fuel tanks designed to move fuel from certain wing tanks to the engines. Capacitance: The property of conductors separated by a dielectric material (for example, air or fuel) that permits the storage of electricity when potential differences exist between conductors.
Center wing fuel tank (CWT): A fuel tank that, in the 747-100 series, is located in the wing center section (WCS), between the rear spar and spanwise beam (SWB) 3 and that has a Jet A fuel capacity of 86,363 pounds (12,890 gallons). (See wing center section.)
Conductivity: A measure of the extent to which a material is capable of conducting an electric current. (See ohm.) Connector: (as used in this report) A device that makes an in-line connection(s) between one or more wires for a continuous electrical path(s) at a location where the wires are subject to being disconnected and reconnected without mismatching circuits. Typical military-specification multicontact electrical connectors are assembled from two subassemblies, the plug and receptacle, which mate to connect wires with pin and socket contacts.
Contact: (as used in this report) A device within an electrical connector used to

provide the electrical path joining two individual wires. Coupling: Transferring energy between elements or circuits of an electrical system.
Current: The movement of electricity (the flow of electrons) through a conductor. Measured in amps.
Dielectric: A nonconductor of electricity. Direct current: An electric current that flows continuously in one direction. Dry bay: A compartment in the WCS that is not intended to contain fuel. In the 747-100, a dry bay is located between SWB3 and the forward spar. Electromagnetic environment (EME): The total of all electromagnetic fields and the associated frequencies, power levels, and polarizations in a given or defined region. The EME consists of natural and manufactured sources of electromagnetic energy. Electromagnetic interference: (as used in this report) Electromagnetic energy from a source either internal or external to an aircraft that imposes greater-than-intended voltage on an electrical system.
Glossary of Terms 419 Aircraft Accident Report Energy: The capacity for doing work. It may exist in potential, kinetic, thermal, electrical, chemical, nuclear, or other forms and be transformed from one form to another. Electromagnetic energy is expressed in units of work, such as joules (J) or kilowatt-hours. Explosion: (as used in this report) The sudden and rapid escape of gases from a confined space, accompanied by high temperatures, violent shock, and loud noise. Extremely improbable failure condition: As defined in Federal Aviation Administration Advisory Circular (AC) 25.1309-1A, a condition so unlikely that it is not anticipated to occur during the entire operational life of all airplanes of one type and that has a probability of occurrence on the order of 1 x 10-9 or less each flight hour, based on a flight of mean duration for the airplane type. Failure modes and effects analysis: A structured and systematic analytical method for identifying potential failure modes of a component or system and for evaluating the potential risk(s) that might be posed by various failure modes. Fault tree analysis: An analysis designed to examine an end event through consideration of assumed precipitating events. Each of these precipitating events is in turn broken down until a level is attained in which no additional precipitating events will occur. The total of all of the events and the way in which they are tied together creates the fault tree analysis.
Fireball: (as defined by the TWA flight 800 investigations' Witness Group) One or more downward-moving ball(s) of fire in the sky. According to the Witness Groups definition, it could be characterized (by witnesses) as either stationary or descending; however, to meet the groups definition of a fireball, it must not have been reported to have appeared in the sky after the termination of a streak of light (if such a streak were reported). It could not have been an ascending object or an object that met the groups definition of a streak of light.
Flash point: The minimum temperature at sea level at which a liquid fuel vaporizes sufficiently to form an ignitable mixture with air (when exposed to an open flame), as determined by a standardized test procedure. Flashing: (as used in this report) A category of electrical activity observed during short-circuit tests conducted by Lectromechemical Design Company (Lectromec) as a part of the TWA flight 800 accident investigation, characterized by an arcing discharge seen as a single flash of light with an accompanying popping sound. Fuel mass loading: A measure of the amount of fuel relative to the entire volume of its container.
Fuel quantity indication system (FQIS): In the 747-100, a system that measures changes in the capacitance of tubular probes located in each fuel tank for the display of fuel quantity on cockpit gauges and on repeater gauges located at the fueling station in the left wing. The system is also connected to systems that require fuel quantity information, Glossary of Terms 420 Aircraft Accident Report including the

gross weight/total fuel weight indicator, airborne integrated data acquisition, and the volumetric shutoff ([VSO] ground refueling) systems. Fuel quantity compensator: A component used in the FQIS or VSO system to compensate for variations in the dielectric constant of fuel, which varies from one type of fuel to another (and even within the same type of fuel, depending on the ibatchi and age of the fuel) to ensure consistent fuel quantity indications. There is at least one compensator in each fuel tank.
Fuel quantity probe: A component of the FQIS, a set of which is positioned in each of an airplane's fuel tanks, used to measure the quantity of fuel in each tank through a range of levels within the tank. The 747-100 may have 65 or more fuel quantity probes positioned within the 7 fuel tanks.
Fuel washing: Motion of fuel over a part, which can lead to electrostatic charge accumulation or removal of contaminants (such as sulfides). Green zone: One of three debris fields, labeled during the TWA flight 800 accident investigation, from which the accident airplane's wreckage was recovered. This zone was located farthest east (farthest from John F. Kennedy International Airport [JFK]) in the wreckage distribution. This zone contained pieces of wreckage from both wings and most of the aft portions of the fuselage, including the following: both wings; all four engines; pieces of SWB1, SWB2, mid spar, and rear spar; the aft portion of the keel beam; the main landing gear; and the tail section. Grounding: Connecting electrical circuits to a large common conductor considered to be at zero electrical potential such as the earth or, in the case of an airplane, the skin of the airplane, which is at a fixed electrical potential. Heat exchangers: (as used in this report) Devices in the 747-100 used to initially cool the heated bleed air coming from the engines located within the air conditioning pack bay under the CWT.
High-intensity radiated fields: High-power electromagnetic fields that exist in a defined environment, particularly in the vicinity of high-power radar sites, broadcast antennas, and other high-power radio frequency sources. Hot surface ignition: A phenomenon in which a very high temperature surface comes into contact with fuel or fuel vapor that results in ignition. Hot surface ignition is highly dependent upon many factors, including the geometric aspects of the hot surface and other environmental conditions that affect fuel and fuel vapor. Existing research indicates that hot surface ignition temperatures at sea level for fuels similar to Jet A range from 900 to 1,300 F. The hot surface ignition temperature increases as the altitude increases.
Glossary of Terms 421 Aircraft Accident Report Ignition energy: The quantity of heat or electrical energy that must be absorbed by a fuel/air vapor mixture in a finite volume to generate a propagating flame. Commonly measured as the energy provided by a small (millimeter size) spark. Impeller: A blade on a rotating part in an air compressor or fuel pump. Improbable failure condition: As defined in AC 25.1309-1A, a condition not anticipated to occur during the entire operational life of a single random airplane; however, it may occur occasionally during the entire operational life of all airplanes of one type. It has the probability of occurrence on the order of 1 x 10-5 or less, but greater than on the order of 1 x 10-9 each flight hour, based on a flight of mean duration for the airplane type.
Jet A fuel: A kerosene fuel used in civilian turbine engine airplanes. Jet A fuel is composed of a mixture of more than 100 distinct types of hydrocarbon molecules; the precise composition often varies between refinery and by season. Jet A fuel is specified to have a minimum flash point of 100 F. Jet A-1 is a similar fuel, but has a slightly lower freezing point. Although Jet A fuel is available in some other countries, it is used primarily in the United States.

Jettison/override pump: In the 747, a fuel pump that has two uses, one of which is to jettison fuel overboard when this function is selected at the flight engineering station. The pump is also designed to provide fuel to the engine manifolds at a higher pressure than the boost pumps, which are located in the wing fuel tanks. Two CWT jettison/override pumps are mounted on the rear spar of the CWT, and pressure from these pumps closes the main tank check valves, resulting in the use of fuel from the CWT before that of fuel from the wing tanks.
Joule (J): A unit of measurement of electrical work or energy; 1 J is the amount of work done by 1 watt of power in 1 second. Keel beam: A box-shaped, load-bearing structure located along the airplane's centerline that extends from the aft wall of the forward cargo compartment below the WCS and through the main and body landing gear compartments to the forward wall of the aft cargo compartment. The CWT is located above the keel beam. Kilojoule (kJ): A unit of measurement equaling 1,000 J. Lower flammability limit: The lowest temperature that will provide a sufficient concentration of fuel vapor to propagate a flame. Millijoule (mJ): A unit of measurement equaling one-thousandth of a J. Minimum ignition energy (MIE): The minimum quantity of heat or electrical energy that must be absorbed by an optimal fuel/air vapor mixture in a finite volume to generate a propagating flame. The MIE for Jet A fuel is generally accepted to be about 0.25 mJ.
Glossary of Terms 422 Aircraft Accident Report Ohm: The unit of resistance of an electrical conductor, at which the fall of potential is 1 volt when the current is 1 amp. (See resistance.) Overpressure event: (as used in this report) An event in which the pressure in the CWT is increased in a relatively short time to a level at which the structural integrity of the CWT is compromised.
Power: The time rate of energy transfer; the practical unit of measurement is 1 watt. (See watt.)
Primary radar target: A radar target produced when a radar signal reflects off of an objects surface and returns to a ground-based radar antenna/site for processing and display.
Quenching: The extinguishment of a combustion flamefront; often as a result of decreased temperature or propagation through a passageway, such as an orifice or a vent. Raceway: A term used to refer to areas within the 747 where wire bundles are grouped into a common route.
Red zone: One of three debris fields, labeled during the TWA flight 800 accident investigation, from which the accident airplane's wreckage was recovered. This zone was located farthest west (closest to JFK) in the wreckage distribution. A relatively small amount of widely dispersed debris was recovered from the red zone, including the following: pieces from the WCS front spar and SWB3, the manufacturing access door from SWB2, pieces of the fuselage from STA 840 and STA 1000, main cabin floor beams and flooring material from above and in front of the WCS area, and the two forward air conditioning packs. (See figure 3a.)
Resistance: The property of a conductor that tends to restrict the flow of an electric current. (See ohm.)
Ring chord: An angle member that attaches the bottom of the forward fuselage section to the front side of the lower pressure bulkhead and the front spar. Scavenge pump: (as used in this report) A small fuel pump designed to remove the last amounts of accessible fuel from the lowest point of a 747 CWT and discharge the fuel into the left inboard fuel tank. Although the scavenge pump removes fuel not accessible by the jettison/override pumps, a small amount of residual fuel will remain in the fuel tank that the scavenge pump is not able to remove. Scintillation:

(as used in this report) A category of electrical activity observed during short-circuit tests conducted by Lectromec as a part of the TWA flight 800 accident investigation, characterized by a high frequency micro-discharge that usually results in the formation of char or soot on a wire (and adjacent wires) over time. Glossary of Terms 423 Aircraft Accident Report Secondary radar target: A radar target produced when a radar signal is detected by an airplane's transponder, which transmits a coded message in response to interrogation by a ground-based transmitter.
Shielding: (as used in this report) Metal covers placed around electric wires and electronic devices to prevent the intrusion of external electrostatic and electromagnetic fields.
Short circuit: An unintended current path between conductors. Short circuits can occur either directly, if the protective insulation covering between internal conductors in each wire is compromised and there is direct contact between the conductors, or through a bridge created by contaminants, such as metal shavings or fluid. Sleeve (wire): A woven or flexible jacket that protects electrical wiring. Small explosive charge: A minimal amount of a highly explosive material (such as a plastic explosive) detonated by a fusing device. Spanwise beam 1: One of the lateral beams in the CWT that divides it into compartments and supports the structure of the WCS. SWB1 is located between the mid and rear spars.
Spanwise beam 2: One of the lateral beams in the CWT that divides it into compartments and supports the structure of the WCS. SWB2 is located between the mid spar and SWB3.
Spanwise beam 3: One of the lateral beams in the CWT that divides it into compartments and supports the structure of the WCS. SWB3 is located between SWB2 and the front spar.
Spar: A beam that extends laterally through the WCS into the outboard wing structure. The 747-100 has front, mid, and rear spars. Splice (wire): (as used in this report) A fixed connection of two electrical wires. Splices can be made by various methods, such as soldering wires together or with crimped metal barrels, and are typically covered by insulating material. Streak of light: (as defined by the TWA flight 800 investigations' Witness Group) An object moving in the sky that could be variously described in witness documents as a point of light, fireworks, a flare, a shooting star, or something similar, which was usually described as ascending, but could also be described as arcing over and/or descending. Streak-of-light witness: (as defined by the TWA flight 800 investigations' Witness Group) Any witness who reported seeing an airplane in the general vicinity of a streak of light at the same time that the streak of light was visible (around the time and vicinity of the TWA flight 800 accident). (See witness.) Glossary of Terms 424 Aircraft Accident Report Stringer: A stiffening member found in the 747-100s fuselage and wings that helps to support and reinforce the structure. Strong arcing: (as used in this report) A category of electrical activity observed during short-circuit tests conducted by Lectromec as a part of the TWA flight 800 accident investigation, characterized by an arcing discharge that could continue for hundreds of cycles, typically involving 5 kJ of electrical energy. Surge tank protection system: A system to detect and extinguish fire that consists of a series of optical photocells that trigger the discharge of Halon (a fire extinguishing agent) into the surge tank when a flame or bright light source is sensed in the surge tank. Discharge of the extinguishing agent is designed to occur about 1 millisecond after the photocell senses a flame. Transient suppression device: An electrical device that limits the amount of energy or current that can pass through it to a

predetermined amount. Transient voltage: A temporary voltage surge or excursion; for example, that which occurs when first turning an electrical system on. Transponder: The airborne receiver/transmitter portion of a radar system that responds to interrogation signals received from ground-based equipment. Ullage: The space in a fuel containing tank not occupied by liquid fuel. Upper flammability limit: The maximum temperature at which a concentration of fuel vapor will propagate a flame.

Volt: The basic unit of measurement of electromotive force (the force that causes electrons to flow through a conductor). One volt is the electromotive force required to cause current to flow at the rate of 1 amp through a resistance of 1 ohm. One volt equals 1 amp times 1 ohm.

Watt: The basic unit of measurement of power. In electrical application, 1 watt equals 1 volt times 1 amp. (See power.)

Weathering: The change in a liquid fuel chemical composition as a result of exposure to environmental conditions. An example involves heating and pressure changes to a vented aircraft fuel tank, where preferential evaporation of the lower molecular weight components of the jet fuel occurs, resulting in a redistribution of the chemical composition of the remaining liquid fuel. Wing center section: A large structural box located aft of the forward cargo compartment and forward of the main landing gear bay in the lower fuselage between the wings, which comprises the CWT and a dry bay directly forward of the CWT. (See center wing fuel tank.)

Glossary of Terms 425 Aircraft Accident Report Witness: (as defined by the TWA flight 800 investigations' Witness Group) Anyone who reported hearing a sound and/or seeing an event or object or objects (including smoke or fire) in the sky around the time and vicinity of the TWA flight 800 accident. According to the Witness Groups definition, it must have been likely that the sound or object observed was related to the crash, and the report must not have been a secondhand account.

Yellow zone: One of three debris fields, labeled during the TWA flight 800 accident investigation, from which the accident airplane's wreckage was recovered. This zone was the smallest of the three zones and was contained within the red zone on its northeastern side and located in a small concentrated area. This zone contained wreckage from the forward portion of the fuselage, from STA 90 (the nose of the airplane) to STA 840, including the cockpit, section 41, and the forward portions of section 42. (See figure 3a.) This wreckage was found relatively intact.

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NTSB AAR 00/03 TWA Flight 800, 17 July 1996, Boeing 747
NTSB AAR 93/06, JAL Flight 46E, 31 March, 1993, Boeing 747

Definitions: Definitions as used in this report:

Bomb: 'Bomb' may mean an explosive device designed to release destructive material at high velocity upon detonation; an explosive device placed in an aircraft with an intent to detonate.
Cargo Door: In the Boeing 747 both the forward and aft lower cargo doors are similar in appearance and operation. They are located on the lower starboard side of the fuselage and are outward opening and nonplug. The door opening is approximately 110 inches wide by 99 inches high, as measured along the fuselage.
Cargo Compartments: The forward and aft freight holds are used for the storage of cargo and baggage in standard air-transportable containers. The forward freight compartment has a length of approximately 40 feet and a depth of approximately 6 feet. The containers are loaded into the forward hold through a large cargo door on the starboard side of the aircraft.
Conclusion of fact: An inference drawn from the subordinate or evidentiary facts.
Conclusive evidence: That which is incontrovertible, either because the law does not permit it to be contradicted, or because it is so strong and convincing as to overbear all proof to the contrary and establish the proposition in question beyond reasonable doubt.
Ear Barotrauma: Injury to the tympanic membrane (eardrum) when a sudden pressure differential exists between the middle ear cavity and the external ear.
Evidence: A species of proof, or probative matter, legally presented at the trial of an issue, by the act of the parties and through the medium of witnesses, records, documents, exhibits, concrete objects, etc., for the purpose of inducing belief in the minds of the court or jury as to their contention.
Circumstantial Evidence: The proof of various facts or circumstances which usually attend the main fact in dispute, and therefore tend to prove its existence, or to sustain, by their consistency, the hypothesis claimed. Testimony not based on actual personal knowledge or observation of the facts in controversy, but of other facts from which deductions are drawn, showing indirectly the facts sought to be proved. Evidence of facts or circumstances from which the existence or nonexistence of fact in issue may be inferred. Inferences drawn from facts proved.
Direct Evidence: Evidence in the form of testimony from a witness who actually saw, heard, or touched the subject of questioning.
Tangible Evidence: Evidence which consists of something that can be seen or touched. In contrast to testimonial evidence, tangible evidence is real evidence.
Expert: One who is knowledgeable in a specialized field, that knowledge being obtained from either education or personal experience. One who by reason of education or special experience has knowledge respecting a subject matter about which persons having no particular training are incapable of forming an accurate opinion or making a correct deduction.
Expert Testimony: Opinion evidence of some person who possesses special skill or knowledge in some science, profession, or business which is not common to the average man and which is possessed by the expert by reason of his special study or experience.
Expert Witness: One who by reason of education or specialized experience possesses superior knowledge respecting a subject about which persons have no particular training are incapable of forming an accurate opinion, or deducing correct conclusions. One possessing, with reference to particular subject, knowledge not acquired by ordinary persons.
Explosion: To burst or cause to burst violently and noisily. The sudden and rapid escape of gases from a confined space, accompanied by high temperatures, violent shock, and loud noise.
Explosive Decompression: Explosive decompression is an aviation term used to mean a sudden and rapid loss of cabin pressurization of higher internal air pressure venting outside to the lower pressure air.
Finding: The result of the deliberations of a jury or a court. A decision upon a question of fact reached as the result of a judicial examination or investigation by a court, jury, referee, coroner, etc. A recital of the facts found.

Outward Opening Nonplug: A type of cargo door which undergoes stress to open in flight under a high pressure differential because it opens outward and the door does not 'plug up' or 'block' the opening.
Premise: A statement of fact or a supposition made or implied as a basis of argument.
Reasonable doubt: The standard used to determine the guilt of innocence of a person criminally charged. Reasonable doubt which will justify acquittal is doubt based on reason and arising from evidence or lack of evidence, and it is doubt which a reasonable man or woman might entertain, and it is not fanciful doubt, is not imagined doubt, and is not doubt that juror might conjure up to avoid performing an unpleasant task or duty. Reasonable doubt is such a doubt as would cause prudent men to hesitate before acting in matters of importance to themselves. Doubt based on reasons which arise from evidence or lack of evidence.
Starboard Side: The right side of the fuselage looking from aft to forward. The port side is the left side looking aft to forward. The starboard side of the aircraft faces the viewer when the nose is to the right. Both cargo doors are on the starboard side of the Boeing 747.
Shorted wiring/forward cargo door rupture/explosive decompression/inflight breakup explanation: Mechanical explanation for the inflight breakup of Air India Flight 182, Pan Am Flight 103, United Airlines Flight 811, and Trans World Airlines Flight 800 as caused by an explosion in the forward cargo compartment of explosive decompression when the forward cargo door ruptures open in flight, probably at one or both of the midspan latches and probably caused by faulty wiring inadvertently turning on the door unlatch motor.

Introduction:

This Smith AAR has been created by an independent aircraft accident investigator who has no affiliation with the manufacturer, law enforcement agencies, attorney, airlines, or victim's families. Much of the text is quoted verbatim from official government documents. The primary documents are NTSB Aircraft Accident Report AAR 00/03 and the NTSB Public Docket SA-516.

This Smith AAR has the benefit of hindsight with the ability to review and analyze dozens of subsequent Boeing 747 accidents as well as evaluating previous accidents of other types. There also exists an early model Boeing 747, United Airlines Flight 811, that suffered an explosion of explosive decompression in a cargo compartment which left much evidence. This AAR shall compare the evidence of Trans World Airlines Flight 800 to that of the other other three explosive events to identify which of the three is most closely matched, the bomb explosion, the center fuel tank explosion, or the ruptured open cargo door explosive decompression explosion.

1. Factual Information

1.1 History of the Flight On July 17, 1996, about 2019, TWA flight 800 took off from John F. Kennedy International Airport (JFK), New York, New York, destined for Charles DeGaulle International Airport, Paris, France. The airplane climbed over the Atlantic Ocean without incident and leveled off at its assigned altitude of 13,000 feet about 2027. At 2030:18, in response to an air traffic control (ATC) instruction to climb to 15,000 feet, the flight crew increased the airplane is engine thrust. The airplane was ascending through 13,760 feet at 2031:12 when both the cockpit voice recorder (CVR) and the flight data recorder ceased recording without warning.

2. Premise Explanations for Trans World Airlines Flight 800

The NTSB report conclusion is interpreted to mean the center wing fuel tank spontaneously

exploded and blew Trans World Airlines Flight 800 out of the sky. That interpretation may not be correct as there are alternatives based on previous similar accidents such as United Airlines Flight 811. An alternative probable cause to Trans World Airlines Flight 800 must be considered if the alternative were:
1. Plausible.
2. Reasonable.
3. Well documented by official investigative reports.
4. Has close precedent.
5. Reveals current hazard.

There is one solid conclusion and four reasonable explanations for the probable cause for Trans World Airlines Flight 800 based upon subsequent similar fatal inflight accidents to early model Boeing 747s:

2.1. Explosion in flight in or near the forward cargo compartment leading to inflight breakup as an initial event and is a solid conclusion. The cause of that explosion is to be determined.

2.2. Missile strike. (Brought up by Trans World Airlines Flight 800.)

2.3. Center wing fuel tank explosion with undetermined ignition source. (Brought up by Trans World Airlines Flight 800.)

2.4. Shorted wiring/forward cargo door rupture/explosive decompression/inflight breakup. (Brought up by United Airlines Flight 811.)

2.5. Explosion in flight from a bomb in the forward cargo compartment. (Brought up by Air India Flight 182, Pan Am Flight 103, Trans World Airlines Flight 800, and United Airlines Flight 811.)

2.1 Premise: Explosion in flight in or near the forward cargo compartment leading to inflight breakup.

2.1.2 Discussion: The unanimous conclusion by authorities of a sudden inflight breakup implies an explosion of explosive decompression since the hull of Trans World Airlines Flight 800 was pressurized at approximately 3.5 pounds per square inch differential between inside and outside air at 13,700 feet above mean sea level. Explosive decompression is a symptom of a sudden hull breakup, not the cause. If the hull is not compromised by a break, hole, or tear in it, decompression does not occur. Any break of substantial size in that highly pressurized hull, for reasons such as a bomb explosion, a midair collision, or an inadvertently opened cargo door, would be sufficient to cause an explosive decompression and subsequent partial or full inflight breakup. Inflight breakups can be caused by an explosive decompression which can be caused by a 'bomb' explosion, or structural failure, or an inadvertent door opening. All bomb explosions, all structural failures, and all inadvertent door openings do not cause inflight breakups; in fact, many aircraft have suffered those events and landed safely. On the other hand, any one of those events has the potential to cause an inflight breakup and have done so in the past, depending on the sizes of the bomb, the skin tear, or the open door.

When a catastrophic event occurs, such as an explosion of a bomb or a large door opening in flight, much evidence is left behind for investigators to recover, examine, and evaluate specific to that cause. All explosions of any kind leave certain similar evidence regardless of the cause of the explosion. Evidence of an explosion does not imply a 'bomb' nor an explosive decompression

from any source. Even when there is a single piece of tangible evidence that indicates a specific type of explosion such as a bomb, structural failure, or an inadvertent door opening, other corroborative evidence is required to sustain the conclusion of the type of explosion since all types of explosions can cause similar evidence and explosive decompressions from any source can mimic a bomb explosion and vice versa.

The evidence which shows there was an explosion in or near the forward cargo compartment can be summed up by the following evidence.

A. Inflight breakup just forward of the wing causing damage to right wing leading edge and engines.
B. Debris pattern showing nose came off the aircraft in flight.
C. Suddenness of event.
D. Sudden loud sound on the CVR.
E. Abrupt power cut to the FDR.
F. First pieces to leave aircraft were from area just forward of the wing.
G. Trajectory pattern shows explosion in or near forward cargo compartment.
H. Outwardly peeled skin in forward cargo compartment area.

There is now revealed a new structural weakness in the forward cargo compartment for Boeing 747s and by implication all pressurized jets with large outward opening nonplug cargo doors.

For the Boeing 747: The four eight foot vertical slices in the fuselage skin for the sides of the forward and aft cargo doors are held in place by only one latch in each side. Each eight foot vertical slice has one midspan latch to hold four feet closed on each side of it. The midspan latch has no locking sector on the latching cam to prevent inadvertent back driving in flight. All of the eight bottom latches on each door, for a total of sixteen latches, have locking sectors. The four midspan latches for the two cargo doors have none. The weakness is at the midspan latches and the absence of locking sectors. One latch with no locking sector for eight feet of fuselage slice is not enough. The aft or forward or both midspan latches ruptures open in flight and causes the tell tale peeled back and down skin from the latch such as in Pan Am Flight 103, United Airlines Flight 811, and Trans World Airlines Flight 800 and apparently Air India Flight 182.

There are many ways for an explosion to occur in or near the forward cargo compartment at the forward cargo door: (Current official opinion in parentheses)

A. Bomb explosion. (Partially accepted for two flights, ruled out for two flights.)
B. Crew or passenger error. (Ruled out for all flights.)
C. Electrical fault in switch or wiring. (Accepted for two flights, ruled out for two flights.
D. Pneumatic overpressure. (Ruled out for all flights.)
E. Cargo shift. (Ruled out for all flights.)
F. Compressed air tank explosion. (Ruled out for all flights.)
G. Fire in compartment. (Ruled out for all flights.)
H. Missile strike. (Ruled out for all flights.)
I. Midair collision. (Ruled out for all flights.)
J. Fuel tank explosion. (Accepted for one flight, ruled out for three flights.)
K. Stowaway. (Ruled out for all flights.)
L. Electromagnetic interference. (Ruled out for all flights.)
M. Comet or meteor. (Ruled out for all flights.)
N. Space debris. (Ruled out for all flights.)
O. Turbulence. (Ruled out for all flights.)
P. Out of rig door. (Ruled out for all flights.)

Q. Lightning. (Ruled out for all flights.)
R. Metal fatigue. (Ruled out for all flights.)
S. Improperly latched. (Initially accepted for one flight, then ruled out for all flights.)
T. Design error. (Accepted for one flight, ruled out for three flights.)
U. Repair error. (Ruled out for all flights.)
V. Maintenance error. (Accepted for one flight, ruled out for three flights.)
W. Collision with terrain. (Ruled out for all flights.)

Of the twenty three ways to cause an explosive decompression in or near the forward cargo compartment in flight, only five are reasonable for Trans World Airlines Flight 800 based on precedent and other evidence.

1. Missile strike. (Brought up by Trans World Airlines Flight 800.)
2. Center fuel tank explosion with undetermined ignition source. (Brought up by Trans World Airlines Flight 800.)
3. Shorted wiring/forward cargo door rupture/explosive decompression/inflight breakup. (Brought up by United Airlines Flight 811.)
4. Bomb. (Brought up by Air India Flight 182 and Pan Am Flight 103 and Trans World Airlines Flight 800 and United Airlines Flight 811.)
5. Rather large shotgun. (Brought up by Pan Am Flight 103.)

2.1.3 Conclusion: There was an explosion in or near the forward cargo compartment which caused an explosive decompression that led the the inflight breakup of Trans World Airlines Flight 800.

2.2.1 Premise: Surface-to-air or air-to-air missile strike inflight:

2.2.2. Discussion: A missile could have struck the aircraft in flight. Only a hit in the forward cargo compartment would have caused the abrupt power cut to the recorders and the sudden loud sound in addition to all the other evidence of inflight damage to the airframe forward of the wing. There is no corroborative evidence that a missile struck Trans World Airlines Flight 800. There were no military planes nearby nor reports of missing missiles, there were no reports of missile sightings at event time, there is no wreckage evidence of residue, missile casing, pitting, or cratering which follows a high explosive detonation, and there was no missile explosion sound on the CVR.

> Page 257 to page 259 of NTSB AAR 00/03 for Trans World Airlines Flight 800: ‘2.2.1.2 Consideration of a High-Energy Explosive Device Detonation (Bomb or Missile Warhead) Several factors led to speculation that the accident might have been caused by a bomb or missile strike. These factors included heightened safety and security concerns because of the 1996 Olympics then being held in the United States, the fact that TWA flight 800 was an international flight, and the sudden and catastrophic nature of the in-flight breakup. In addition, numerous witnesses to the accident reported seeing a streak of light and then a fireball, which some people believed represented a missile destroying the airplane. Further, some anomalous primary radar targets were recorded by the Islip, New York, radar site in the general vicinity of TWA flight 800 at the time of the accident that apparently could not be explained. Accordingly, the Safety Board considered the possibility that a bomb exploded inside the airplane or that a missile warhead from a shoulder-launched missile exploded upon impact with the airplane. Testing performed by the Federal Bureau of Investigation (FBI) found trace amounts of explosives on three

separate pieces of airplane wreckage (described by the FBI as a piece of canvaslike material and two pieces of floor panel). However, none of the damage characteristics typically associated with a high-energy explosion of a bomb or missile warhead (such as severe pitting, cratering, petalling, or hot gas washing) were found on any portion of the recovered airplane structure, including the pieces on which the trace amounts of explosives were found. Only about 5 percent of the airplane's fuselage was not recovered, and none of the areas of missing fuselage were large enough to have encompassed all of the damage that would have been caused by the detonation of a bomb or missile. Although several large holes are visible in the reconstructed portion of the airplane fuselage, almost all of the structure that originally filled in these holes is attached to the remaining structure but is folded either inward or outward. No area of structure in the reconstructed portion of the airplane contained any unexplained holes large enough to represent the entry point of a missile. Further, the victims remains showed no evidence of injuries that could have been caused by high-energy explosives, nor was there any damage to the airplane seats and other interior components consistent with a high-energy explosion. Investigators considered several scenarios to determine how the trace amounts of explosive residue might have gotten on the wreckage from the accident airplane. Trace amounts of explosive residue could have been transferred to the contaminated pieces from the military personnel (and their associated clothing, boots, and equipment) that were on board the accident airplane when it was used to transport troops during the Gulf War in 1991. In addition, explosives were placed and then removed from several locations in the accident airplane during a dog-training explosive detection exercise about 1 month before the accident. Despite being unable to determine the exact source of the trace amounts of explosive residue found on the wreckage, the lack of any corroborating evidence associated with a high-energy explosion indicates that these trace amounts did not result from the detonation of a high-energy explosive device on TWA flight 800. Accordingly, the Safety Board concludes that the in-flight breakup of TWA flight 800 was not initiated by a bomb or a missile strike."

2.2.3 Conclusion: Based upon lack of corroborative evidence, a missile strike as a probable cause for Trans World Airlines Flight 800 may be ruled out.

2.3.1 Premise: CWT fire/explosion with undetermined ignition source as the initial event:

2.3.2 Discussion: The evidence shows that there was a fire and/or an explosion in the center wing fuel tank of Trans World Airlines Flight 800. However, the explosion of the CWT was not the initial event. The fire/explosion was a secondary symptom, not a probable cause of the eventual destruction.

NTSB documentation of CWT fire/explosion below:

Public Docket SA-516, Exhibit 20A
Fire and Explosion Group Factual Report

Details of the Investigation: Extensive fire damage is limited to a few specific areas of the airplane. Fire damage was found on components in the center wing tank; floor beams and some of the seats above and just aft of the center wing tank; part of the fuselage over the right wing; parts of the right wing including the wing front spar; and parts of the left wing just outboard of the number 1 engine. Sooting of the

fuselage aft of the front spar was generally limited to the external skin of the aircraft. However, there was heavy sooting on the aft (broken near the midspar) section of the keel beam. The forward section of the keel beam shows little sooting.

The wreckage showed evidence of an over-pressurization (explosion) in the center wing tank. Evidence of a center wing tank explosion occurring early in the accident sequence is supported by the combination of fire/sooting/structural deformation patterns along with location of parts found in the first debris field. These parts included center wing tank pieces, parts mounted underneath the center wing tank, and fuselage parts just forward of the front spar, all found along the first part of the debris path. Reconstruction of the recovered pieces of the center wing tank was initiated to provide a better picture of how the damage to the various pieces was interrelated. As additional pieces were recovered during the investigation, they were fitted into the reconstruction.

Various potential ignition sources have been considered for the center wing tank explosion. These include mechanical/electrical, a pre-existing fire below the CWT, a bomb, and a missile. Inspection of the lower surface of the CWT, the keel beam, and the air cycle machines has shown no evidence of a pre-existing fire below the CWT. No evidence of a bomb or a missile has been found on the hardware of the center wing tank or surrounding area. No ignition source has been confirmed by the Fire/Explosion Group. Ignition sources that are being explored include the electrical fuel gauging system, electrical power to the fuel pumps, static electric charge/discharge, and other systems.

Pieces of the tank that were found in the first debris field below the flight path of TWA 800 show little if any fire or soot damage. These include the majority of the parts from the front spar and spanwise beam #3, and the manufacturing access panel from spanwise beam #2. No other pieces of spanwise beam #2 were found in the first debris field. The majority of parts from the front spar and spanwise beam #3 are free of fire/sooting damage. Most pieces of spanwise beam #2 were extensively fire damaged, 1 BL 0 is Buttock line 0 which represents the centerline of the airplane running fore and aft with small areas of melted aluminum at various locations. However, the manufacturing access panel (CW703, Tag 490) in spanwise beam #2 was found in the first debris filed and is almost free of any fire damage or sooting.

Large pieces of the fuselage immediately forward of the front spar are also free of fire/sooting and were found in the first debris field. Main cabin floor beams and flooring material (composite fiberglass) were also found in the first debris field and are free of fire/soot damage. The two air cycle machines (ACM) located under the forward part of the center wing tank to the right and left of the keel beam were recovered from the first debris field. These ACMs did not show any heat damage, and the turbine sections were intact.

The two most forward large pieces of upper skin of the center wing tank are free of fire damage (see diagram 1 and 2). The upper surface of these two pieces is clean of sooting. The lower surface is moderately sooted forward of spanwise beam #3 and outboard of RBL 75. These pieces are fractured at approximately spanwise beam #2. The large upper right skin piece is extensively bowed upward to the right of center. The left piece is also deformed. The upper skin pieces on the right side,

immediately aft of the forward piece, are heavily sooted including the fracture surfaces. The sooting patterns on the upper and lower skin pieces of the center wing tank are shown in diagrams 1 through 4. A large piece of the right fuselage with attached upper tank skin and upper surface of the right wing is heavily sooted. The fuselage section of this piece exhibits evidence of melting aluminum and broomstrawing.

A large center piece of the rear spar is heat damaged and sooted heavily. The sooting is on the outside and inside surfaces of this center piece. The pieces of the rear spar on both sides of this center piece are only lightly sooted.

The keel beam was broken between the midspar and spanwise beam number 1. The forward piece is relatively clean with some sooting just forward of the trim air tube that passes through the keel beam at approximately station 1125. The fracture surfaces on this section of the keel beam are free of soot. The aft section of the keel beam is heavily sooted including the fracture surfaces.

No seats forward of the center wing tank (forward of front spar) showed fire damage. Some fire damage was noted on seats aft of the rear spar. No passengers showed inhalation fire damage or serious external burns.

Based on the fire damage and soot deposits, a fire occurred after the explosion in this tank. An ignition source for this explosion, has not as yet been identified. No evidence of electrical arcing or other mechanical failure signature has been noted on the hardware."

Public Docket SA-516, Exhibit 8A, Powerplants, Page 11, paragraph 3, discussing results of engine 3 disassembly, "Of the 46 fan blades in the fan rotor, 21 blades with complete or partial airfoils and 6 root sections were recovered. All of the fan blades had sooting on the convex airfoil surfaces. Most of the full length airfoils were bent rearward and the tips outboard of the outer midspan shroud were bent forward slightly. About half of the fan blades had impact damage to the leading and trailing edges. Almost all of the impact damage to the airfoils could be matched to contact with the midspan shroud on an adjacent blade. One full length blade had four soft body impacts along the leading edge and a partial airfoil had a soft body impact, which had some streaking extending rearward."

Public Docket Number SA-516, Exhibit No. 22A, Trajectory Study, page 3: The wreckage distribution shows that parts were initially shed from the area just forward of the wing. This was followed by the separation of the forward fuselage. This study concentrated on items in the red field, the first ground search area along the flight path. This corresponded to items shed between the initial event and the separation of the forward fuselage.

As will be seen, the trajectory study shows that the red zone pieces departed the aircraft in the first few seconds after the initial event.

Using the last FDR speed and pitch angle, it is possible to roughly calculate the time from the initial event to the nose separation. However, because of the large uncertainty, this time ranges from 3.9 seconds to 7.5 seconds.

From Public Docket SA-516, Exhibit 7A Structures
Fuselage The fuselage of the airplane was severely fragmented and recovered predominantly from the three debris fields. (Some parts were recovered outside these established debris fields during the trawling operation.) The Red debris field contained fuselage pieces from an area just forward of the center wing tank. Generally, these pieces were from the circumference of the fuselage between fuselage station (STA) 840 and 1000; all of the pieces in this area of the fuselage have not been accounted for. The Yellow debris field contained fuselage sections generally forward of STA 840. The Green debris field contained fuselage sections generally aft of STA 1000.

Below pictures are from NTSB Exhibit 17 D of Public Docket SA 516 and show the left front and the right front of the plane.

The left front of the reconstruction at LF4

Nose to left.

Right front of the plane

Nose to right.

NTSB / AFP

Right front and middle of Trans World Airlines Flight 800 revealing sharp sooted and non sooted cut in fuselage, nose to right.

Analysis of the above NTSB documentation:

A CWT fire/explosion needs three things to occur, fuel, air, and ignition source. Without any one

of those three, there can be no conclusion as to when or where the event occurred. As a secondary event after the forward cargo door ruptured open an ignition source for the fire was present. As an initial event of CWT fire/explosion the ignition source for the fire was absent and undetermined even after an extensive search.

A CWT fire/explosion would give sooting on the entire tank, seats above it, burns on passengers, and soot on the pieces of wreckage which left the aircraft first. That was not so. A CWT fire/explosion after the forward section of the aircraft had broken away would give no sooting on the departed section and leave soot on the remaining sections. That was so.

A CWT fire/explosion as the initial event would not give the clean cut of sooted outside fuselage skin and the sooted section as can be seen by the photographs of the wreckage reconstruction.

A CWT fire/explosion would be spherical, not directed, and would produce equal damage on both sides of the fuselage of TWA 800. However, the wreckage reconstruction shows smooth skin with little damage forward of the wing on the port/left side yet severe, shattered, torn, and frayed damage on the starboard/right side of the fuselage in the cargo door area. A CWT fire/explosion would not cause unilateral damage on starboard side only, as can be seen.

A CWT fire/explosion would give equal damage to engines number two and three; however, only engine number three revealed any unusual inflight damage of missing turbine blades, sooting, and soft body impacts.

A CWT fire/explosion as the initial event would cause the first pieces to depart the aircraft to come from aft of the leading edge of the wing; however, the first pieces to depart were forward of the wing.

The sudden loud sound on Cockpit Voice Recorder is described as the initial event and start of aircraft breakup but is not the sound of a fuel tank explosion which, if it were the initial event, would be heard on the recorder. The sudden sound on the CVR does not match another staged Boeing 747 center fuel tank explosion. An explosion in the center tank powerful enough to start the aircraft breakup by blowing off the nose of a Boeing 747 would be heard first on the CVR and was not. The sound of the subsequent secondary explosion in the CWT was not heard because the power had previously been cut to the recorders after the sudden loud sound on the CVR.

A CWT fire/explosion would be far enough away from power cables on top of the fuselage and recorders in the aft end to allow the Flight Data Recorder to record slightly longer than the abrupt power cut it suffered. A CWT fire/explosion which was not loud enough to be heard on the CVR and some distance away would not be powerful enough to abruptly cease power to the FDR and CVR which is what occurred.

The timing of the CWT fireball as seen by other nearby aircraft is at least twelve seconds after the initial event of the sudden loud sound where the nose separated approximately four seconds after the sudden loud sound.

The corroborative evidence required to be present for the CWT fire/explosion to be the initial event would be equal sooting around the explosion area, fireball seen at the initial event time, the sudden loud sound to be matched to the staged fuel tank explosion, burns on passengers above the tank, bilateral damage on the sides of the fuselage, bilateral damage to engines two and three, an ignition source determined, and first pieces to depart the aircraft to be from the center fuel tank. That evidence was not present and thus the CWT fire/explosion as the initial event may be ruled out.

The CWT fire/explosion as a secondary event:

A CWT fire/explosion needs three things to occur, fuel, air, and ignition source. Without any one of those three, there can be no conclusion as to when or where the event occurred. As a secondary event an ignition source was present as an on fire engine number three. As an initial event the ignition source was absent.

The evidence of a secondary event would be sooted turbine blades in engine number three, a clean cut separating the forward section of the fuselage from the middle, no soot on the forward broken part of the CWT and other parts forward of the clean cut, and soot on the remaining sections. That corroborative evidence was present.

After the forward part of the fuselage separated approximately several seconds after the initial event of the sudden loud sound, the rest of the aircraft would start to disintegrate from the wind forces on the now compromised structural integrity of the fuselage. As the fuselage and wings with broken fuel tanks fell, fuel vapor would be in a cloud around the debris. Engine number three would be spewing fire from its exhaust because of the foreign objects ingested into it which would ignite the fuel vapor cloud thousands of feet and seconds later than the initial event.

The corroborative evidence required to be present for the CWT fire/explosion to be the secondary event would be a clean cut of a sooted and a not sooted area at the separation point of the forward section of the fuselage, non burned passengers, the sudden loud sound at initial event time to be some other source than a fuel/air explosion, an ignition source determined, unilateral damage to engine number three, unilateral damage to the starboard side of the fuselage, and the first pieces to depart the aircraft were from just forward of the wing. That evidence was present.

2.3.3 Conclusions:

A. The corroborative evidence required for the CWT fire/explosion with undetermined ignition source to be the initial event is lacking and therefore may be ruled out.

B. The corroborative evidence required for the CWT fire/explosion to be the secondary event is present and therefore may be ruled in.

2.4.1 Premise: Explosion in the forward cargo compartment on the starboard side caused by explosive decompression caused by structural failure of a ruptured open forward cargo door at one or both of the midspan latches caused by faulty electrical wiring or switch shorting on the door unlatch motor.

2.4.2. Discussion:

A. The wiring/cargo door explanation is plausible as a sequence of events from wiring short to airframe breakup as it all could happen according to physical laws of nature.

B. Its reasonable because of the explosive effects of an unintentional hull rupture in a pressurized jet as learned from the Comet and DC-10 experiences.

C. Its well documented by the Kirpal Report, the Canadian Aviation Safety Board AAR, Three NTSB AARs (90/01 and 92/02, and 00/03), AAIB Aircraft Accident Report No 2/90 (EW/C1094), and aviation safety public docket information.

D. It has close precedent because of United Airlines Flight 811 (NTSB AAR 92/02).

E. It reveals a current hazard of aging defective wiring in early Boeing 747s of which about 500 are still in service and it reveals a poorly designed outward opening nonplug cargo door.

The corroborative evidence is literally in volumes: NTSB AAR 90/01 and NTSB AAR 92/02 for United Airlines Flight 811 and AAIB 2/90 for Pan Am Flight 103.

Below are specific matches between Trans World Airlines Flight 800 and UAL 811 gleaned from those government AARs. Both were:
aged
high flight time
poly x wired
early model Boeing 747
and shortly after takeoff
experienced hull rupture forward of the wing
foreign object damage to starboard engine number 3
fire in number three engine
more severe inflight damage on starboard side,
at least nine never recovered bodies,
torn off skin in forward cargo door area on starboard side,
post side smooth forward of the wing.
rupture at forward cargo door at aft midspan latch,
outward peeled skin on upper forward fuselage,
downward bent floor beams in cargo door area,
bare wire found in cargo door area.
vertical fuselage tear lines forward of the wing
parts initially shed from just forward of the wing
first pieces of structure to leave aircraft in flight from forward cargo bay
forward cargo door frayed
hoop stress found in cargo door area
door skin shattered outward.
sudden sound on CVR
loud sound on the CVR
short duration sound on the CVR
abrupt data loss to FDR
inadvertent opening of forward cargo door in flight considered initially thought to be a bomb
but later ruled out.

Below Sole NTSB documentation for consideration of the shorted wiring/forward cargo door rupture/explosive decompression/inflight breakup explanation for Trans World Airlines Flight 800:

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594

April 22, 1997

METALLURGIST'S FACTUAL REPORT Report No. 97-82

A. ACCIDENT

Place : East Moriches, New York
Date : July 17, 1996
Vehicle : Boeing 747-100
NTSB No. : DCA96-M-A070
Investigator : Al Dickinson, AS-10

B. COMPONENTS EXAMINED

Section 41 / Section 42 joint, Lower Lobe Forward Cargo Door

C. DETAILS OF THE EXAMINATION

The joint between manufactured sections 41 and 42 is located at station (STA) 520. The fuselage skin at this location is butted together with a strap on the inside of the skin. Stringers (S) aft of STA 520 (section 42) have a "hat" cross section, while stringers forward of STA 50 (section 41) have a "Z" shape. The stringers across STA 520 are connected with splices. The frame at STA 520 is added in sections and is larger than the typical nearby frames. The forward edge of the lower lobe forward cargo door is located several feet aft of STA 520 on the lower right side of the fuselage. The STA 520 joint and cargo door were examined on the reconstructed airplane.

The joint at STA 520 was not separated across the top of the airplane (between S-2AL and S5R), along portions of the right side (between S-19R and S-28R and between S-40R and S-45R), and along portions of the left side (between S-18L and S-39L and between S44L and S-47L). The portions of the STA 520 joint that were separated were examined for evidence of preexisting fatigue or other preexisting damage. All fractures were typical of overstress separations, and no evidence of fatigue, fretting, or significant corrosion was noted.

Examination of the lower lobe forward cargo door showed that all eight of the door latching cams remain attached (along with pieces of the door itself) to the pins along the lower door sill.

Overall examination of the forward portion of the airplane showed that sections 41 and 42 contained uniform crushing damage that extended from S-39L across the bottom of the fuselage and up above the right side main cabin window belt to S-14R. This crushing damage is consistent with the intact forward portion of the airplane (including sections 41 and 42) impacting the water with a right wing low attitude. The lower lobe forward cargo door was in the crush area.

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National Resource Specialist - Metallurgy

From NTSB AAR 00/03:
2.2.1.1 Consideration of a Structural Failure and Decompression Close examination of the wreckage revealed no evidence of preexisting airplane structural faults (such as fatigue, corrosion, or mechanical damage) that could have contributed to the in-flight breakup. The examination revealed that the structure did have minimal preexisting corrosion damage, none of which could have led to or affected the breakup of the airplane. Small fatigue cracks were found in some parts of the airplane, including in the lower chord of the front spar and in the shear ties for the floor beams and stiffeners at the front spar; however, none of these cracks had coalesced into a propagating crack that could have led to the in-flight breakup. Further, although the joint between fuselage sections 41 and 42 on some 747s purportedly had been subject to manufacturing assembly problems, there was no evidence that it had separated in any locations before impact.

It was also suggested that the breakup could have been initiated by the in-flight separation of the forward cargo door. However, all eight of the latching cams along the bottom of the door (and some pieces of the cargo door itself) remained attached to the pins along the lower door sill, and there were no indications of preimpact failure of the hinge at the top of the door. This evidence indicates that the door was closed and locked at impact. Further, deformation and fracture patterns on the door matched damage to the adjacent fuselage structure, confirming that the door was in the closed position at the time of impact. Therefore, the Safety Board concludes that the in-flight breakup of TWA flight 800 was not initiated by a preexisting condition resulting in a structural failure and decompression.

1. Docket No. SA-516, Exhibit No. 18A, Sequencing Study, page 20, "Downward separation directions were noted at STA 900, 880, 840, 820, 800, and 780..." and ""The initial opening of the fuselage lower lobe (e.g. LF6A) would have the expected result of rapid depressurization accompanied by collapse of the main deck floor for some distance forward of STA 1000. The red area recovery of interior components as far forward as STA 600 would not be inconsistent with this floor collapse and associated structural breakup."
2. Docket No. SA-516, Exhibit No. 7A, Structures Group Chairman's Factual Report of Investigation, page 11 which discusses direct circumferential tension or hoop stress tension found on lower right side skin in the red zone only.
3. Docket Number SA-516, Exhibit No. 15C, Report Number 97-82, Section

> 41/42 Joint, Forward Cargo Door, "Examination of the lower lobe forward cargo door showed that all eight of the door latching cams remain attached (along with pieces of the door itself) to the pins along the lower door sill."
>
> From NTSB AAR 00/03:
>
> 1.16.4.4 Metallurgical Examination of the Forward Cargo Door The Safety Board also considered the possibility that the forward cargo door (the forward edge of which is located several feet aft of STA 520 on the lower right side of the fuselage) separated from the accident airplane in flight and that this separation initiated the breakup sequence. The Board examined the pieces of the forward cargo door, which were recovered from the yellow zone. All eight of the latching cams at the bottom of the door were recovered attached to pieces of the lower end of the door and were in the latched position. Additionally, the latching cams and pieces of the cargo door remained attached to the pins along the lower door sill. The hinge at the top of the door was broken into several pieces, but the hinge pin still held the various pieces of the hinge together. There was no evidence to suggest that this hinge separated. The forward cargo door exhibited severe crushing deformation and fragmentation, very similar to damage observed on the adjacent fuselage structure. “

Analysis of above NTSB documentation:

(The photographs and analysis which matches up the forward cargo door areas of Pan Am Flight 103, United Airlines Flight 811, Trans World Airlines Flight 800, and a drawing of Air India Flight 182 are shown in Part III: Door Story, of this Smith AAR for Trans World Airlines Flight 800.)

A detailed examination of a possibly defective forward cargo door was done in the second AAR for United Airlines Flight 811 (NTSB 92/02). It includes close examination of the latch pins for bluing from overpressure, the hinges for overtravel, the torque tubes for bending, the bellcranks for slack, the overpressure relief doors for operation, the manual locking handle for status, the locking sectors for damage, and other evaluations. There is little discussion of the forward cargo door in NTSB 00/03. The forward cargo door area does need the depth of examination that was conducted for United Airlines Flight 811 and described in Part II of this Smith AAR.

The cargo doors on Boeing 747s have been the subject of many Airworthiness Directives over the years to correct problems such as bent sills, exposed wiring, too soft metal, and poorly placed safety placards There are many Service Difficulty Reports of leaking seals requiring emergency landings. Cargo doors on Boeing 747s are extremely complex devices, proven capable of explosive action, poorly designed, and prone to failure. They have failed in flight before in addition to the fatal event of United Airlines Flight 811.

> From NTSB 92/02: Previous Cargo Door Incident On March 10, 1987, a Pan American Airways B-747-122, N740PA, operating as flight 125 from London to New York, experienced an incident involving the forward cargo door. According to Pan Am and Boeing officials who investigated this incident, the flightcrew experienced pressurization problems as the airplane was climbing through about 20,000 feet. The crew began a descent and the pressurization problem ceased about 15,000 feet. The crew began to climb again, but about 20,000 feet, the cabin altitude began to rise rapidly again. The flight returned to London. When the

> airplane was examined on the ground, the forward cargo door was found open about 1 1/2 inches along the bottom with the latch cams unlatched and the master latch lock handle closed. The cockpit cargo door warning light was off. (Note that Pan Am Flight 125 was the same airline as Pan Am Flight 103 and the aircraft, N740PA, is the sister ship of N739PA- PA 103. Author)

TWA 800 wreckage reconstruction shows red paints smears only above the forward cargo door area and nowhere else on both side of the Boeing 747 fuselage. After the rupture at the aft midspan latch, the door fractured and upper piece of the red painted door was pushed outward, rotated on its hinge, slammed upward and smashed into the white painted fuselage skin above, transferring red paint to the white painted area between the passengers windows, as shown by the TWA 800 reconstruction.

The explosive decompression in the cargo compartment would severely disrupt the cargo hold floor and the adjacent main equipment compartment in which the power cables are located. The severe disruption would abruptly cease power to the FDR and CVR.

The rupture of the forward cargo door area when the aft midspan latch ruptured and subsequent explosive decompression would give the shattered, torn and frayed damage to the starboard cargo door area while leaving the port/left/opposite side smooth and light damage. The forward cargo door rupture would give the unilateral damage on starboard side as shown by TWA 800 wreckage and also give the sole foreign object damage to the adjacent engine number three.

The sudden loud sound is the sound of explosive decompression which gives a sudden loud sound when forward cargo door ruptures/opens in flight. The TWA 800 sudden loud sound was linked to PA 103 sudden loud sound on CVR which was linked to AI 182 sudden loud sound on CVR which was linked to confirmed DC-10 cargo door explosive decompression on CVR. UAL 811 had a cargo door rupture/open in flight and recorded a sudden loud sound on the CVR. The sound is the sudden rushing of air molecules which were compressed now moving fast outward to equalize with the lower pressure outside air.

The cargo door theory explains the steak because the initial event happened when the plane was in the correct sun angle and time of day for the fuselage to reflect sun to observers on the ground. At any other 23 hours and 30 minutes of the day, the streak would not have been seen. But, at 8:31 PM on July 17th near NYC the sun angle was correct for the departing metal door to reflect evening orange sunlight to ground observers to the west as the shiny metal pieces spun away.

The cargo door theory may explain the mysterious radar blip near the initial event time because the spinning metal cargo door with fuselage skin attached would reflect primary radar at that distance, just like it did with the DC-10 cargo door and the UAL 811 cargo door departures.

2.4.3 Conclusions: Based upon an abundance of corroborative evidence, (Detailed in Part II: Comparison) an electrical problem of wiring or switch causing a hull rupture in flight at the midspan latches of the forward cargo door as a probable cause for Trans World Airlines Flight 800 may be ruled in.

2.5.1. Premise: Explosion of a improvised explosive device in the forward cargo compartment.

2.5.2 Discussion: The evaluation which refutes an explosion of a bomb in the forward cargo compartment can be summed up by the following evidence.

If a powerful bomb were to explode in the forward cargo hold of Trans World Airlines Flight 800, certain corroborating evidence would be present such as hot-gas pitting on pieces of metal, punctures, shrapnel, explosive residue, pitting, cratering, explosive type injuries to passengers sitting in the cabin, timer, fuze, and a bomb explosion sound on the cockpit voice recorder.

For Trans World Airlines Flight 800:

A. Pitting: Absent
B. Cratering: Absent
C. Hot gas washing: Absent
D. Holes: Absent
E. Punctures: Absent
F. Shrapnel: Absent
G. Explosive residue: Found.
H. Burn injuries to passengers sitting in the cabin: Absent
I. Sooted metal: Present
J . Timer or bomb casing: Absent
K. Fuze: Absent
L. Bomb explosion sound on the cockpit voice recorder: Absent

Bombs have been considered for Air India Flight 182 and Trans World Airlines Flight 800 as well as Pan Am Flight 103 and thus extensively investigated. The same reasons for ruling out a bomb for Trans World Airlines Flight 800 are the same reasons to rule it out for Air India Flight 182 and Pan Am Flight 103.

> The NTSB states in AAR 00/03 regarding Trans World Airlines Flight 800: Page 180, footnote 368: ‘Evidence of a bomb explosion included deformation of materials away from a location at the height of the passenger seat pan, hot-gas pitting damage on multiple pieces of wreckage that formed a pattern radiating from the same location (including into the CWT), punctures radiating from the same location, and shrapnel. Further, according to the FBI's laboratory report, No. 91204034 S YQ YB/91207052 S YQ YB, dated January 30, 1990, chemical analysis of a piece of wreckage from the right side of the CWT identified the presence of RDX and PETN high explosive. These two explosives comprise about 86 percent of the composition of SEMTEX, which is a rubberlike material manufactured by Synthesia Corporation of Semtin, Czechoslovakia, primarily for use in mining and other civil engineering activities. According to the FBI, SEMTEX has been used by criminal and terrorist elements in Europe since 1966. (SEMTEX was identified as the material used in the bomb placed on Pan Am flight 103. For additional information, see section 1.11.1.2.)’
>
> Page 257 to page 259 of NTSB AAR 00/03 for Trans World Airlines Flight 800 ‘2.2.1.2 Consideration of a High-Energy Explosive Device Detonation (Bomb or Missile Warhead) Several factors led to speculation that the accident might have been caused by a bomb or missile strike. These factors included heightened safety and security concerns because of the 1996 Olympics then being held in the United States, the fact that TWA flight 800 was an international flight, and the sudden and catastrophic nature of the in-flight breakup. In addition, numerous witnesses to the accident reported seeing a streak of light and then a fireball, which some people believed represented a missile destroying the airplane. Further, some anomalous primary radar targets were recorded by the Islip, New York, radar site in the

> general vicinity of TWA flight 800 at the time of the accident that apparently could not be explained. Accordingly, the Safety Board considered the possibility that a bomb exploded inside the airplane or that a missile warhead from a shoulder-launched missile exploded upon impact with the airplane. Testing performed by the Federal Bureau of Investigation (FBI) found trace amounts of explosives on three separate pieces of airplane wreckage (described by the FBI as a piece of canvaslike material and two pieces of floor panel). However, none of the damage characteristics typically associated with a high-energy explosion of a bomb or missile warhead (such as severe pitting, cratering, petalling, or hot gas washing) were found on any portion of the recovered airplane structure, including the pieces on which the trace amounts of explosives were found. Only about 5 percent of the airplane's fuselage was not recovered, and none of the areas of missing fuselage were large enough to have encompassed all of the damage that would have been caused by the detonation of a bomb or missile. Although several large holes are visible in the reconstructed portion of the airplane fuselage, almost all of the structure that originally filled in these holes is attached to the remaining structure but is folded either inward or outward. No area of structure in the reconstructed portion of the airplane contained any unexplained holes large enough to represent the entry point of a missile. Further, the victims remains showed no evidence of injuries that could have been caused by high-energy explosives, nor was there any damage to the airplane seats and other interior components consistent with a high-energy explosion. Investigators considered several scenarios to determine how the trace amounts of explosive residue might have gotten on the wreckage from the accident airplane. Trace amounts of explosive residue could have been transferred to the contaminated pieces from the military personnel (and their associated clothing, boots, and equipment) that were on board the accident airplane when it was used to transport troops during the Gulf War in 1991. In addition, explosives were placed and then removed from several locations in the accident airplane during a dog-training explosive detection exercise about 1 month before the accident. Despite being unable to determine the exact source of the trace amounts of explosive residue found on the wreckage, the lack of any corroborating evidence associated with a high-energy explosion indicates that these trace amounts did not result from the detonation of a high-energy explosive device on TWA flight 800. Accordingly, the Safety Board concludes that the in-flight breakup of TWA flight 800 was not initiated by a bomb or a missile strike."

The initial event time was officially determined to be the sudden loud sound on the CVR. The initial event of the sudden loud sound is likely the explosive decompression sound when the rupture/structural failure occurred and the air molecules rushed out making the sudden loud sound on the CVR. Pan Am Flight 103 has been matched to Air India Flight 182 in the AAIB report. This initial event sudden sound on the CVR for Air India Flight 182 has been matched to a DC-10 explosive decompression sound when its cargo door opened in flight. All four Boeing 747 sudden sound events have been matched by NTSB in Chart 12 of the public docket for Trans World Airlines Flight 800 (Chart 12 on cover sheet of Part II). The accidents are all linked together by the sudden loud sound on the CVR which is the primary, not the secondary event, of the structural failure when the door ruptured open and explosive decompression ensued. (Detailed in Part II: Comparisons.)

2.5.3 Conclusion: Based upon a very small amount or a benign finding of corroborative evidence, an explosion of a powerful explosion from a bomb as a probable cause for Trans World Airlines Flight 800 may be ruled out.

2.6. Summary: To summarize conclusions about Trans World Airlines Flight 800:

A. No bomb explosion.

B. No missile strike.

C. Center wing tank explosion was not the initial event but a secondary event.

D. Initial event was faulty wiring shorting on the forward cargo door unlatch motor causing ruptures at the midspan latches and subsequent explosive decompression.

3. Sequence of disintegration for TWA Flight 800

Hot humid air in forward cargo compartment was subjected to cold conditioned air after takeoff from hot summer evening near New York on July 17, 1996. Condensation was precipitated out and formed on cold metal fuselage skin. Poly-X wire bundle which held cargo door motor on power was chafed by the friction of continuous vibration against clamp or many door openings and closings on it. Sheath around bundle was worn through to insulation and then worn through to bare wire. Condensed water met the bare wire and shorted against fuselage metal charring wires and powering on door motor which attempted to turn all ten cam sectors to unlocked position. At 13700 feet MSL and 300 KCAS, the eight lower cam sectors were prevented from unlocking because of strengthened locking sectors. However, the two midspan latches have no locking sectors at all. The slack in bellcranks, torque tubes, and high time worn cam latches allowed the aft midspan latch to rotate just past center allowing the 3.5 PSI internal pressure to rupture outward the forward cargo door at the aft midspan latch.

The nine foot by nine foot squarish door burst open at midspan latch sending the latch and door material spinning away in the setting sun which reflected upon the shiny metal as it spun away erratically and appeared as red-orange streak to ground observers moving all which ways. The aft door frame was clean of attachment to door and bulged outward. Fuselage skin was torn vertically. The door fractured and shattered. The bottom eight latches held tight to the bottom eight latch pins on bottom sill while bottom external skin of door blew away. The top piece of red topped cargo door opened out and up smashing into the white fuselage skin above it leaving the red paint of the door on the white paint between passenger windows above. The red paint of the trim was rubbed away showing the white paint underneath The top piece of the door took the hinge with it and fuselage skin as it is tore away. The loose red painted trim piece and top of door flew directly aft and impacted the right horizontal stabilizer leaving a red paint transfer mark on it. The hinge still appears to be working normally likely having overtravel impression marks on the opposite hinge when door overextended to slam on fuselage above. The top piece of the door shows inward damage when it hit fuselage above.

The explosive decompression of the thirty eight thousand pounds of internal force on the door blew out a large hole about twenty feet wide and forty feet high on the right side of the nose forward of the wing. Parts of the cargo hold structure were the first parts to leave the aircraft. The now uncompressed air molecules rushed out of the huge hole equalizing high pressure inside to low pressure outside while making a very loud noise. Fuselage skin was peeled outward at various places on the right side of the nose. The sudden rushing air was recorded on the Cockpit Voice Recorder as a sudden loud sound. The explosive decompression of the forward cargo hold severely disrupted the nearby main equipment compartment which housed power cables and abruptly shut off power to the Flight Data Recorder.

At least nine passenger's bodies were never found, only bone fragments. The number three engine also ingested metal in baggage and started on fire from inefficient burning of fuel. The number three engine with pylon started to vibrate and a stator blade from the engine was spit out and

impacted directly behind it in the right horizontal stabilizer.

The floor beams above the cargo hold were bent downward, fractured and broken from the sudden decompression. The main structural members of door and frame were gone and compromised. The flight attitude of the aircraft was askew to the left from reaction of explosive decompression to the right. Air rushed into the hole and weakened other skin and frame peeling skin outward. The 300 knots of air pressed upon the weakened nose and crumpled it into the large hole. The nose tore off and landed in a dense debris heap apart from the rest of the plane.

The port side forward of the wing was smooth and unshattered while the starboard side forward of the wing was shattered, torn, and frayed at ruptured cargo door area and severely disturbed over twenty feet by forty foot explosive decompression zone. Outward petal shaped fuselage skin appeared at aft midspan latch from rupture. Aft midspan latch was blown away. Outward peeled skin appeared from blowout. Fuselage skin remained smooth next to blown out skin.

The rest of the plane without the nose suddenly decelerated from 300 knots and caused whiplash injuries to passengers. Passengers inside fuselage had baro-trauma to eardrums which ruptured trying to equalize middle ear pressure. The plane maneuvered with huge gaping wound in front increasing drag. The wind force disintegrated the fuselage and wings. Fuel poured out of ruptured tanks as wreckage fell. The broken fuselage, the ruptured wings, the fuel cloud, the center tank, and the spinning, on fire engine number three met at 7500 feet and exploded into a bright loud fireball putting singe marks on the fuselage skin while leaving earlier departed nose burn and singe mark free. The center tank exploded as well as other nearby fuel tanks. Forward passengers were not burned because they were in the earlier separated nose.The debris fell and spread out from 7500 feet to sea level in windblown southeast directly, leaving a wide debris field.

Ground observers heard the fireball explosion of the center tank and other fuel and looked up. They saw fire and smoke and falling debris.

Explosive decompression at the forward cargo hold led to suspicion of bomb in cargo compartment but bomb later ruled out. Debris ejected to the right from explosive decompression led to suspicion of missile exploding on left side of nose. Streak of shiny metal object spinning away reflecting evening sun to ground observers led to suspicion of missile exhaust but later ruled out.

Fire/explosion of center tank into fireball led to suspicion of center tank explosion as initial event. There were difficulties in determining ignition source, fuel volatility, unheard fuel explosion sound on CVR, unilateral fuselage damage, singe marks, and other evidence needed to corroborate center tank explosion as initial explosion.

Fuselage rupture at aft midspan latch of forward cargo door inflight is initially rejected because bottom eight latches are found latched around locking pins while two midspan latches are unexamined and status unreported.

4 . Hindsight Pattern. A pattern has been revealed which includes Pan Am Flight 103.

Significant Direct and Tangible Evidence Obtained for Four B747 Breakups in Flight

	AI 182	PA103	UAL 811	TWA 800
Boeing 747	Yes	Yes	Yes	Yes
Early model -100 or -200	Yes	Yes	Yes	Yes
Pressure Relief doors open or jammed	Maybe	Yes	Yes	Yes
Sudden airframe breakup in flight (partial or total)	Yes	Yes	Yes	Yes
Breakup occurs amidships	Yes	Yes	Yes	Yes
High flight time (over 55,000 flight hours)	No	Yes	Yes	Yes

Aged airframe (over 18 years of service)	No	Yes	Yes	Yes
Previous maintenance problems with forward cargo door	Yes	Maybe	Yes	Maybe
Initial event within an hour after takeoff	No	Yes	Yes	Yes
Initial event at about 300 knots				
while proceeding normally in all parameters	Yes	Yes	Yes	Yes
Initial event has unusual radar contacts	Maybe	Yes	Yes	Yes
Initial event involves hull rupture in or near forward cargo door area	Yes	Yes	Yes	Yes
Initial event starts with sudden sound	Yes	Yes	Yes	Yes
Initial event sound is loud	Yes	Yes	Yes	Yes
Initial event sound is audible to humans	Yes	Yes	Yes	Yes
Initial event followed immediately by abrupt power cut to data recorders	Yes	Yes	Yes	Yes
Initial event sound matched to explosion of bomb sound	No	No	No	No
Initial event sound matched to explosive decompression sound				
in wide body airliner	Yes	Yes	Yes	Yes
Torn off skin on fuselage above forward cargo door area	Yes	Yes	Yes	Yes
Unusual paint smears on and above forward cargo door	Maybe	Maybe	Yes	Yes
Evidence of explosion in forward cargo compartment	Yes	Yes	Yes	Yes
Foreign object damage to engine or cowling of engine number three	Yes	Yes	Yes	Yes
Fire/soot in engine number three	Maybe	Yes	Yes	Yes
Foreign object damage to engine or cowling of engine number four	Yes	Yes	Yes	Yes
Right wing leading edge damaged in flight	Yes	Maybe	Yes	Maybe
Vertical stabilizer damaged in flight	Yes	Yes	Yes	Maybe
Right horizontal stabilizer damaged in flight	Yes	Yes	Yes	Yes
More severe inflight damage on starboard side than port side	Yes	Yes	Yes	Yes
Port side relatively undamaged by inflight debris	Yes	Yes	Yes	Yes
Vertical fuselage tear lines just aft or forward of the forward cargo door	Yes	Yes	Yes	Yes
Fracture/tear/rupture at a midspan latch of forward cargo door	Maybe	Yes	Yes	Yes
Midspan latching status of forward cargo door reported as latched	No	No	No	No
Airworthiness Directive 88-12-04 implemented (stronger lock sectors)	No	No	No	Yes
Outwardly peeled skin on upper forward fuselage	Yes	Yes	Yes	Yes
Rectangular shape of shattered area around forward cargo door	Yes	Yes	Yes	Yes
Forward cargo door fractured in two longitudinally	Yes	Yes	Yes	Maybe
Status of aft cargo door as intact and latched	Yes	Yes	Yes	Maybe
Passengers suffered decompression type injuries	Yes	Yes	Yes	Yes
At least nine missing and never recovered passenger bodies	Yes	Yes	Yes	Yes
Wreckage debris field in two main areas,				
forward and aft sections of aircraft	Yes	Yes	No	Yes
Initial official opinion of probable cause as bomb explosion.	Yes	Yes	Yes	Yes
Initial official opinion modified from bomb explosion	Yes	Yes	Yes	Yes
Structural failure considered for probable cause	Yes	Yes	Yes	Yes
Inadvertently opened forward cargo door considered for probable cause	Yes	No	Yes	Yes
Official probable cause as bomb explosion	Yes	Yes	No	No
Official probable cause as 'improvised explosive device'	No	Yes	No	No
Official probable cause as explosion by unstated cause	Yes	No	No	No
Official probable cause as explosion in center fuel tank				
with unknown ignition source	No	No	No	Yes
Official probable cause as improper latching of forward cargo door	No	No	Yes	No
Official probable cause as switch /wiring				
inadvertently opening forward cargo door	No	No	Yes	No
Significant Direct and Tangible Evidence Obtained for Four B747 Breakups in Flight				
	AI 182	PA103	UAL 811	TWA 800

The pattern above is based on similar evidence in four early model Boeing 747 inflight fatal events. The pattern is clear yet complex and detailed. When a forward cargo door ruptures open in flight, certain things have to happen and they happened for Air India Flight 182, Pan Am Flight 103, United Airlines Flight 811, and Trans World Airlines Flight 800.

The significance of the pattern is that it is possible only one cause is for all and that cause, faulty electrical wiring or switch, still exists, is a current hazard. There is urgency.

An additional significance of the pattern is that enough current hard evidence exists to justify a supplemental safety investigation into Trans World Airlines Flight 800, Air India Flight 182, and Pan Am Flight 103, based upon subsequent similar accidents such as United Airlines Flight 811.

5. Specific Conclusions for Trans World Airlines Flight 800:

A. While proceeding normally, an inflight breakup of Trans World Airlines Flight 800 occurred suddenly and catastrophically at 13700 feet at 300 knots TAS. There were no survivors.

B. The breakup was caused by an explosion in the forward cargo compartment.

C. The explosion was a severe and sudden explosive decompression.

D. The explosive decompression was caused by the suddenly ruptured open forward cargo door probably at one or both of the midspan latches.

E. The ruptured open forward cargo door was probably caused by faulty wiring which turned on the door unlatch motor which unlatched the latching cams from around the latching pins in flight.

F. The wiring fault was probably the Poly X wiring with inferior insulation which easily cracks or chafes to bare wire especially in the presence of moisture.

G. There was no bomb explosion in any cargo compartment, crew cabin, passenger cabin, or anywhere else on the aircraft.

H. There was no explosion in the aft cargo compartment.

I. The sudden loud sound on the cockpit voice recorder was the sound of the air rushing out during the explosive decompression in the forward cargo compartment.

J. The abrupt power cut to the recorders was caused by the explosive effects of the decompression affecting the power cables in the adjacent main equipment compartment to the forward cargo compartment.

K. The explosion in the Center Wing Tank was not the initial event but happened after the nose had separated from the rest of the aircraft.

L. The ignition source for the explosion of the CWT was probably the on fire engine number three igniting the fuel vapors from the disintegrating fuel tank as both fell to the ocean.

M. The streak was probably evening orange sunlight reflecting off the pieces of the forward fuselage as they tore away from the aircraft and were reflected to the observers on the ground to the west.

6. Concluding Comment on Part I: The hazard of faulty wiring or switch still exists in the five hundred early model Boeing 747s in service and the design flaw of inadequate midspan latches with no locking sectors in a non plug cargo door exists in many thousands of Boeing airliners in service today. These hazards present dangers which are preventable.