



# TWA 800 Overview

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Director, Office of Aviation Safety

***National Transportation Safety Board***

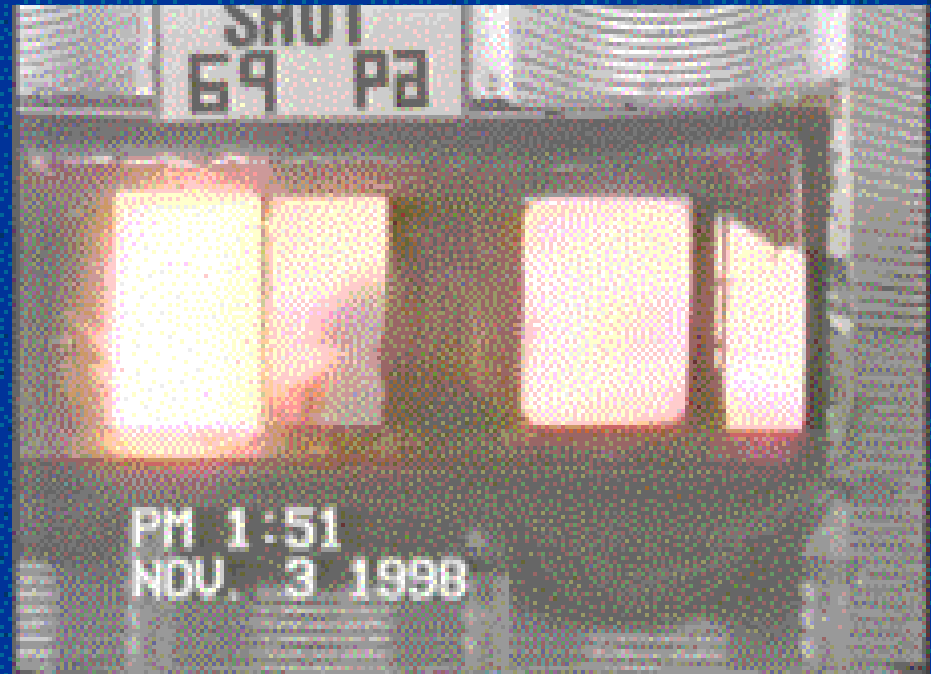
Investigation Into Trans World Airlines Flight 800



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**Most extensive and encompassing  
accident investigation ever  
undertaken by the Safety Board**





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**Significant findings of the investigation:**



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# **Evidence of In-Flight Breakup**

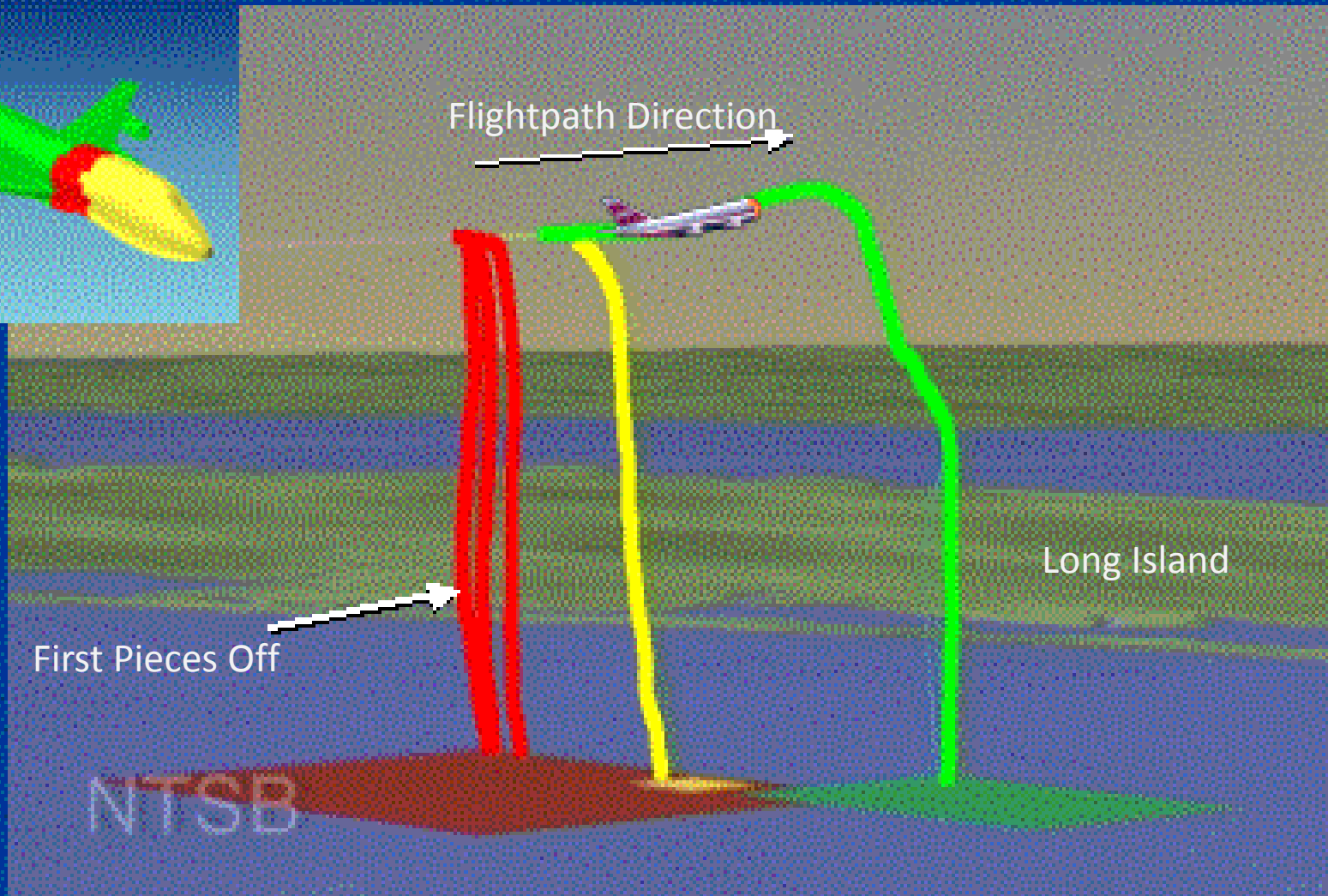
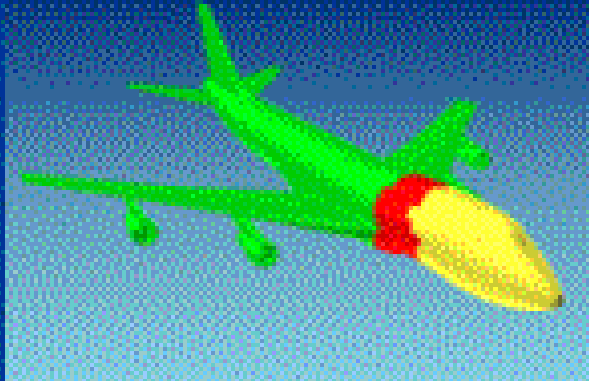
- Radar data showing wide dispersion of primary returns after loss of transponder
- Wreckage recovery from green, yellow, and red zones



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## Wreckage Dispersion: Red, Yellow, and Green Zones





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# **Possible Causes of In-Flight Breakup**

- Structural failure and decompression
- Detonation of high-energy explosive device (bomb or missile)
- Fuel/air vapor explosion in center wing tank



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# **No Evidence of Structural Failure and Decompression**

- No metal fatigue
- No corrosion
- No structural faults



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# **No Evidence of High-Energy Explosion**

- No pitting
- No cratering
- No gas-washing
- No petalling





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## **Participants in Examination of Wreckage**

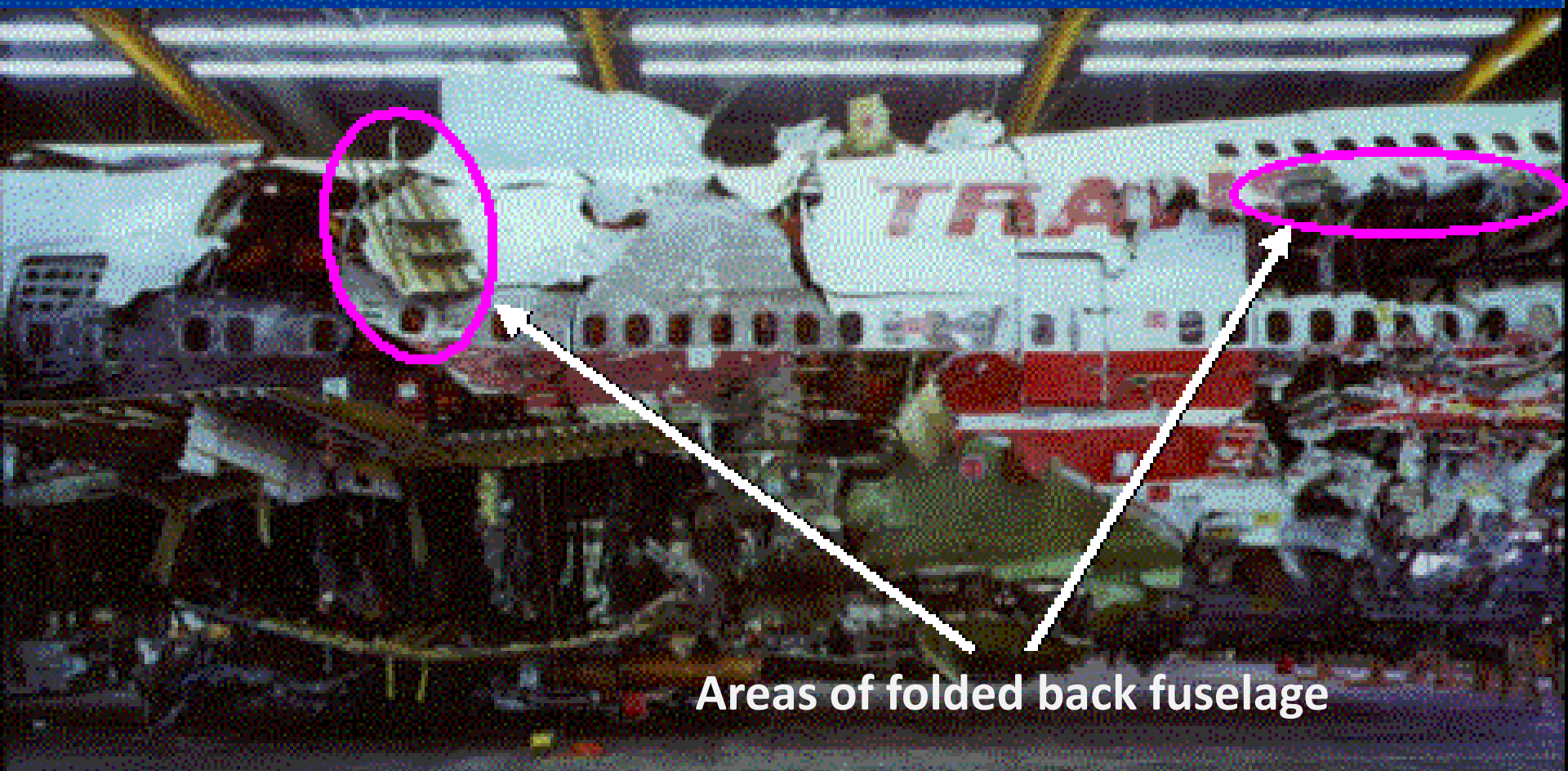
- Federal Aviation Administration
- Naval Air Warfare Center, China Lake
- Missile and Space Intelligence Center
- Federal Bureau of Investigation
- Brookhaven Laboratories
- Bureau of Alcohol Tobacco & Firearms
- National Aeronautics and Space Administration
- British Defense Evaluation and Research Agency
- Wright Laboratory
- Sandia National Laboratories
- Oak Ridge National Laboratories
- Air Accidents Investigation Branch (United Kingdom)
- Bureau Enquetes Accidents (France)
- Bureau of Air Safety Investigations (Australia)
- Trans World Airlines
- Boeing Commercial Airplane Group
- Air Line Pilots Association
- International Association of Machinists, Aerospace Workers, and Flight Attendants
- Crane Company, Hydro-Aire, Inc.



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Reconstruction shows no evidence of large holes suggestive of missile penetration.



Areas of folded back fuselage



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- **No localized areas of severe thermal or fragmentation injuries**
- **No localized areas of severe damage or fragmentation of seats**



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# **Bomb or Missile Strike Ruled Out**



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# **FBI Found Trace Amounts of Explosive Residue on Some Wreckage Pieces**

## **Possible Sources:**

- Ferrying troop operations during Gulf War
- Dog-training explosive detection exercise
- Recovery operations



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# **Physical Evidence Consistent with Fuel/Air Vapor Explosion in Center Wing Tank**

- Pieces from center wing tank were ejected first
- Overpressure in center wing tank was earliest event in breakup sequence



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**Overpressure inside center wing  
tank must have been caused by a  
fuel/air vapor explosion**



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# Questions Raised

- Was TWA 800's center wing tank flammable?
  - Would it explode if ignited?
- Can a Jet A fuel/air explosion generate enough pressure to destroy an airplane?





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## **JFK FLIGHT TEST**



**Evergreen Airlines**



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# **Flight Test and Flammability Research Showed**

- Fuel/air vapor temperatures at the time of accident were 101° to 127° F
- Vapor could have ignited at 96° F
- Combustion pressures could exceed structural limitations of the center wing tank



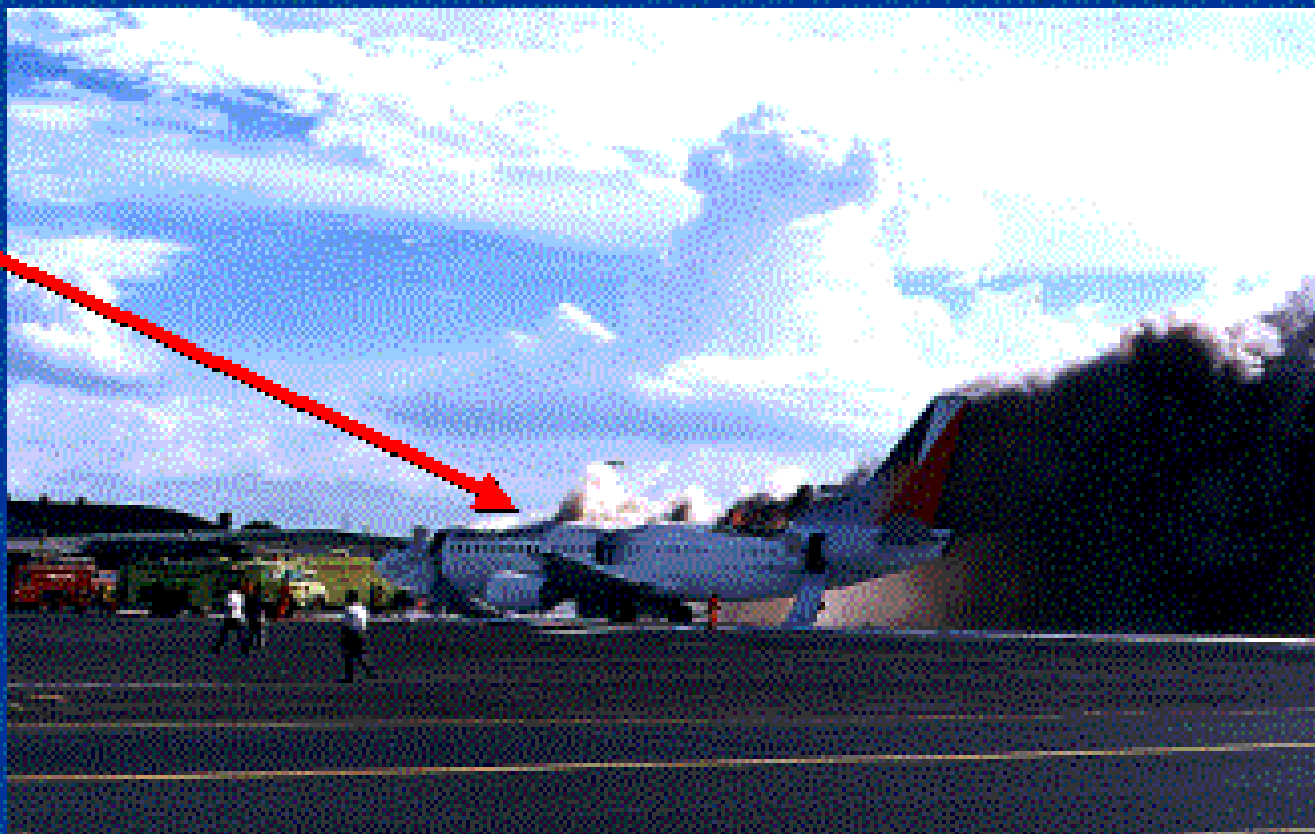
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## Previous Fuel/Air Explosions in Center Wing Tanks

- Avianca Boeing 727 – November 1989

- Philippine Airlines  
Boeing 737  
May 1990





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# **Conclusions Regarding Fuel/Air Vapor Explosion**

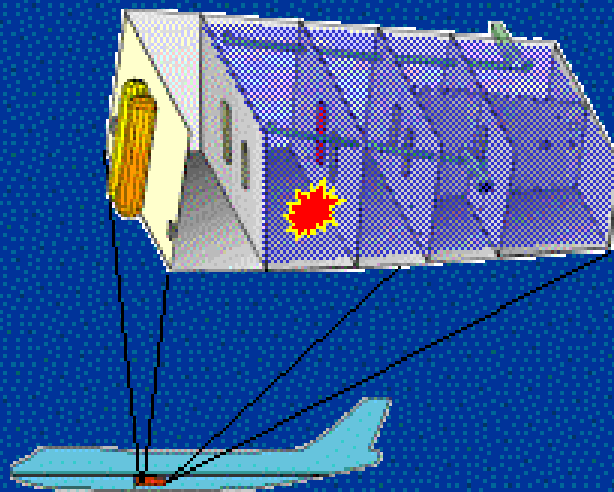
- Jet A fuel/air vapor in center wing tank of TWA 800 was flammable
- Jet A fuel/air explosion can generate sufficient pressure to break apart the structure of the center wing tank



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**Cause of the in-flight breakup  
was a fuel/air vapor explosion in  
the center wing tank**





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## **Search for Ignition Source**





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## **Very Unlikely Ignition Sources**

- Lightning strike
- Meteorite strike
- Missile fragment
- Small explosive charge
- Auto ignition/hot surface ignition
- Fire through vent system
- Uncontained engine failure
- Air conditioning turbine burst
- Jettison/override pump malfunction
- Scavenge pump malfunction
- Static electricity
- Electromagnetic interference



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# **Most Likely Ignition Scenario**

- Short circuit outside center wing tank
- Excess voltage transferred to fuel quantity indication system wires





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# **Maintenance and Aging Aircraft Issues**

- Cracked, damaged, and contaminated wire insulation is common
- Current maintenance practices do not adequately protect integrity of wiring



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**Six Safety Board safety  
recommendations issued to the  
FAA in April 1998 regarding  
aircraft wiring and potential  
fuel tank ignition sources**



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# **FAA Initiatives to Address Aging Systems**

- Aging Transport Non-Structural Systems Plan
- Aging Transport Systems Rulemaking  
Advisory Committee



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# **Current Design and Certification Philosophy**

- Assumes that a flammable fuel/air mixture exists at all times
- Attempts to eliminate ignition sources



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# **Flaws in the Current Design and Certification Philosophy**

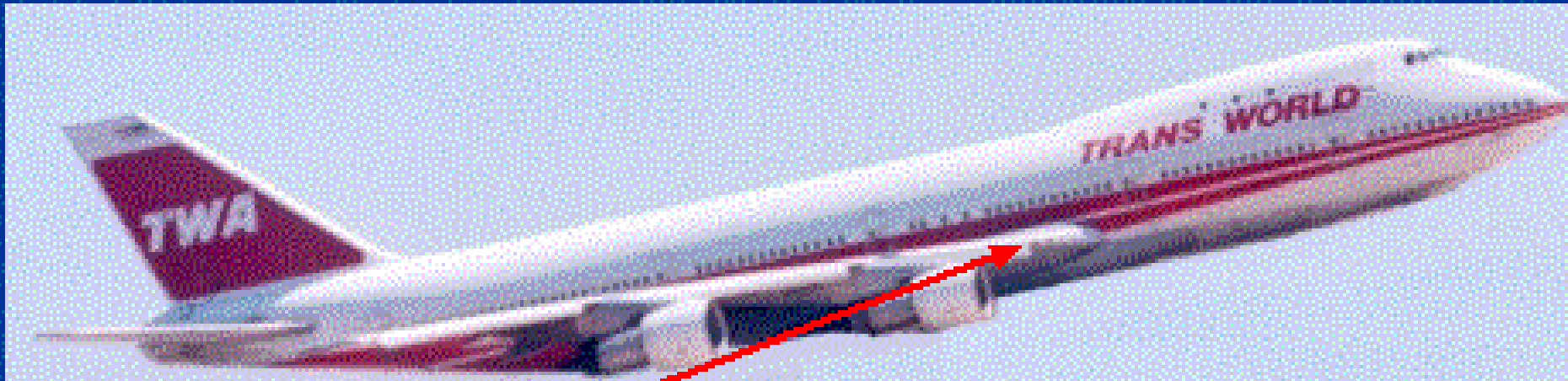
- We cannot eliminate all ignition sources that have been identified
- We cannot predict all possible ignition sources



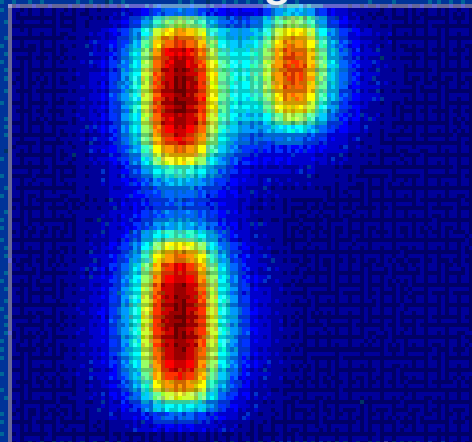
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## Center Wing Tank Heating



Pack Heat Signature





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**No Flammable Vapor = No Accident**



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# **December 1996 Safety Recommendations to the FAA**

- Preclude operation with explosive fuel/air mixtures in fuel tanks
- Consider long-term design modifications, such as fuel tank inerting
- Require short-term operational changes to reduce potential for flammable mixtures





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# **FAA Response to December 1996 Safety Recommendations**

- Proposed rulemaking to “minimize flammability in future designs”
- Evaluate ventilation to cool center wing tank
- Evaluate ground cooling instead of air conditioning packs
- Evaluate fuel tank inerting systems



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# **Certification Issues for Future Consideration**

- Adequacy of risk analyses used to demonstrate compliance with regulations
- Need for reliable, independent means to overcome catastrophic effects of failure – regardless of the calculated probability of failure



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# Witness Observations

- 736 witnesses
- 258 of witnesses reported a “streak of light”
- Almost all witness accounts are consistent with their having observed the airplane on fire
- 56 witness reports are not completely consistent with airplane’s flightpath; however, they can be explained



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# **Safety Issues Identified During the TWA 800 Accident Investigation**

- Fuel tank flammability
- Potential ignition sources in aircraft fuel tanks
- Maintenance/aging of aircraft electrical wiring



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