

# EXHIBITS

## EXHIBIT 1 - FUEL QUANTITIES AND WHAT THEY TELL US

By Captain Howard T. Mann

We were told at the Public Hearing in Baltimore that FL800 was making a normal climb-out with wings level when the center tank exploded. On other occasions, we were told something happened to the aircraft and that 20 seconds later the center fuel tank blew up. Reference to the Flight Data Recorder indicates the aircraft went through some violent maneuvers before the loss of electrical power. The 20:31:12 second line of the FL800 Flight Data Recording indicated the aircraft was rolling to the right and was in a steep bank. The purpose of this document is to support the FDR information by reference to a totally different system. I refer to the Fuel Quantity Indicating System (FQIS). The quantities indicated below are from official NTSB documents.

|             | Fuel out of JFK | Indicates 4,500#s Taxi Fuel | 747 Fuel Flow Instruments incorporate a feature that keeps a motor-driven running total of fuel used, in pounds, from engine start to the time of the accident. | Calculated fuel in tanks at time of accident | Motor driven fuel quantity indications (Found in wreckage) | Fuel Discrepancy in pounds   |
|-------------|-----------------|-----------------------------|---|--|--|--|
| #1 Reserve  | 3,400           | 0                           | 3400  | 3100#  | -300   | All of the discrepancies can be explained by reference to the tank geometry, but only if the aircraft is in a steep right-bank as indicated on the DFDR. |
| #1 Main     | 24,600          | -2,680                      | 21,920  | 22,200#                                      | +280   |  |
| #2 Main     | 62,900          | -2,710                      | 60,190  | 57,500#                                      | -2,690   |  |
| Center Tank | 300             | 0                           | 300   | 640#   | +340   |  |
| #3 Main     | 62,700          | -2,740 *                    | 59,960  | 60,100#                                      | +140   |  |
| #4 Main     | 24,600          | -2,630                      | 21,770  | 27,300#                                      | +5,530   |  |
| #4 Reserve  | 3,300           | 0                           | 3,300   | 3,300#                                       | 0  |  |

\* Unreliable, used 1,2,& 4 average.

- Fuel quantity indications are valid in the wreckage because the indicators are motor driven and do not move when electrical power is removed.

The obvious discrepancy in the fuel figures for the #4 main tank tell us this aircraft was in a steep right bank just as the Flight Data last second line indicated when electrical power was lost. To understand what happened with the fuel quantity in the #4 main fuel tank takes some orientation about the tank itself and about the fuel quantity probes.

The #4 tank is approximately 30 feet long and tapers in both width and depth, averaging approximately 12 feet wide with the depth from 26" at the inboard end and 15" at the outboard end. The tank description is further complicated by the 7-degree wing dihedral. Because the tank takes on a general shape of a long thin flat wedge, where the fuel is located in the tank affects the accuracy of the quantity calculation. There are 12 probes strategically located in the tank. These probes are of the capacitance type and use the fuel as a dielectric. Fuel standing in the tube changes the capacitance between the outer and inner element. It is the sum of the capacitance of all the probes in a tank that determines the fuel quantity indication. The system is very accurate when the aircraft is in a nearly level attitude. On Flight 800, it appears the steep bank angle allowed fuel to run from the large end of the tank to the small end of the tank and cover some probes while uncovering certain others with less capacitance, resulting in a obvious erroneous fuel quantity indication. The same principle applies in other tanks but to a lesser extent, depending on how near full they were (1R & 4R) and allowing for some space above the fuel. The inboard mains are only about 75% full and their depth to length ratio is less affected by the bank angle. The cockpit Fuel Remaining and Aircraft Gross Weight indications both reflect this error because the data they utilize comes from the individual fuel quantity gauges.