Politics - The Media and Investigations - and The Law.

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DATED MATERIAL

Two accidents in the 1996 year point out the vast difference of purpose aircraft accident investigations can take on. Case in point ValuJet and TWA - 800.

Both disasters were sufficiently close to home and devastating in result that they became the center of the media frenzy that one comes to expect from the news media and politicians. America's right to a free press and its rapture with the sensational creates the ability to sell papers and create ratings. Just as some court cases create media personalities so does some aviation crash disasters.

The media demand for immediate answers puts some pressure upon the investigative team to give premature answers always steeped with the escape clause "The premature focus is on, or preliminary facts tend to focus on... "The point being that major aviation disasters of unknown cause take months to investigate and sort out.

In both ValuJet and TWA, certain factual data was immediately available. That was the radio transmissions and the flight path radar data. Both included eyewitness descriptions. After that both were similar in the retrieval operations were conducted in the most inhospitable areas imaginable. One a swamp, the other, the Atlantic coastal waters.

There have been other disasters in which massive investigations have been undertaken, The Air India investigation and retrieval off the coast of Ireland, and the Lockerbie - Pan Am 747 in Scotland come to mind. Of course the space Shuttle Challenger retrieval comes to mind as well.

In Challenger, as contrast, there were good telescopic photography, good telemetry data and a known category one hazard potential with the seals. Thus the recovery operation while massive and impressive, were not the key data required for conclusion. Such was not the case in either ValuJet or TWA - 800.

The ValuJet accident initially was portrayed as an upstart company using aged DC-9 equipment, as if something was inherently wrong with older equipment, and low cost- no frills approach to safety. After a period of time ValuJet was grounded by FAA order and a myriad of safety related problems were investigated and corrected. However, nothing was found to suggest that the age of the aircraft structure had anything to do with the accident.

While the anchor persons reported from dikes close to the crash sight and pundits speculated from distant air conditioned TV studios the real heroes slogged and dived below the swamp to retrieve evidence of what really happened. These are the

true heroes of this tragedy. The air safety investigators and their specialist work partners. After months the evidence was retrieved and by the looks of the evidence retrieved to date, it becomes obvious that a unauthorized hazardous cargo, Called HAZMAT in the business, is a player if not the sole cause of this disaster.

It appears that a shipment of Oxygen generators was being incorrectly or illegally shipped aboard the front cargo bin of the DC-9. For reasons still being investigated, the canisters began supplying a 100 % Oxygen environment to the cargo bin. This Oxygen environment combined with other material in the bin ignited. A rapid inferno was created that burned upward into the first class compartment through the flooring.

At the date of this publishing, it still has not been reported, whether or not the flight crew donned smoke goggles and Oxygen masks as the first step in the Fire and Smoke checklist. It also has not been reported whether the aircraft was flyable or whether the fire rendered the machine uncontrollable.

A major emphasis of the investigation has moved on to the operational aspects of how such a cargo came to be so mishandled and how such a cargo came to be positioned incorrectly in the baggage bin of the fated aircraft. A government investigation is interested in safety - after the fact. How to prevent a re occurrence. Lawyers are interested in fault and recovery for their clients. News Media are simply interested in reporting the story. Before, the results from ValuJet could be learned a even more ominous disaster occurred at sea off Long Island New York. A early version TWA 747 suffered an explosion while climbing through 13,000 feet on the way to Paris France. Over 200 passengers and all crewmembers were killed.

The wreckage was spread over ten miles of ocean bottom just off the Long Island coast. There was immediate shock and confusion as America jumped to the conclusion that International terrorism had once again manifested itself against an American entity. Timing was one principal reason to believe this was an act of terrorism. It happened only days before the opening ceremony at America's Party - The 1996 Atlanta Olympic Games. America had been well primed for the expectation of international terrorism, since such a contingency occurrence was expected and planned for in the immense security preparations for the Atlanta games. It was almost normal that people concluded that TWA - 800 was a bomb.

The TV pundits reinforced the believe, as they reported and editorialized the news from Long Island. Statements similar to these were routinely reported.

" Only a bomb could have caused such damage "

" Eye witnesses reported seeing something that could be a missile "

" Afghanistan rebels sent a FAX only days before that suggested a terrorist attack was imminent "

" It is probably a bomb placed aboard the aircraft at Athens...everyone knows Athens airport security is below standards "

And the rumors and conspiracy theories began.

" It was a missile fired by mistake from a U.S. Navy Frigate conducting live firing exercises."

Of course there was no evidence of any of this as the T.V. Talking heads created headlines. Only the beginning of a retrieval operation was in place as cause was being speculated about. The Spokesperson and NTSB board member Robert Francis was correct in urging restraint. His point was that with effort, enough evidence could and would be retrieved from the ocean floor to reconstruct the aircraft, and to hopefully determine the exact cause of the accident. Since the possibility - probability existed that the disaster was indeed the result of a criminal act, the FBI was given Co authority in the investigation. Since the United States navy possessed special talents at deep sea retrieval, they and others were brought into the investigation as invitees.

Very early in the investigation, as pieces of the aircraft were recovered, It became evident that the center fuel tank had suffered a low order fuel vapor explosion. The finger prints of such explosions are well documented in earlier accidents. The simple finding that a vapor filled tank did explode did not preclude either a bomb or a missile as the original ignition source for the vapors within the center tank. Quite simply an external ignition source could puncture the tank and provide the heat source (energy source) sufficient to cause ignition.

As more and more pieces of the tank were found, such an occurrence becomes less and less likely, since no tank pieces have as yet exhibited any such punctures as would be expected. Internal and external to the aircraft FBI forensic experts, and other experts have tried to locate some remnants that would show the “fingerprints" of a high order explosion. To date no such forensic evidence has been forthcoming. At this writing there are a few remnants of the aircraft still missing. Now it is all most obvious to anyone who followed progress of this investigation that it could be characterized or categorized into a few select possibilities and since in the first few days little wreckage was recovered, pundits opted for the hypothetical solution method of investigation.

The possibilities that seemed probable were:

A. Sabotage in the form of a bomb or missile.

B. Fire then explosion from unknown source.
or explosion then fire from unknown source

C. Aircraft structural failure.

As wreckage became available the investigators were able to conduct a

investigation by exclusion. An investigation where scenarios were discarded as impossible or improbable. For instance they were able to discount any engine problems almost as soon as they were retrieved from the ocean floor. The engines themselves were not victim from either internal or external explosion. As soon as the Cockpit voice recorder and Flight data recorder were retrieved it was possible to say that all engines appeared normal and producing power at the time. This finding created a little consternation with the missile theory, although not enough to rule out missiles. Most shoulder fired missiles are infra red heat seekers, and often they track a jet exhaust to the heat source - an engine. Such is not always the case and aircraft have been hit in places other than a engine.

A little research in armament journals, and other sources tended to discount a hand held missile because of the extreme range considerations. It was hypothesized that such a missile could only be successful if launched from a boat.[This due to extreme range. Even such a shot would be at maximum range for known ordinance] Still later in the investigation, as more aircraft parts became available, the pieces of external aircraft wreckage were devoid of fingerprints associated with a missile hit.

The focus then became a bomb placed internal to the aircraft. As more and more evidence was recovered from the ocean floor, major portions of the cabin area around the center section of the aircraft were found. This included seats, flooring, side walls, bodies, metal structure and baggage from both the carry on variety and from the baggage bin areas close to the suspected areas.

These were scrutinized for the fingerprints of a high order explosive device including shrapnel. Autopsy and chemical analysis offered no solutions. No such conclusive evidence has been found to date. (see section on high order explosive devices) The government forensic labs searched for traces or chemical residue from known explosives. Minute traces of explosive have been found, (similar to Semtex or C-4) but these have so far been explained as either left over from troop transport returning from Desert Storm or much more likely some residue of a dog sniffing security drill conducted with live ordinance. It is reported that Semtex was hidden to give bomb sniffing dog training.

Finally as more and more parts from the fuel tank were found it has so far shown that the tank has not been punctured from an external source. This is not entirely conclusive since 100 % of the tank has not been reported reconstructed. At this writing a fuel boost pump and some backing boards are missing as well as other sidewall structural parts. The probabilities are moving toward a conclusion that a explosion occurred internal to the fuel tank and the question remains what was the source of ignition. At this point in time, because less than 100% of the tank has been recovered a shaped charge explosive device can't be 100% discounted.

However a small device carried aboard the aircraft, of the shaped charge variety, could not insure success unless it was specifically placed and directed. A passenger, unless a suicide, could not be counted on to correctly place such a charge.

To date there is no evidence of such a charges existence.

If one conducts his investigation by exclusion and probability. Then one is now left with other possibilities to explore, and questions to answer. They are:

What could cause a vapor laden Center fuel tank to explode. This requires the investigator to focus on potential ignition sources within the tank. They are:

* Static electricity - unlikely
* Fuel pumps - electric faults or overheating.
* Fuel quantity probes - electric faults- unlikely because low energy.
* Fuel valve solenoid switches - electrical faults.
* Fuel leak external- external ignition and fire - backs into tank through tank vents.
*Wire chaffing the insulation off.

A useful tool to an investigator is to investigate history for lessons learned. This is conducted to see if similar occurrences have been recorded in the same or similar equipment. Now in a legal sense, such circumstances are deemed non evidence if the circumstances are not substantially the same. A system Safety engineer or an air safety investigator is not held to such exclusion and history may provide insight to the probabilities of this occurrence.

There have been several in flight explosions of Air Force B-52 aircraft and KC-135 tankers that may have bearing on the current situation. There have also been numerous ground fire accidents in which pump defects have caused ignition while running dry in a vapor environment. Much investigative effort has gone into each such accident and the findings, while privileged due to military regulation are well known in the industry.

To name a few accidents:

o A B-52 ground accident at Loring AFB in 1970. - The submersible fuel boost pump bearing was faulted.

o A B-52 on the ground at Warner Robbins AFB in 1978. - A faulty pump was the cause. In this case it was believed that an overhaul of the pump was to blame causing electrical sparks.

o A B-52 airborne explosion near Minot South Dakota, was officially cause unknown - however, an intensive search was conducted in attempt to find a fuel pump blown free of the wreckage distribution path.

o. A B-52 airborne explosion at K/I Sawyer AFB in Dec. 1989- The cause a pump overheated bearing or case was the suspected cause.

o an Air National Guard KC-15 on the ground at Fairbanks Alaska. Taxiing in - suspect was a transfer pump.

o An Air National Guard KC-135 accident on the ground at Milwaukee, Wisconsin. A defective fuel boost pump was run in a vapor atmosphere. The defect was an electrical short blamed on a pump overhaul procedure.

o A KC -135 explosion over Joliet Illinois- different theories were expounded, ranging from static electricity, unauthorized smoking to a defective pump theory.

o A KC -135 explosion returning to Loring AFB.

From these accidents it is obvious that some varieties failure modes can exist within fuel vapor tanks. It is further obvious that fuel vapor within the explosive range can exist within fuel tanks. It is also obvious that explosions from such tanks can an do cause massive structural damage. For instance in the B-52 explosion at K.I. Sawyer the tail was found to be far removed from the fuselage. Immediately surrounding the exploding tank, aircraft skin was blown down, outward and upward away from the epicenter.

More on Vapor Pressure Explosions

For a tank full of vapor to explode, the fuel air mixture must be precisely within the explosive range. A fuel tank may have a small amount of fuel trapped within as unusable or residual fuel. This may in fact be several hundred lbs in a large tank.

It is entirely possible, although unlikely to have a large tank filled with some residual fuel that could burn, a portion of the tank filled with fuel air vapor outside the explosive range and parts of the same tank within the explosive range.

Most tanks are sufficiently vented so that fuel air vapor in the explosive range should not exist within the tanks. In an entirely different context Chemical plants and often ships at sea provide inserting systems of nitrogen or CO2 to replace vapors, and protect against vapor explosions.

When an aircraft fuel tank is filled with vapors in the explosive range, there must still be an ignition source capable of igniting the fuel air combinations. The amount of heat energy sufficient to cause ignition depends on several variables.
The variables include:

The vapor range limits,
The temperature,
The O2 content,
The variety of petro chemical.

As an example a tank full of JP-4 Jet fuel on the ground at standard temperatures and pressures may vaporize to the extent required to be within the flammable or explosive range. As the aircraft climbs the tanks will become too rich

with vapor to be within the range. On the other hand Jp-5 and Jet A - kerosene will not vaporize sufficiently for a tank to be in explosive range on the ground while at altitude the converse may be true.

Once such a vapor pressure blast occurs the explosive force is relatively slow burning (as compared to explosives) and the forces created are in the range of 5 to 8 with 10 maximum atmosphere pressure overloads. The shock wave propagation of a vapor pressure explosion is clearly subsonic. Structural failures caused by the propagation of such an explosion are easily identifiable.

Usually the propagation is away and out from the ignition source. The first container to rupture is naturally the tank itself. It bulges out from the epicenter and ruptures at its weakest points. Usually sidewalls and portions of rubber bladder material are blown free to fall to earth apart from main wreckage. Since a large portion of the tank is empty and totally free of fuel the only heat it senses is the very high temperature of the blast front. This lasts a very minute time and those parts that are blown free suffer only internal singeing if any heat damage at all.

Depending upon the tank structure, it's location and the plumbing of the system in both transfer lines and vent lines, the heat source and explosive vapors may set off adjoining tanks by either structurally rupturing them or entering through the vent systems.

Depending upon the location of the tank itself, wing or fuselage, tip or drop tank, the damage may be catastrophic or contained.

If an investigator finds bulged fuel tank remnants, relatively free from heat damage, at locations distant from the main wreckage he may assume that there was an explosion in that fuel tank. Generally, parts blown free from the aircraft that came from first tank to blow does not show much if any fire damage. This is true because the fire damage and fire patterns are as a result, usually, of remaining fuel burning after the explosion. (a residual fuel fire). Now the question for the investigator still remains. What was the ignition source ? Was the ignition source within the tank or external?

Explosives on the other hand create a high energy shock wave or front that is extremely hot and fast moving. Temperatures exceed 2,500 degrees. The shock wave is supersonic. Again the shock wave propagates away from the epicenter. It can be funneled to a path of least resistance. Ergo in a rifle all the escaping gases move down the barrel with the projectile (the path of least resistance, while the laws of physics create only a kick of the weapon itself)

Close to the explosive location the devastation is clearly identifiable and easily differentiated from a vapor explosion. The high heat and supersonic shock wave tears metal and shreds it. One side closest to the blast will have distinctive heat pitting marks. In the vapor explosion neither occurs. Aluminum will bulge and ductile stretching usually occurs at rivet holes. One side of the aluminum, on the heat side may

show heat distress, while the opposite side shows little or none.

In a high energy explosion, the chemical reaction of the explosive leaves distinctive chemical residue on materials impinged upon by the shock wave. Chemical analysis of the residue can identify the explosive type. Once the type explosive is known, and the location of the charge determined, a forensic expert can usually closely estimate the amount of explosive needed to cause the damage pattern found by the investigator.

The problem with explosives on aircraft is the fact that small, well placed charges can excite secondary results that are often the true cause of the catastrophe. When the explosion or fire is airborne, the scatter pattern is immense. When such an occurrence happens over water the problems magnified for the investigators. Fuel pumps are simply not manufactured and installed on aircraft. Before such equipment can be used a myriad of difficult qualification tests are required. The following listing is only partial. They are similar to the tests described.

DRY Run
100 hours dry run, 5 hours at a time, 20 tests, sea level 60 degrees ambient, and 60,000ft 60 degrees and 90 degrees ambient temperature. The same pump must complete the entire test without change or failure. The pump must have been chosen randomly or prototype built up from random parts. The case temp could not exceed 300 degrees after five hours dry runs.

DEMONSTRATED PUMP DOWN of FUEL TO DRY RUN
Here a random pump is to pump down a tank of fuel to empty and then run dry. The test is conducted at sea level. To be successful the tank must not ignite.

Klixon heating tests
Klixons are temperature-sensing elements within a pumps electrical windings. Such Klixons work as an overheat protective device that turns of electricity when a certain pre set temperature is sensed. Pumps should demonstrate that Klixons will trip before the pump outer case exceeds temperature limits.

Pump - impellor drag down tests.
A pumps rotor is slowed by friction or stopped. This simulates a foreign object clogging the impellors free motion. This, in turn, causes the pump to draw increased electrical load. Here the Klixon should trigger or the circuit breaker should pop.

Explosive proofing
A spark plug is initiated within the submersible pump case. The pump is in a Methane atmosphere. The atmosphere should not explode if the pumps explosive proof cap has been designed correctly.

Single phase failure testing

One of three phases of a pump motor is failed and the other two continue pumping with extra heat and lack of efficiency - The test is to see that the pump is protected against overheat. With exemplar pumps passing testing like this it is difficult to imagine that a submersible fuel pump could be the source of ignition in a fuel tank. The fuel probes are designed to use so little current, they are not suspected of having potential energy sufficient to act as an ignition source. They have gone through extensive testing as well.

The problem can not manifest itself if the defect is submerged. Only when the defect is exposed to a explosive atmosphere is there a potential for disaster. This only occurs in empty tanks (nearly empty) Logic suggests that if an explosive device is illuminated, one must concentrate on the probable.

Another possibility does exist. A fuel leak could have caused a fire to ignite outside the tank and that fire entered the vapor tank through a normal exit vent. Consecutive vapor tank explosions have been recorded where the flame patterns or explosion propagation path was from vent line to tank to vent line to next empty fuel tank. Thus it is well recorded that such propagation can take place.

The problems associated with retrieving all parts of the aircraft as well as the problem associated with long term water immersion makes this accident investigation one of the most difficult ever attempted. The government of the United States should be praised for their monumental efforts in attempting such a recovery and reconstruction effort. We as users of the air commerce system of this country can certainly see the effort undertaken to assign probable cause in this most difficult situation.

Until a true source of ignition is found, it is interesting to watch the pre positioning of interested parties to this investigation. The agendas of each such party is clearly more evident than the cause of the accident.

It is noteworthy that airlines and military aircraft with large fuel tanks immediately changed fuel burn procedures so as to always keep some fuel in each tank. This change kept fuel gauges wiring and pumps submerged. The Air Force increased requirements that more unburned fuel be saved in certain aircraft fuel tanks. This precludes exposure of overheat or sparking to reach a fuel air mixture.

UPDATE 2014. Even today, there are Conspiracy Theorists that suggest it was a terrorist act, a errant Navy missile or even space aliens. If one weighs the evidence, you must conclude the fuel tank exploded from within and high explosives were not the ignition source.