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copy to Senator Hollings
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Dear Mr. Holliman:

With reference to fax sent to you on 5/10/97 the following has occurred: With the flight of STS-87 on November 19, 1997 we have seen the implementation of new guidance system software for the shuttle guidance system computers. We already know about the 180 degree roll to heads up maneuver made possible by individual control of the main engines, whereas previously they were steered together as an integral unit.

But far more importantly we have seen the tentative "fix" of the anomalous flame problem discussed in the fax to you dated 5/10/97, manifest in the new guidance system software.

Prior to STS-87 the main engines were commanded to follow the changing center of gravity as fuel was used and in so doing were steered toward the solid rocket booster exhaust plumes, whereby SRB and main engine exhaust plume interaction resulted in dangerous deflected flames at the bottom of the hydrogen tank and adjacent areas. Now, instead of the corrective commands being sent to the main engine gimbal system, the main engines are more or less constrained to their starting positions and the corrective commands are sent to the solid rocket booster nozzles gimbaling system and the SRB nozzles are steered AWAY from the main engines to compensate for the changing center of gravity. This new software fix is called tentative because it will

work only if it continues to be used, there is a slight power reduction along the flight path for a short time when the SRB and main engine plumes are working against each other slightly, this may reduce payload capacity for high inclination and/or high altitude orbits.

The main thrust vector of the shuttle vehicle is the resultant or vector sum of the main engines and the solid rocket boosters thrust vectors, steering the main engines TOWARD the SRB exhaust OR steering the SRB nozzles AWAY from the main engine exhaust affects the main thrust vector in the same way, NASA has adopted the latter over the former case with STS-87 and the SRB and main engine exhausts now diverge away from each other instead of converging on each other and the dangerous flames did not occur on STS-87. See the launch replays of STS-87, TV-4B beachtracker and TV-5 VAB roof camera views, and you will see what is happening for yourself.

Unfortunately, this new guidance system software will become old guidance system software when NASA starts to fly the new super lightweight lithium-aluminum fuel tank with heavy space station components in the shuttle payload bay; because this represents a NEW vehicle design from a control system point of view. It is not just the weight reduction, the lithium-aluminum tank weighs 7,500 lbs. less than the current tank, it is the DISTRIBUTION of weight along the yaw axis of the vehicle that is critical here. With the lighter fuel tank and a heavier payload the center of gravity will shift toward the shuttle at liftoff, the starting position of the main engines is determined by the center of gravity, the starting positions of the main engines will have to be positioned closer to vertical TWO times, once for the heavier payload and AGAIN for the lighter fuel tank.

Now, IF the guidance system software and/or the engine nozzle hardware limits cannot compensate for this newly positioned center of gravity (which varies even with PAYLOAD mass distribution in the cargo bay) along the yaw axis, especially

as it changes with fuel use, then you will see the following catastrophic failure sequence: Within several minutes after liftoff the center of gravity will migrate toward the shuttle payload bay doors, the guidance system will not be able to compensate for it and will then lose control, the shuttle will rotate on its pitch axis, going tail up and nose down and the entire vehicle will disintegrate.

And, if you think this can't happen, we should discuss the disaster which took place June 4, 1996. After 10 years of work and over 8.6 billion dollars to develop the bigger Ariane 5 rocket the European Space Agency launched the Ariane 5 on its maiden flight and it blew up less than a minute later. Why? Neglect. The engineers loaded guidance system software for the smaller Ariane 4 into the computers of the Ariane 5 thinking it would suffice to control the new vehicle. It lost control and the vehicle was destroyed.

Some people will need to do more work on their high speed computers, just to double check if nothing else.

Some comments on the hearing of 9/18/97: I can understand James Van Laak of NASA saying they expect 170 failures per year on the American side of the ISS alone, but he went on to say it was a perfectly satisfactory piece of space hardware. Sure. Where is security for the ISS? Do we know who can and how easy it is to knock it out during a hostile attack? NASA has guards with assault weapons and security aircraft at KSC but the ISS will be a sitting duck with no protection.

Space in general: Mr. Frank Culbertson said it all: " You can't imagine a more hostile environment than outer space." Indeed we can't IMAGINE the havoc on human space travellers.

Arthur Heald