BEFORE THE
NATIONAL TRANSPORTATION SAFETY BOARD
Washington, D.C.

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In the matter of the investigation :
of the accident involving :
Trans World Airlines, Inc. :
Flight 800, B-747-131, N93119, :
8 miles south East Moriches, :
New York on July 17, 1996 :
- - - - - - - - - - - - - - - - - - -X

Baltimore Convention Center
Halls A and B
One West Pratt Street
Baltimore, Maryland 21201-2499

Friday, December 12, 1997

The above-entitled matter reconvened for hearing pursuant to notice, at 9:00 a.m.

APPEARANCES:

Board of Inquiry:

Honorable Jim Hall Chairman	Member NTSB
Dr. Bernard Loeb	Director, Office of Aviation Safety
Dr. Vernon Ellingstad	Director, Office of Research and Engineering
Mr. Barry Sweedler	Director, Office of Safety Recommendations and Accomplishments
Mr. Dan Campbell	General Counsel

Technical Panel:

Thomas Haueter	Chief, Major Investigations Division
Al Dickinson	Investigator-in-Charge, Operations

Also Present:

Debra Eckrote
Norman Wiemeyer
Malcolm Brenner
James Wildey
John Clark
Frank Hilldrup
David Mayer
But Simon
Henry Hughes
George Anderson
Doug Wiegman
Mitchell Garber
Merritt Birky
Dan Bower
Dennis Crider
Robert Swaim
Charles Pereira
Deepak Joshi
Larry Jackson

Parties:

Lyle K. Streeter	Air Safety Investigator, Department of Transportation, FAA
Captain Jerome Rekart	Chief Accident Investigator, Air Line Pilots Association
Captain Robert Young	Director of Flight Operations Safety, Trans World Airlines
J. Dennie Rodrigues	Senior Air Safety Investigator, Boeing Commercial Airplane Group
Fred Liddell	Chief Investigator, International Association of Machinists and Aerospace Workers
Hal Thomas	Technical Engineer, Honeywell
Raymond Boushie	President, Hydro-Aire

I N D E X

Opening Statements: **Page**

None.

WITNESS

E X H I B I T S

EXHIBIT NUMBER **DESCRIPTION**

None.

Closing Statements: **Page**

None.

P R O C E E D I N G S

(Time Noted: 8:55)

CHAIRMAN HALL: We will reconvene this hearing of the National Transportation Safety Board that is being held in connection with the investigation of an aircraft accident involving Trans World Airlines Flight 800, a Boeing 747-131 that occurred eight miles south of East Moriches, New York July 17th, 1996. Information on this hearing and the proceedings can be obtained off the Internet at www.ntsb.gov.

I would like to welcome the panel back this morning. I would like to welcome an addition to the panel, Dr. Shepherd who has appeared with us before and has been previously sworn from Cal. Tech.

Before we turn it over to the Technical Panel -- Dr. Ball, you moved this morning. I see you are down there. I have found this letter I was so frantically searching for yesterday, and to my able staff I say thank you. We have received thousands of pieces of correspondence, and the one I wanted to bring to your attention was from -- was written to Senator McCain by Peter Carnivell (sic), a Research Engineer in Sonoita, Arizona.

He writes, "Dear Senator McCain, with the death of some 230 people on TWA Flight 800, I feel an

obligation to help solve a very serious defect in our commercial airline fleet. During the Vietnam War I equipped all military combat air craft with reticulate polyurethane foam in the fuel tanks. The aircraft you flew was so equipped."

We are not sure of that, so whether it was a maybe or not -- but, "the material accomplished two things. It acted as an infinite baffle which kept the fuel in a liquid state in a crash, thus reducing the fire hazard, and it also quenched any fire that would start from any ignition source of an empty fuel cell."

"This material was tested by the FAA in 1965. The FAA test substantiated the Air Force test findings that the foam-filled tanks substantially reduced the risk of fire and/or explosion of empty fuel tanks during crash landings and from any ignition source in the air. Even incendiary rounds were unable to ignite these tanks."

"FAA decided not to use this technology due to their development program for solidified fuels. In the middle 80's they finally tested their solidified fuels with disastrous results at Mojave. I submit that for thirty years there has been a solution that could have saved Flight 800 and possibly saved many more lives during crash landings."

"The reticulate polyurethane foam reduced the available fuel by about two percent and is completely passive. After twenty years of operations at F-4's, McDonnell Douglas found no deterioration of the foam material in the tanks. Also, there has been no microbiological growth in the tanks due to the foam."

"I firmly believe that this material should be used in all commercial aircraft. The cost is minimal and the benefits outweigh the two percent loss in fuel. Fuel system purging can be accomplished in many different ways, nitrogen being the most common method, but no other system is completely passive, which is still the biggest attraction of the foam."

"Additional information can be obtained on the Air Force project from the Aeronautical Systems Division. Write Patterson Air Force Base in Dayton, Ohio. The contract numbers which pertain to this project were Air Force 33-615-54-24, Air Force 33-615-12-17, Air Force 33-615-32-77 and Air Force 33-617-38-80."

"I was project manager for this program and would be willing to assist the implementation of this project."

Senator McCain sent this letter over to me and we responded to Mr. Carnivelle on July 8th, and

which we had a discussion that I won't go into because you covered a lot of the material about the -- about the use of this foam, but we did -- I did close the letter by saying, "We appreciate your bringing this subject to our renewed attention. Please be assured during our continuing investigation of the TWA Flight 800 accident we will consider this issue further, including discussing with the FAA further research into the use of reticulate polyurethane foam in fuel tanks."

That letter got my specific attention because like Senator McCain, I am a Vietnam Era Veteran, although I served in the Army, and I was very aware of Senator McCain's excellent service to our country and what he did, and when somebody talked about it being in his airplane, I -- that got my special attention.

So, maybe as we get into the rest of the panel today we can discuss it a little more, but you think -- the Navy did not have that in their airplanes, right?

MR. BALL: It has been my experience that the Navy did not use foam in their aircraft in Southeast Asia primarily because they flew JP-5 which is a significantly less volatile fuel, and therefore they didn't feel they had the problem that the Air Force had with the JP-4.

The Air Force developed this orange foam and put it into many of their aircraft, literally tacking it into the aircraft, because at that time we did not fully understand how it worked and we wanted to make sure it was effective. We know it saved quite a few aircraft in Southeast Asia.

CHAIRMAN HALL: Well, I don't guess -- now, who is the gentleman from Wright-Patman? Yes, sir? Mr. Lauzze, do you know this gentleman?

MR. LAUZZE: No, I do not know him, sir.

CHAIRMAN HALL: Okay, well, you might want to check him out. He says he is still willing to help.

MR. LAUZZE: We will follow up on it, sir.

CHAIRMAN HALL: He sounds very knowledgeable. Well, I will turn it back over now to the panel and, Mr. Anderson, if you want to continue with the conversations.

MR. ANDERSON: Thank you, Mr. Chairman. Good morning, Mr. McSweeney.

MR. McSWEENEY: Good morning.

Whereupon,

TOM McSWEENEY, **GREGORY DUNN**, **BILL CROW**, GEORGE SLENSKI, KEN CRAYCRAFT, IVOR THOMAS, ALEX TAYLOR AND ROBERT VANNOY

were re-called as witnesses by and on behalf of the

NTSB, and, after having been previously duly sworn, were examined and testified further as follows.

DIRECT EXAMINATION

BY MR. ANDERSON:

Q We invited you to this panel today to discuss the impact that the military survivability techniques that we have discussed in the last session might -- and also existing fuel protection designs -- might have on the FAA's view of the regulatory problem concerning fuel tank safety.

In view of what we heard yesterday from Dr. Ball and the testing people with the DOD, which one of these concepts or designs, preferably ones that are all ready in use by the military, would you say would be most applicable and be most quickly adapted into a commercial environment?

A Well, I think it would be a mistake to make that decision here today. If you consider the fuel triangle and the three components, the FAA's program deals with looking at the fuel, the ignition and the oxidizer, in this case oxygen.

I think it would be premature to say anything other than everything is on the table. Until all are weighed against each other, I think it is premature to make any decisions about which are more feasible in civil aviation than any others.

Q Do I understand you to say, sir, that this

process of evaluation of these systems is just beginning?

A Oh, absolutely not. I mean, the FAA did in fact look at nitrogen and inerting years ago. We have been looking at everything dealing with the fuel triangle since the accident.

One of the greatest myths is that we have only been concerned about ignition sources, and that is in fact a myth because that has not been our sole approach since the accident.

Q Thank you very much. My point here -- perhaps I should restate the question -- is that we have a series of technologies, we have provided a tutorial, if you will, on the theoretical underpinnings.

It would seem reasonable that some of these technologies would have a shorter past development, and given that the FAA has been studying this and my records show here since at least 1971, that there would be some engineering data on the part of the FAA that would relate to this question and perhaps could be shared with the public.

A If I may, I think your statement that we have been studying it from '71 is really only partially correct. We did study it in '71 and we did make a

decision, and the decision was made in the 70's. What is true is that we haven't studied it since, until this accident.

But, I don't want to leave the impression that the FAA has been studying something for the last twenty-five years.

Q What is your opinion of the -- we have been discussing the foam technique for inerting or preventing catastrophic explosion in fuel tanks. What is your opinion of that technology at this point, sir?

DR. LOEB: Before you answer that, let -- I would just like to ask a question, Mr. McSweeney. Why is it that given that the fuel approach that you took failed, why is it that you did not go back and take a look at other options after the success of the early 1970 foam work?

WITNESS McSWEENEY: The tests that I think you are referring to is anti-misting kerosene, and that was --

DR. LOEB: That is correct.

WITNESS McSWEENEY: That was the test in the desert. That test showed that the benefits that people expected to have gotten from anti-misting kerosene and the benefits before that time were seen in the laboratory just did not present themselves in full

scale testing.

An interesting piece of information is a very similar accident to that test in the desert occurred one month after, and that was the Manchester accident in which hot fuel came out of the wing and impinged on an engine that was very hot, just like what happened in that test in the desert.

That whole effort, though, was at post-crash fires. I think that is important for everybody to understand. The FAA at that time was looking at post-crash fires and did, in fact, come to conclusions that the anti-misting kerosene was not the way to go.

So, it took a different path, and it has completed that path, and that path consists of hardening the interior for fire entry into the cabin, and that includes side wall ceiling panel flammability, low level lighting, lavatory smoke detectors, et cetera, et cetera.

DR. LOEB: All right, and I do recognize that that was directed solely or primarily at post-crash fire. However, the foam would be helpful in both post-crash fire and helpful to prevent explosions of the tank.

The early work indicated that the foam had promise, at least, great promise in helping in both

directions. When the test in the Mojave failed, why did you not go back and take a look at the foam as another possibility. Incidently, we have had post-crash fires in accidents involving transport aircraft since then.

WITNESS McSWEENEY: Well, I would not deny that statistic. The success, though, has been much greater than it was before the 70's and 80's.

DR. LOEB: Yeah, I would agree.

WITNESS McSWEENEY: The lives lost have gone done significantly.

DR. LOEB: Yeah, I will agree with that. I am just asking why you didn't go back and take a second look. I mean, it may have been -- there may have been some factors that we need to know about here that were involved in why you didn't; weight, or the penalties, or --

WITNESS McSWEENEY: At the -- well, I wasn't in the decision-making at the time, so I can't be exact, but my recollection of reading the material was that we believed it was not a safety improvement that mandated -- or, warranted that kind of action at the time, because we were focusing on post-crash fires.

DR. LOEB: Is the FAA now looking at foam as a potential source for both remediating fuel

explosions, fuel air explosions in the tank, and post-crash fire?

WITNESS McSWEENEY: We are looking at all three elements of the fuel triangle -- the fire triangle as possible solutions to explosions in fuel tanks.

DR. LOEB: All right, but specifically --

WITNESS McSWEENEY: And everything is on the table.

DR. LOEB: Specifically, are you looking at foam right now?

WITNESS McSWEENEY: Yes.

DR. LOEB: Are there studies underway, and can you help us out by telling us what you are doing in that --

WITNESS McSWEENEY: I don't personally know of any studies. I guess first of all I would ask what you mean by a study. We certainly are looking at what has been done. We are working with the military in trying to capture their experience and, as I said, everything is on the table.

CHAIRMAN HALL: Was this letter correct? Was there something done in 1965?

WITNESS McSWEENEY: Mr. Chairman, I am really not familiar with the letter.

CHAIRMAN HALL: I know that goes back a long time, Mr. McSweeney.

WITNESS McSWEENEY: So, I really hate to comment on something I don't really have any knowledge of.

CHAIRMAN HALL: Okay, I would appreciate it if there was a test for -- in 1965 of this material, that it could be provided for the record.

WITNESS McSWEENEY: We will be glad to do that.

CHAIRMAN HALL: Mr. Anderson?

BY MR. ANDERSON: (Resuming.)

Q Mr. McSweeney, following along here, I think the foam is a good example of a technology that, of course, deserves attention. But, I guess what we are interested in is how the FAA is going to evaluate this, what type of resources will be used and what the total role will be of the FAA.

For instance, will your research facilities be actually conducting tests, will you contract this out? Just how would this program proceed, and could you give us some idea of time that is involved?

A Well, it is really a multi-faceted effort. We have a lot of expertise in fires, we have a lot of expertise in fuels at the Technical Center. They have

been involved in the issues all along. They are involved in the present effort.

We have several folks in Seattle working, in effect, full time dealing with the possible solutions to explosions in the fuel tank.

CHAIRMAN HALL: Mr. McSweeney, that leads me to ask the question why, with all the expertise the FAA has, was the decision made to have this studied by an ARAC group for six months, which was Ms. Garvey's response to the Chairman on December 3rd in regard to our recommendations.

WITNESS McSWEENEY: I was --

CHAIRMAN HALL: Do you know what the budget is in Atlantic City, the fire --

WITNESS McSWEENEY: Not off the top of my head, no. No. I was about to get to that very point in my answer. In the letter from Administrator Garvey, it makes the clear point that the FAA has decided it is going to do something.

That is not -- ARAC has not been asked to study something. ARAC has been given -- is going to be given the specific charter to develop specific solutions, as everybody on ARAC sees them, of how to deal with minimizing or eliminating explosive mixtures in fuel tanks.

What we will -- are expecting to get at the six month period is specific technical answers and solutions.

CHAIRMAN HALL: Well, let me ask one other question, then -- and let me say again, sometimes I don't think the public appreciates some of the regulatory processes that are in place at the FAA that require you all to -- and are there obviously to be sure hasty decisions and wrong decisions aren't made which everybody, I think, acknowledges and appreciates.

But, it says "after the notice of the new task assignment goes to the Federal Register." Could you give us a date this morning on when that will go to the Federal Register?

WITNESS McSWEENEY: We have promised that within two months of sending that letter to you we will have the notice in the Federal Register. We expect to beat that by a significant amount of time.

CHAIRMAN HALL: What would be the situation as we found with flight and duty time where the ARAC committee locked down and came up with no decision? What would the FAA's position be then?

WITNESS McSWEENEY: Well, it was -- it's -- because of some past --

CHAIRMAN HALL: And let me say, the reason I

ask that, Mr. McSweeney, as it says in the letter to me, "FAA will then," referring to after the ARAC committee, "will then act upon the ARAC recommendations and make appropriate judgment and decisions on further actions expeditiously."

Does that mean that if -- I guess just for clarification, if the ARAC comes up with no recommendation, or no consensus, do you have any idea -- and I know you can't speak for the Administrator on this -- unless maybe you can -- can -- what -- do you know what would be the FAA's position in that situation?

WITNESS McSWEENEY: Well, I certainly can't speak for the Administrator, but I can certainly recommend to the Administrator.

The ARAC is constructed this time for some very good reasons, and you raised those reasons. We at times in the past have seen ARAC committees get bogged down because there are conflicting interests on ARAC. So, we have set a specific time frame of six months, and we have said we want a report that will be a technical report of solutions, not issues to study.

It may contain differences of opinion, and that is fine. We will then take that report, we will then make a decision within the Agency on where to go

and then we will charter ARAC, or we will do it ourselves, immediately prepare a notice of proposed rule making for whatever decisions we believe are appropriate. So, we really tried to set this up so that it can be absolutely as fast track as we can make it.

Quite frankly, the ARAC process is the only process that offers the opportunity for the U.S. Government to meet with private people, including citizens, to discuss regulations openly and above board and on the table.

My predication has always been that if we were to take a controversial thing like this and not put it into ARAC and just simply do an FAA notice, that it would become so controversial during the comments stage that we would actually take more time doing it that way.

CHAIRMAN HALL: Well, I guess -- I don't want to leave the impression that we are just beginning. I think you had a committee, a comment period, right? -- that took place this year in regard to our recommendations to the FAA, and the industry put together a unique group.

In fact, it seemed to be one of the first times that I have seen the international and domestic

manufacturers and associations all come together, and they made specific comments to the FAA in regard to the recommendations. Is that not sufficient?

WITNESS McSWEENEY: The recommendations weren't -- the comments we received from the docket weren't specific as to exactly what the solutions should be for the fuel triangle, and some people recommended we deal with the sparks, other people recommended we deal with the fuel which showed some very good promise, and other people said let's inert the tanks, or let's put foam in.

What ARAC is going to do is take all of that information, the information from the FAA and SAE fuels conference and the information from this hearing right here, synergize it all together and come up with a solution with very specific actions being recommended.

CHAIRMAN HALL: Again, did you say when that notice would go out to start the six month period running?

WITNESS McSWEENEY: We have promised to have the notice out within two months of the letter to the Board. We will probably beat that time.

CHAIRMAN HALL: Thank you.

WITNESS McSWEENEY: The notice is presently drafted all ready.

CHAIRMAN HALL: George?

MR. ANDERSON: Thank you, sir.

BY MR. ANDERSON: (Resuming.)

Q Mr. McSweeney, I would like to sort of back up here and discuss the process by which we get from the studying of the problem to the final system that is on the commercial airplane.

I would like to just briefly list those steps so that the public understands what we are talking about here and where we stand. The first step in my terminology would be a paper study, which we have heard some of these where no hardware is being built, but concepts are being evaluated and weighed and so on.

The next step is really what you represent in the FAA, and that is the policy decision of what will be required. Only when that decision is made can design begin by the commercial industry, and design is followed by development, and development in the case of what we are hearing here may take some time because of the problems inherent in using the technology that we may have seen all ready.

The last step is to manufacture hardware, and it has a lead time that may even eclipse the other areas, and having said that, Mr. McSweeney, I would like to point out that the military has completed all

these five steps.

They are today operating airplanes with these systems on board. What I seem to be hearing from you is that the FAA is still on step one. Have I missed something, or have we actually gone further down the road?

A To answer your question, I would like to ask the question of the military, if I could.

Q Who would you like to direct it to, Mr. McSweeney?

A Either the Air Force or the Navy.

Q Mr. --

WITNESS McSWEENEY: My question is, does either one of the gentlemen representing those services believe that the existing military systems can be retrofitable right now into commercial airplanes?

MR. ANDERSON: Mr. Lauzze?

MR. LAUZZE: I don't believe you would take it right off the shelf and retrofit it. I believe there would definitely be some study required and a lot of engineering required before it would be directly applicable.

MR. ANDERSON: I would think -- is that all, Mr. Lauzze?

MR. LAUZZE: Yes.

WITNESS McSWEENEY: I would then add, because that is what I thought the answer would be, that it is really not, first of all, a paper study. It is an engineering study, it is a risk assessment study.

Anything you do in that fuel tank is going to add risk. Whatever it is, you have to make sure it is dealt with. Even foam adds risk to the maintenance cycle. We heard that yesterday. It --

CHAIRMAN HALL: My only concern on that, Mr. McSweeney, is why that work didn't begin in the summer of '96.

WITNESS McSWEENEY: In the summer of '96, I don't think it was clear to anybody as part of that accident investigation that foam was the immediate solution to that problem.

CHAIRMAN HALL: I am not saying foam, I am saying looking at all these military alternatives that had been available and had been used, some since the early 60's.

WITNESS McSWEENEY: As I said earlier, our folks began very soon, within a few weeks after the accident, looking at all possible causes, which then led us to all possible solutions. So, we have been looking at things.

DR. ELLINGSTAD: Excuse me. Could I follow

up, Mr. McSweeney? In addition to the ARAC process, you have indicated that there is a considerable amount of research and engineering analysis.

What kind of resources is the FAA committing, either in terms of the programs at the Technical Center, or in terms of any extramural research activity addressed to these activities?

WITNESS McSWEENEY: What activities, now, are you speaking of?

DR. ELLINGSTAD: We are talking about this whole business of looking at controlling flammability, the kinds of suggestions that have been discussed here.

WITNESS McSWEENEY: Well, let me take the three elements of the triangle, the fire triangle, one at a time. First of all, fuel. We have written to the American Petroleum Institute and asked them to form a group to begin looking at using JP-5 in commercial aviation as a replacement for Jet-A. So, we are dealing with that part of the triangle.

We believe people like the American Petroleum Institute have far more expertise than any of us on what it would take to do that, because the cracking facilities in the United States are probably the greatest issue there.

As far as ignition sources, we have issued

several Airworthiness Directives, we have dealt with two possible accident scenarios in our Airworthiness Directives. One, quite frankly, is a notice, and I recognize that.

As far as the -- dealing with the oxygen, we have looked at and talked to people who have submitted comments to our docket proposing everything from CO_2 to nitrogen inerting. We have spent a lot of time talking to those people that use nitrogen inerting. I personally have talked to some McDonnell Douglas people on the C-17 program. So, we really have made an effort to look at all this.

Now, as far as fuel research itself, up to this point we have been more than happy to be just -- we have been more than happy to let the NTSB lead that effort. We know you have ongoing research. We certainly don't -- we certainly believe it is headed in the right direction. So, we have not felt compelled to do any of that research ourselves. We think that it would be a waste of the taxpayer's money.

That is basically it, in a nutshell. I could give you more time if you would wish, but that is a capsulation of it.

DR. ELLINGSTAD: No, that's fine, thank you.

CHAIRMAN HALL: Please proceed, Mr. Anderson.

BY MR. ANDERSON: (Resuming.)

Q Mr. McSweeney, your question of the military and Mr. Lauzze is interesting, but I would like to point out using my frame work here that you are asking him a question that would take place after the policy decision was made by the FAA to proceed.

He could not fairly answer your question until you could tell him what requirements you have set out for the systems to meet. Is that a true statement?

A First of all, my point in making the question -- asking the question, was that even when you do have the policy, you have to engineer the solution to every single airplane, and what is engineered into the 747 might be totally different than what is engineered into any other Boeing product, not to mention the fact that Air Bus and Volker (sic) and others might do it differently.

So, each and every model of airplane has to be engineered, and you are correct in saying that the first step is for the FAA to establish the criteria. We have to define an objective standard to define what level of flammability we would be willing to allow or not allow in an aircraft.

We would not probably, as a result of any rule making action, mandate a particular solution.

There are many who have studied the Agency, including the recent NCAR commission who have given us what I believe are very appropriate recommendations to set the safety objectives, not the design criteria.

It is entirely possible to set a safety standard and have one manufacturer do inerting and another manufacturer cool down the tank or remove the heat sources, or something like that.

Q Yes, Mr. McSweeney, I agree entirely with your statement, and I think it just enhances this process, that what you are saying is that the policy process is a daunting thing, because you must consider the last three steps which is design, development and manufacture, and they carry with it a lot of considerations.

However, do you not agree that until the policy information is available to the manufacturing and the aircraft operators that we cannot proceed?

A Policy is certainly the first step, and that is what ARAC is going to be doing. There are some solutions, though, like JP-5 that don't have airplane design and manufacturing problems.

They have other issues that have to be addressed, but those issues are not with the individual aircraft itself, and once solved one of those issues

would be solved for all aircraft at one time.

CHAIRMAN HALL: Mr. McKinney (sic), since we are talking about, obviously, something that sounds to me years in the future, Ms. Garvey's response to me on page four says, "the FAA does not now see a significant safety benefit from adding center -- adding fuel to the center tank when it would normally be empty, but the FAA is open to any future findings coming from the Board's accident investigation."

Have you had an opportunity to look at the work Dr. Shepherd has done, and would that in any way impact the FAA's position, or will it at least be taken under consideration?

WITNESS McSWEENEY: Yes, we have had a chance to look at that. In fact, the very night of that presentation I held a meeting with my folks that were here and we discussed that matter.

What we said in Ms. Garvey's letter is in fact true. It still is true. What Dr. Shepherd presented is information that appears to be different than the information we had when we made that statement.

CHAIRMAN HALL: But, I believe he made this presentation at the Fuel Flammability Conference to the whole industry, but that didn't seem to change their

opinion.

WITNESS McSWEENEY: I was just going to get to that point. The material was presented at the Fuels Conference. I personally discovered that after it was presented here. I then talked to lots of folks, both in the FAA and outside the FAA who were at that conference.

Nobody that I talked to could recall it from that Fuels Conference. So, for some reason it wasn't recognized for the value -- and I think that is an appropriate term -- of the presentation from that Fuels Conference. I don't know why, but it wasn't.

CHAIRMAN HALL: Dr. Shepherd, are you -- well, let's let -- Dr. Shepherd, are you that boring, or did you not present the information?

DR. SHEPHERD: Well, I sure hope I am not that boring.

(Laughter.)

WITNESS McSWEENEY: Certainly my comment was not intended to be a personal comment about anybody.

DR. ELLINGSTAD: We might also note that the proceedings of that conference were made available before the conference was adjourned, including Dr. Shepherd's paper.

WITNESS McSWEENEY: That is correct, but I am

here to say for the record that that information was not considered at all, because we literally didn't focus on it and it did not get our attention at that Fuels Conference.

So, the letter referred only to other information, and I think we still have to spend some time studying the information that Dr. Shepherd has presented here, and we began that two days ago.

CHAIRMAN HALL: Well, that's the main thing. We can have -- there is, obviously, honest misunderstandings, and if it wasn't highlighted at the Conference, then all I am asking is you are going to consider that information now?

WITNESS McSWEENEY: Absolutely.

CHAIRMAN HALL: Thank you.

DR. LOEB: Mr. McSweeney, I -- just for clarification on the JP-5 issue which I think is certainly an interesting -- an interesting prospect, if we can solve the problems within this country, what do we do about the issues of the availability or non-availability of JP-5 outside of the country and the myriad foreign countries that our carriers fly to?

WITNESS McSWEENEY: That certainly is an issue that has to be dealt with. There are many cases when other countries take the lead of the United

States. There are international oil societies and organizations, and certainly we would be approaching those.

The encouraging thing about JP-5 is the forty degrees fahrenheit change in flammability. It literally is like taking this curve over here, the tall curve on the left, and dropping it down to the horizontal access.

That would -- it is not -- I know it is not mathematically that, but that is what the effect would be. The other interesting point is that JP-5 is all ready approved for the engines of today.

I want to not be overly excited about JP-5. I want to put some caution in there. It does not, though, give us a freezing point problem. The freezing point is equal to, or a little bit less than the fuels we have now.

So, we are not going to have a problem with cold soak at altitude. It starts a little harder on the ground if you cold soak an airplane with fuel overnight at minus degrees.

But, the point is if you could in fact be successful with JP-5 in getting it into the airplanes, it would not require a change to the airplane. It would give you an immediate improvement such that no

wing fuel tank would have an explosive mixture immediately.

You might have to do more to a center fuel tank to drop it a few more degrees, but out analysis shows just using the flammability limits at sea level that you could go from -- you could make a twenty fold increase in safety in the center fuel tank on the 747. That is worth going after.

DR. LOEB: Oh, I agree. I mean, I think it is certainly something that is very worth exploring. How do you intend to address this on the international level, going through IKAO, or just going through a bilateral process, or --

WITNESS McSWEENEY: I don't think IKAO is the form. I think the international oil consortiums are probably the way to go. I have already had discussions with Mobil Oil to try to get them very active into the ARAC process. My plans in the future -- and I am quite frankly haven't started the international part yet.

I think it is important to get the domestic part going first -- but, my plans in the future would be to contact people like that and see if we can get the U.S. industry to stimulate that kind of involvement.

DR. LOEB: Have you been given any indication

from industry what kind of time frame we may be talking about to get something going?

WITNESS McSWEENEY: That is the focus of our letter to the American Petroleum Institute.

DR. LOEB: Okay. Well, did we ask for a copy of that for the record? I don't think we have seen that letter, and if we could --

WITNESS McSWEENEY: We can certainly provide it.

DR. LOEB: Thank you.

BY MR. ANDERSON: (Resuming.)

Q Mr. McSweeney, in view of the previous remarks, it would probably be appropriate at this time to ask you to describe the ARAC members that you know of right now. Who are you going to invite to sit on this committee, and who do they represent?

A ARAC is a group of people that represent manufacturers, operators, flying public and citizen groups. They represent all elements of aviation. The FAA doesn't invite members to sit on particular ARAC efforts. ARAC is a standing committee. It is an advisory committee under the law. It has sixty-some members, I believe, at this point.

Members themselves -- once ARAC is chartered with something to do, the members themselves make up

their mind as to whether they want to be on that effort, or not.

Sometimes we have reached out to specific members and specific elements of the community and said, "This is important and your input is very important and, so, we would really encourage you to be on this particular ARAC effort, because without your input into the synergy of the solution, we don't think we will probably have the right solution." That is kind of how it works.

Q Let me try some names. Would representatives of the airlines be on this ARAC committee?

A Yes.

Q Would representatives of the Air Transport Association be on this committee?

A I believe so.

Q Would members of manufacturers who manufacture foam products, would manufacturers who manufacture the various types of nitrogen inerting be on this committee?

A That question, I don't know at this point.

Q Would that be a good idea?

A To get the input from those people, yes, that would be a very good idea.

Q I was --

A You can be a member of the active working group and be representing anybody and not be on the full committee, though. It is possible for that to happen.

Q Why would they not be a full member? Why would they be different?

A ARAC, up to this point, has been a fluid group. People have joined as they see many times the opportunity to involve themselves in regulatory actions with the Agency.

I don't know why the industry that represents any kind of foam or nitrogen inerting haven't been on ARAC. You would really have to ask them. I would assume that if they want to become involved and be a member of ARAC right now that their application would be appropriate.

We do not invite or bar anybody from being on ARAC. I mean, it is an industry, it is a public thing.

Q I understand, sir. In your opinion, as we sit here today do you believe that it would be advantageous to this process to have representation from these industries?

A Yes, I do.

Q Thank you. I would like to ask another question, Mr. McSweeney. In your role of setting

standards which, of course, as we said before, is the very beginning of this process of getting safer airplanes, is there anything in the certifications regulations that you write and make available to the industry that limits the amount of safety that an operator can put on his airplane?

In other words, are there airplanes out there that are safer than others because of their designs?

A Our regulations define a very high level of safety. One of the things that I absolutely despise is the word "minimum." It is a legal term, I believe. It is minimal -- it is the minimum standards that are required, but they certainly are not minimum safety. We set a very high safety standard.

When the FAA certifies an aircraft, it certifies that that aircraft complies with those very high standards. It does not say that that airplane is safe, or that one airplane is safer than another. It says that the standards on which that safety have been judged have been met.

We do not have a way -- and I don't believe anybody has a way -- of looking at an airplane and saying overall it is safer than another airplane. It is a very -- it would be a very complicated thing.

There are airplanes that for some very good

reasons, like airline dispatch requirements, have components in them that go beyond -- and levels of safety that go beyond what the regulations require.

Those are for economic reasons. They are not for safety reasons. They are so that when you are sitting at the gate and a particular component happens to fail, they can go to the master minimum equipment list, or their minimum equipment list, they can do what is necessary and dispatch the airplane so the hundreds of people on that airplane can get to their destination. So, that is kind of why that equipment is in there.

(Tape change.)

Q Thank you, sir. Is there -- let's take a hypothetical situation in which an airline decided that they wanted to speed up the process that we perhaps are beginning here and try an advance type of system.

Would there be anything in the certification regulations that would prohibit somebody from moving ahead in a more quick manner? -- and the FAR is what I am referring to.

A There is nothing prohibiting anybody from putting anything in the airplane that will improve safety. We would have to do two things. We would have to make sure that it is, in fact, an improvement in

safety, and we would have to make sure -- and this is most important -- that it is fully certified as improved before it goes in airline passenger operation.

In other words, we don't use airline aircraft to do any kind of testing. It would have to have been totally proven out before then.

Q But, if an airline decided they wanted this to begin, would you work with them and would you accelerate the process so that they would be able to do this?

A Oh, absolutely. I mean, we would be more than willing to work with anybody about anything that has to do with safety.

Q That gets me back to our discussions yesterday. Would the military's experience and the fact that the military has fielded systems that are operating help you and speed you on that process?

A Well, that's almost a given in my mind. I mean, any technical information that has been -- that is available from past efforts is certainly going to speed up a future effort, because we all learn by connecting what we know to what new information we have.

Q Thank you, sir.

A That is the way the human works.

MR. ANDERSON: I would like to go to Mr. Thomas just for a side question here along this line.

DIRECT EXAMINATION

BY MR. ANDERSON:

Q Good morning, Mr. Thomas. To your memory, has Boeing Aircraft ever received specific requirements for an airplane that they bought which weren't your generic offering?

A Could you repeat the question?

Q Yes. When a customer comes to you, have they asked for special features that you don't routinely offer on a --

CHAIRMAN HALL: Mr. Anderson, let me get this more specific. Mr. Thomas, first of all, I appreciate -- what is this, your fourth or fifth panel?

WITNESS THOMAS: Fourth time, I believe.

CHAIRMAN HALL: That is -- and as anybody who has had the opportunity to sit under these lights, you know what a pleasure that is.

WITNESS THOMAS: Yes.

CHAIRMAN HALL: You know, the Safety Board has 400 employees. The FAA has about 40,000, and about 4,000 of those are in Flight Standards. Boeing is the flagship industry of our nation, with over 200,000 employees.

Could you tell me what you all have done since the TWA accident in the area of looking at foam,

looking at inerting, looking at the possibility of any technology that would keep wires out of fuel tanks, any things that would run the wires for the fuel quantity indication system in a -- separate from the low signal wires, or to add some shielding which I think is usually done in the chemical industry any time you have parallel wires like that run?

What has Boeing done in that regard since the accident?

WITNESS THOMAS: That is a long question. Let me try and answer it. We have been studying all of these options basically since we realized that we were not going to find an easy solution to TWA 800.

It became very obvious we needed to expand our attention. The NTSB recommendations focused our attention on a lot of these things. We undertook to study those things.

We have looked at fuel tank inerting, we have looked at foam, we have looked at JP-5, we have looked at ullage sweeping. We have done all of these things. We have looked very carefully at our systems. We continue to do so.

We have looked at are there techniques to get away from electrical driven fuel pumps. These things are all the issues we have been looking at. Shielding;

I am not an electrical engineer. I know we have discussed it at length as to the options.

Some of our later airplanes are shielded already simply for performance reasons, particularly the later airplanes where we changed technology in how we sense the signals to and from the gaging system.

We required those systems be shielded, so we have incorporated those into the later airplanes. Not for safety, per se, but for performance reasons where there are some side benefits from that. So, we have done all of that.

We were -- a lot of that is -- you referred to the industry response to the FAA. A lot of those studies are documented in that response. I was literally technical leader, if I can use that term, of that response, and a lot of the work was based upon studies done at the Boeing Company and in cooperation with McDonnell Douglas.

At the time we did all of that work, McDonnell Douglas was still a separate corporation and we cooperated with McDonnell Douglas, we cooperated with Air Bus and we cooperated with Lockheed.

CHAIRMAN HALL: Have you -- do you anticipate participating in this ARAC committee that the FAA will put together?

WITNESS THOMAS: The Boeing Company certainly will participate.

CHAIRMAN HALL: What is done in the Boeing Company between the military side of the house and the commercial side of the house in sharing safety information on similar products, aircraft types, and what have you done?

Are there any of the Boeing aircraft types that have the foam or the inerting systems? Any experience that you would want to share with us?

WITNESS THOMAS: Yes, sir. Certainly. The answer to the first part of your question as far as sharing information; there is a -- not what I would call a formal process of us going over to the military side of the house and vice versa.

We do on a regular basis exchange employees. If the military has a need for a two year project, one of our engineers, or two or three of our engineers will be loaned to that military project. When they come back, they will bring that information with them.

I certainly have been involved in that kind of thing. So, most of the fuel system -- particularly the senior fuel system people get involved. One of the issues, obviously, on the military side of the house is security.

We have black holes where people literally disappear for six months and, you know, we just do not see or hear from them. You know, we know they are working on a military project.

When they reappear in the commercial side of the house, they actually cannot talk about the specifics of what they were working on, but if there is some particular safety benefit, then that becomes available.

A good example of that is the study of a fuel tank inerting system we reported in our response to the FAA. We had two key players in that activity in the Boeing Company, both of whom had worked on military airplanes and were very, very familiar with the military side of the house and development of the OBIG system.

We use the military side of the house, the computer codes, the size, the OBIG system. We used those codes to develop the response that was in the -- that we sent to the FAA. So, there is a lot of -- I think -- I myself, personally have worked at various times on fuel tank inerting. We have looked at foams.

The presentations that were given yesterday, I was certainly familiar with all of the information presented.

CHAIRMAN HALL: Can you give us again what specific information -- action has been taken by Boeing since -- under service bulletin since the accident in regard to the 747 center fuel tank system?

WITNESS THOMAS: I am not sure I can come up with a complete list. I can certainly sit down with --

CHAIRMAN HALL: Well, we will take a break here in a little while, and if you could get the table to do it. I would like to just have on the record the things that the company has done, and I understand that you all had some concerns about inerting. Do you want to put those on the record?

WITNESS THOMAS: I would certainly like to speak to that after the break.

CHAIRMAN HALL: Okay. I am sorry, Mr. Anderson, I keep interrupting, but it is day five. Go ahead.

MR. ANDERSON: Thank you, sir.

BY MR. ANDERSON: (Resuming.)

Q Mr. Thomas, following on, I am interested in the perception of your customers over time. Has anybody discussed inerting or other means of enhancing protection of fuel tanks on any of your products?

I would ask you to consider both your military and commercial customers. Have they inquired

about these programs? Have you bid to the military to produce an alternate system than what is currently in use?

A Excuse me, what was the word you used? -- bid?

Q Bid. When you -- normally the process of obtaining business from the military is that you bid. You submit a bid where you have a design and the military evaluates it, and if they like it they award you the contract.

A As I demonstrated, I am not familiar with the military side of the house. I have been in the commercial side of the Boeing Company for all my career.

As far as customers coming to us, yes, the customers have come and asked our opinions on a lot of these issues. We have responded. Certainly when we put together the response to the FAA, a lot of our customers were involved in looking at those responses.

Q Thank you sir. I --

CHAIRMAN HALL: Mr. Thomas, so I understand, if you don't think it is unfair for the Chairman to ask, since the taxpayers basically fund the military in this country, that if there is safety information that that somehow gets transferred? I don't want to be out

of order here.

WITNESS THOMAS: No, absolutely, sir. I think what we try and do --

CHAIRMAN HALL: And I don't think that most Americans want -- you know, they are not interested in strafing areas in their commercial planes, so there is a difference.

But, if there is safety things; fuel tank, electrical system, things like that, you know, could you maybe look at how you might be sure you got all those safety benefits being exchanged?

WITNESS THOMAS: Yes, sir. I think that is -- I think a lot of what is going on takes place in the open committees, the SAE meetings, those kinds of things.

There is -- that is probably where the military and the commercial side come together for conversations and to catch up with what is going on. We have members on those SAE committees.

They bring back information. I see regular reports from those activities. That is probably why I know -- I am pretty familiar with most of the topics that have been talked about this morning.

CHAIRMAN HALL: Well, again, that is what got me back -- you know, the testimony -- I guess it was

Dr. Ball about losing the 5,000 planes during the Vietnam era and how much better we did in the Gulf War and, you know, that is all technology and things we learned through the loss of American lives and the expenditure of American dollars, and I would just like to be sure we have that benefit on the commercial side, as well.

WITNESS THOMAS: On that point I would -- for the record, when we have been talking about looking at, you know -- I lost the right word -- external threats to the airplane. When we were considering those we engaged with our military people. The survivability and vulnerability people on the F-22 were brought into the team and supported us for many, many months.

CHAIRMAN HALL: What are you doing on the fuels area? Did we touch on that, Mr. Anderson?

MR. ANDERSON: I would like to develop --

CHAIRMAN HALL: Is that a future question? What, have you all been looking at any alternate fuels?

WITNESS THOMAS: I believe we were the company that proposed looking at JP-5, sir, when we first started talking about this. Because of the forty degree shift to the right, if you will, on the curve of the flammability, we could see there was some significant benefits and, as Mr. McSweeney has said, it

becomes an option that becomes readily available to all the fleet.

CHAIRMAN HALL: Dr. Shepherd, have we looked at JP-5? Is that something that could be incorporated in your work?

DR. SHEPHERD: We could do that, but we haven't done that at this point.

CHAIRMAN HALL: All right, but we might -- that is something we might want to get Mr. McSweeney and Mr. Thomas' input on, and that is something that we ought to do as part of this -- your ongoing efforts -- that is something we ought to consider.

MR. BIRKY: Mr. Chairman, could I follow up on a question you had asked a little while ago of Mr. Ivor Thomas? After the Filipino explosion, I know we talked rather extensively about the technology of gaging the tank without putting wires in the tank.

Is any technology being pursued, development, or what is available to do that at this time?

WITNESS THOMAS: At the present time the technologies we have looked at on the 777; we use a new technology called ultrasonic technology, which is in layman's terms a sonar pinger at the bottom of the tank that sends a pulse of sound to the fuel servers.

It bounces back down, and you time the -- you

basically measure the time it takes to travel that distance, and then the computer calculates the height of the fuel and then calculates how much fuel is in the tank. That is the technology. That still involves wiring going into the tank.

We have looked at and have tested -- what's the right word? -- pressure sensitive systems. In other words, it will have three pressure sensors in a triangle. I can measure the height of the fuel from those three pressure sensors and also the angle of the surface.

So, if I now know the attitude of the airplane and the angle of the surface, mathematically I can calculate how much fuel is in the tank. We have tried that in a limited experiment. The problem there is the accuracy of the pressure transducers and the reliability of the pressure transducers to be able to -- you know, we want to be able to measure a quarter of an inch so we can calculate the fuel accurately enough.

We currently have gaging systems that are accurate to half of one percent of the tank. If you are lucky, your average gas gage is probably good to maybe twenty percent. My car at low fuel volumes is hopelessly inaccurate.

So, in that regard it is very important if the gentleman next to me wants to know how much fuel is in his airplane. As a result, we have to be very, very accurate and very reliable. So, we have looked at those things. So, I think that answers the question. We continue to look at alternatives.

People have proposed fiber optic systems to look at fuel tanks, also.

CHAIRMAN HALL: Mr. Thomas, since this, have you all looked at what is done in the chemical industry and the nuclear industry? I have gotten so many letters from people with Ph.D. and stuff after their name saying, you know, these -- we had these things and experiences in the marine industry, and I know it is not exactly compatible, but is there anything we can learn from the experience in other industries? Have you all looked at those?

WITNESS THOMAS: At this point we have done some limited looking. I think we need to go further. We have some engineers who have been in the oil business, or the petrochemical industries. So, we get some feedback from those people and we discuss it.

We have not pursued that at a high level. We have been focusing on other solutions, like JP-5. So, I think we need to continue with that expansion of our

knowledge base into the petrochemical industry and nuclear industry. But, we have not done a lot at this point.

CHAIRMAN HALL: Well, my brother is a chemical engineer. He went, unfortunately, to Vanderbilt University.

(Laughter.)

I went to the University of Tennessee, but he has been talking to me since -- everybody talks to the Chairman about this accident, and I am pleased to hear you are going to pursue those things, because he thinks there are things that might be able to be learned from the refining and chemical industries.

MR. BIRKY: The interesting thing, I think, from the chemical industry is they start with a little bit of a different philosophy or premise; they cannot design out all ignition sources, so they have to take some other action.

I wonder if that philosophy would be applicable in this environment we are talking about. So, I am suggesting we might look at removing all electrical systems from a tank, for example.

WITNESS THOMAS: We have talked about that. As I said, we have talked about going to non-electrical FQIS fuel gaging systems. We have talked about non-

electric pumps, or moving the -- you know, finding some non-electrical devices that we could use.

We have talked about that. That is a fairly long research project to develop these things. Our current technology has taken us a long time to develop to the state of the art where it is right now. We need to go further, I think.

There is -- I came back to the Chairman's comment about the military. I think the military has probably used more hydraulically driven pumps and other such things on the fighters than we ever have, and I think there is a database that we need to go and explore.

CHAIRMAN HALL: We don't have any of the engine manufacturers involved as a party to this investigation, but Mr. McSweeney and Mr. Thomas, are you all working with them in terms of the JP-5 and looking at the fuels, as well, and they will be part of the ARAC group?

WITNESS McSWEENEY: Yeah. Two weeks ago I contacted my -- the Director and Manager and the Engine Director who reports to me to make sure that they had a specific effort working with the major engine manufacturers to begin looking at JP-5 well before even we got into it on ARAC, to make sure all of the data

was ready to go, and they have looked at it. I since have received two pieces of information back.

CHAIRMAN HALL: Let me apologize and correct the record. Dr. Loeb correctly points out that we do have an engine manufacturer as a party, but they have not been designated as a party to this hearing because that was not an issue.

WITNESS THOMAS: If I can follow up on Mr. McSweeney's reply as far as involving the engine companies. I am the Chairman of the Propulsion Harmonization Working Group, which is another working group to look at the harmonization of rules also sponsored under the ARAC process.

We had a meeting in Phoenix probably six weeks ago where we discussed at length the upcoming ARAC activities to make sure that all the engine and the auxiliary power unit people, which are also involved in this, were aware of this upcoming activity.

So, I think the industry is aware. We are ready. We will work with the FAA on this very hard.

CHAIRMAN HALL: Mr. McSweeney, how would you involve the military, these three gentlemen at the end of the table that seem to have some knowledge in this area? Would they be on the working group, or could the working group access their information?

WITNESS McSWEENEY: Well, whether or not they are on the working group, I would leave it up to them. But, certainly to proceed forward and not access their information would be wrong. So, we are certainly going to have to do that.

CHAIRMAN HALL: Thank you.

BY MR. ANDERSON: (Resuming.)

Q Mr. McSweeney, I would like to follow up on that. Would you invite -- be prepared to invite them to participate today?

A On the working group, yes, we can do that. As a member of ARAC, it -- it -- I don't know the process by which we would do that. But, as a working group -- we have had -- we have had the military involved in our programs at the Tech Center, be it Halon replacement, or be it investigations of fuel and flammability in the past.

We have direct contacts in the research community with the military on a great deal of -- a great number of projects. So, it wouldn't be unique for us.

Q Yes, sir. I -- what I am getting at here is not that the military has not been consulted or that you are unaware of their research, but there is a communication process going on with that committee

where people make inputs and reports are generated.

It would be comforting to know that their inputs would be made in that final report. Do you understand?

A Well, yes. I already said yes, they would be.

Q Yes, and -- so, because most people see the results; they don't see the process. So, if things get lost in the process there is no way of tracking it anymore.

At any rate, I wanted to kind of bring to closure this area of discussion, and to do that I wanted -- we are going to get into later the FAA's request for public comments on the NTSB recommendation.

We have a copy here. There were over 700 pages of public comments received by the FAA relative to your request. So, we would like to discuss that, but before that, because I think it is relevant to what we have been discussing, especially with Boeing, we have a letter here from a person who represents a company who produced foam, Kaleidoscope Company.

I would just like to read into the record just a short part of this discussion, because this is another view of what we have been discussing, and I quote, "Any change to the 747 fleet or others will

require engineering and some engineering changes."

"The penalties and added weight, cost, fuel capacity and added other costs are expected. A 747 center wing tank foam kit would require about twenty days design work, and an additional thirty days to provide a proof kit. Kit costs un-installed would be less than $100,000 each," and so on.

This is an opposing view that I believe should be considered in this committee, and I am concerned that there should be some representation of these kind of specific numbers.

A You know, as I have already said, we are going to consider all that input. I would ask you, though, if you are going to put that comment in the docket that maybe the other thousand pages of comments ought to be also in the docket because that is the only way I think the American public are going to see what all the comments have said.

CHAIRMAN HALL: That will be done. Let's put the whole comments in the docket.

MR. ANDERSON: Yes, we will certainly be glad to do that, and when we proceed further we will try to call upon your memory and deal with those that you feel are helpful to illustrate the problems.

CHAIRMAN HALL: The only thing, Mr.

McSweeney, I would like to mention is that -- and the reason I think Mr. Anderson is pursuing this and we are concerned about it is that there were a lot of representations.

We understand that things have to make sense dollar-wise, but, you know, we had an experience here recently with the Value Jet accident where the estimates and the actual cost of installing the suppression equipment in the cargo holds turned out to be dramatically different.

Since you do have to go through a cost benefit analysis on some of these items under the present process, we want to be sure that you are getting a wide range of estimates from individuals and manufacturers and airlines and other interested parties. So, that is -- I think that is one of our concerns.

WITNESS McSWEENEY: I certainly share that concern, and I thank you for affording people the opportunity to see all the comments.

I think the first issue that we are going to address, though, is not cost. The first issue we are going to address is safety, and we have got to look at the safety objective of where we are headed in this effort, and that has to drive everything we are doing.

MR. SWAIM: Mr. McSweeney, I have a question, a couple of questions for you before we get too far from our last part of the conversation.

In the 70's the FAA -- you had mentioned that the flammability studies previously were for post-crash fires. In the 70's the FAA went so far as to SDC a DC-9 with a nitrogen system.

My question is, what is to keep this effort going that it does not get like the post-crash fire fuel misting effort and run out of steam at some point there? How many NRS's or other people do you have dedicated to this type of an effort?

WITNESS McSWEENEY: We have -- not counting the people at the Tech Center that are supporting us and have a lot of experience in this area, we have spent on this accident I would say over 15,000 hours of work, and at one time or another I have had over 100 people working on this program.

I don't know how I would respond to a presumption that maybe we will slow down our vigor on this effort, because all I can say to you is this effort has been a top effort in our organization.

It has been one that I have personally been involved in. I brought nine personal notebooks of information to this hearing that I have amassed myself,

and I am not making the technical decisions. I am a manager.

So, we are on top of this as much as we can be. I have 1,000 resources at my beck and call. About 350 of those are engineers. We will put whatever people we need to on this -- on this effort.

I think it is important to recognize that the real message behind Ms. Garvey's letter is that we have -- there is no doubt, we are going to do something. What is up for debate is how are we going to take those three sides of the triangle and develop a synergy of those solutions that is the best solution for this and all other possible ignition sources.

MR. SWAIM: Great, thank you. That is what I wanted to hear. My next question is -- you had mentioned -- you had used the word "minimizing the flammability" earlier. My question is, how far in general terms are we talking?

Are we talking a six percent reduction in the time that we have a flammability problem, or are we talking about reducing to six percent the exposure, or are we talking about trying to make it go away totally?

WITNESS McSWEENEY: I believe the words I used and the words that are in our documentation are "minimize or eliminate." We haven't ruled out

eliminating.

So, the key is, if you look at some of the possible solutions you have, I think that whole range from where we are today to total and absolute elimination. We haven't ruled that out.

What we want to do is to see what are the possibilities that is out there. If JP-5, for instance, proves out, we could probably get a twenty fold reduction in accidents, twenty fold increase in safety. What we -- what you might want to add to that to get you down to zero times in flight when you would have an explosive mixture might be quite minimal.

You could also look at it from, "well, we won't deal with the fuel, we will deal with inerting the tanks." Whatever the solution is, I think it all has to meet the same safety objective of significantly reducing or eliminating explosions in fuel tanks.

MR. SWAIM: Thank you. George?

MR. ANDERSON: Thank you, sir. I would like to go over to Captain Steve Green at this time.

Whereupon,

CAPTAIN STEVE GREEN,

was called as witnesses by and on behalf of the NTSB, and, after having been first duly sworn, was examined and testified on his oath as follows.

DIRECT EXAMINATION

BY MR. ANDERSON:

Q Good morning, Captain Green.

A Good morning, Mr. Anderson.

Q I want to say first that when we put together this panel I think that the -- Mr. Green representing ALPA, Air Line Pilots Association, we were at least a little bit wondering where -- why they belonged on this panel, and my feeling about it was that we had to discuss among the other complexities the importance of the final operator of any new modification or system, or whatever came out of this process of change.

Captain Green, we have been discussing some significant potential here that would affect the commercial air fleet. I would ask you, what are some of the operational concerns. That would be from the crew members, the maintainers and the people that you work with every day that you would envision as meeting scrutiny -- and I know that you have some other comments concerning the methodology that might be used to approach this.

A Okay, I think I can address that. I first wanted to establish, Mr. Chairman, some of my basic credentials. Number one, I have been in the center tank; two, I have read Dr. Ball's book; and three, we

will be at the ARAC.

So, we have covered most of those issues, I think, all ready. Can I put up my first slide?

(Slide shown.)

Thank you. I want to borrow a little bit from Dr. Ball's book and go back to his basic equation of combat survivability in which he said that that was equal to one minus susceptibility times vulnerability. In his case, he is defining susceptibility as exposure to a military damage mechanism, a missile round or some type of weaponry, and vulnerability is the damage mechanism in tolerance that the airplane exhibits.

I think part of the effort here is trying to develop a way to write across some of the military design philosophy into the civilian sector, and I think we can do that beginning with this equation.

If we move into the civilian side of the house, we can write this to say that Flight Safety will equal one minus the susceptibility times the vulnerability, as well, except in our case we define the susceptibility differently.

It is not a combat threat, it is an exposure to a system failure and/or a damage mechanism within the system. Our vulnerability remains very much the same. It is an intolerance to system failure, or the

damage mechanism.

I think the thing that is significant to focus on here is that the susceptibility we are dealing with is very different from the susceptibility that the military is dealing with. We carry our damage threats on board the airplane. They are not located at some geographic site that either can be avoided or perhaps not avoided.

In other words, I don't have the opportunity to elect to operate within the exposure area. I am operating in the exposure area from the time I step on the airplane to the time I step off.

That really is what has driven the civilian approach to this all along. If we take the Flight Safety term, we want to make it one. There are a number of ways that -- well, two ways we can do it.

One is we can drive susceptibility to zero, or we can drive vulnerability to zero, or we can do both. Traditionally, we try to drive susceptibility to zero because we are exposed to that damage source all the time.

As I said, it is part of our mission. We can't say, "well, today the inerting system doesn't work, so we are not going to fly this airplane in combat."

This remains an important concept, but what we are proposing now is that we move towards driving both of these terms to zero, which obviously enhances the opportunity to get a one out of the Flight Safety number.

But, I think we want to be careful that we don't look at this as a swap of philosophies. In other words, I don't want to do away with the approach of eliminating ignition sources. I have got to have a fuel tank with no ignition sources in it, even if I inert the tank because, depending on the design, I don't know if my inerting system is going to be with me all the time, or not.

What is even more important is that a similar damage mechanism may attack other vulnerabilities, and one of the things that I think we may have forgotten here is that due to the outstanding work, for the record, that Mr. Swaim has done in investigating aircraft wiring, we may have identified a damage mechanism that can do me a lot of damage in a number of other ways besides exposing an ullage. So, that damage mechanism becomes very interesting in and of itself.

Reducing that susceptibility has to remain primary because of the capability of that damage mechanism to influence other vulnerabilities, and then

also because my vulnerability reduction, if it is inerting, or what have you, depending on design, may fail during flight.

If I am half way across the Atlantic with a nitrogen inerting system and the little light comes on and says that the inerting is no longer maintaining a nine percent oxygen content in my tank, it has gone up to fifteen, I hope there are no ignition sources in there. I can't afford that.

So, this is really not a design philosophy swap. It is an improvement in design philosophy, and a radical improvement and a needed improvement. But, it is a little different than perhaps the way it has been portrayed in the media to date.

From our perspective, vulnerability reduction must, first of all, have no adverse impact on aircraft system reliability. Now, Mr. Thomas mentioned the other day that the primary purpose behind the fuel system is to provide a reliable and safe fuel flow to the engines, and I am rather fond of that.

I cannot afford any adverse impact. I can't have a vent valve cause me a flow problem. I don't have vent valves now, but I would if I put a nitrogen inerting system in it, or some designs of it.

I can't have a piece of hydrolytically

unstable foam wandering around the fuel system. These are all considerations. They are not insurmountable, but they are all considerations that we have to focus on.

Secondly, one of the interesting aspects of some active inerting systems is that it moves the responsibility for maintaining a safe fuel tank into the cockpit to one degree or another, and that's fine. We have a number of other systems we are responsible for.

We are not necessarily objecting to having an additional one, but if we go that particular route, if that is the option that is chosen, the system needs to exhibit a safe and reliable man-machine interface. We don't want to have a system that comes into the cockpit that introduces a couple more problems that open themselves up to human error, et cetera, et cetera.

Finally, I think, you know, the thing that is also important -- and for this reason we had more or less independently arrived at the conclusion that JP-5 was a very interesting alternative. We need to apply this to all fuel tanks.

The center fuel tank is the focus of attention for obvious reasons, but if we go back to the Madrid accident we see the affects of an outboard wing

fuel tank explosion. We really can't tolerate any fuel tank explosions, and we need to apply it to all aircraft and scheduled passenger service, and I think the Board is familiar with that area of discussion. But, we have been focused on large aircraft. We think the solution needs to incorporate everything down to a Beach 1900 and right on up.

The most important thing, as I said, though, is the design philosophy that exists today must not change. It must be augmented by vulnerability reduction. But, we can't afford to let go of that susceptibility issue. Again, I am really interested in the other ramifications of some of the ignition source possibilities that we have been talking about.

That pretty much concludes that area that I wanted to talk with you about.

CHAIRMAN HALL: Well, let me just comment on that briefly, Captain Green. I think your thoughts are well thought out and well presented.

The Safety Board's position has been a two-track approach to continue to look at removing the possibility of the ignition sources which has to be done, as well as addressing the subject of explosive vapors which previously had not been as fully addressed as the other subject had been.

I, again, am very pleased to see that from both the Federal Aviation Administration and the Boeing Commercial Airplane Group that that is a commitment that the American people now have, that those both are going to be addressed.

In addition, we looked in our recommendations at both the short term and long term, because we realize that a lot of this involves design engineering, and you don't want to put anything on the airplane that would cause it to be less safe. But, so, we had made short term and long term recommendations.

So, I thank you for a well thought out, well presented presentation. Mr. Anderson?

MR. ANDERSON: Thank you, sir.

BY MR. ANDERSON: (Resuming.)

Q Captain Green, you made I believe an important point when you talked about the -- rather, extending this problem to handle all airplanes, basically referring to size and type, but that are endangered.

Could you expand on that a little more and sort of give your concept of that complexity?

A I think it goes back to a requirement. Again, as I think we have all been discussing, if we can establish, which is what we would hope to do

through the ARAC process, a requirement for reducing the flammability of a tank, then it falls upon the manufacturer to decide what technology he is going to use to do that.

There is obviously a variety of opportunities, and I don't think there is any need for all airplanes to use the same technology. The concept of a nitrogen inerting system on a Beach 1900 has got to be kind of overwhelming to the poor folks at Raytheon, and yet it may be reasonable for an airplane such as the 747, depending on how it is developed.

We are very interested in -- and consequently, we are very interested in universal solutions, beginning with a look at JP-5 or derivative fuels, because obviously they apply to all turbine powered airplanes and it is a rather elegant solution, if it is a solution at all.

Foam is another interesting angle, because it is applicable to small fuel tanks. The military has made good use of it in small fuel tanks. It also has no moving parts, which is something we also find very attractive.

But, I think the main thing that is important is that we establish a requirement for how we are -- you know, what the flammability must be, or what the

reduction must be in the tank and then move on from there.

Q I understand. As a charter member of the group that will be attempting to produce recommendations, are you comfortable that the obvious bias that is a natural part of diverse group of parties coming together to do a technical job is going to be held in abeyance while this important work continues?

What I mean by that is, I detect a strong bias against certain technology, and I understand that probably part of that is because of the daunting costs or the unknowns, but how does one, when you are drafting policy, not be thinking about these? How would you imagine that would be put aside?

A I think that is an interesting question. I think you are referring specifically towards the ARAC process, or something of that nature?

Q At least the ARAC process. I know there is many more processes, including, you know, public discussion and the forums.

A I think to begin with it -- we have to remember that we have got a very, very major devastating accident at hand here which, frankly, in my experience with the ARAC process, we are not always equipped with that close and meaningful a purpose.

Secondly, there has been quite an educational process going on in the industry, beginning with the flammability conference, and certainly with this hearing, which has been very, very informative for me. I think as we develop that information, the better we develop it when we go into the ARAC process, it clears away a lot of those obstacles.

Finally, the FAA has taken the initiative to put at least that process on a six month time line, which is something they haven't done before, and I have been involved in the ARAC process for several years, as you may be aware, with in flight icing, and have experienced the frustrations of that.

I think this is maybe a little bit of a different approach that they are taking now.

Q Thank you. I just have one final question, and it has to do with testing. What is needed? What is the key part in a lot of what you express are concerns? Is it the reliability of the system, that it is properly designed and it does not contain inherent failure modes?

That is one thing that was brought out I think yesterday, but perhaps not emphasized in this context, and that is that a system once proposed and even shown to function is not ready to be put on an

aircraft or a fleet, but money must be expended for testing. In some cases the more complex the system the more money must be spent, and I suppose that will be one of the drivers.

Do you feel that this is something that should move ahead on an accelerated schedule?

A We certainly do. I mean, I can't overemphasize our feeling that there is a need to do this sort of thing. We generally don't approach this from a financial side of the house, because we are obviously not paying any of the bills. But, we do have to keep in mind that somebody is, and we do have to get it done.

We are really interested in a solution, and we are also interested in making sure that we don't engage in something that is so costly that it becomes almost un-doable. So, we need to keep it all in balance, but we do want to accelerate this work.

Q Yes, sir. My final point there would be would it not be meaningful and important to at least conduct some testing to resolve some of the questions that arise during the ARAC so that their final results, if you will, are informed and based on more factual information?

A I think that is definitely a need. In fact,

the more information we have going into the ARAC process, the better that would work. I think that Mr. McSweeney made a good point earlier when he said that the Safety Board was engaged in a lot of the testing that will be meaningful on a number of fronts.

Not just flammability, but, as I said earlier, the investigation that Mr. Swaim had conducted, and the more that information is shared throughout the civilian side of the industry between FAA and NTSB and the manufacturers and ATA and AIA and so forth, I think the more effective that ARAC is going to be.

If we can go in with completed work with some reasonably sound, fundamental conclusions, then we don't have to spend a lot of time in the ARAC wondering whether we need to be doing this or not, or whether Dr. Shepherd has actually completed his work, or whether it has been appropriately criticized and found to be sound and so forth and so on, which is the kind of thing that threatens to take place if we are not careful with it.

Q I understand. Is there any other remarks before we go on to another subject from you, Captain Green?

A I think the only thing that I would offer in addition is, as I said, we were interested in the fuel

concept, and I was also very interested at the flammability conference in what Dr. Shepherd had to say about the affect of temperature on the minimum ignition energy.

I think that is a significant player. The temperature control approaches probably should not be overlooked, particular in the short term because they may be an easier approach in the short term.

But, other than that we plan to be very much involved in this and stay involved, and hopefully provide a little bit of a semi-independent perspective in the ARAC and other areas, because we are not a manufacturer and we are not an operator and we are in the airplane quite a bit more than anyone else. So, we have kind of a vested interest here.

Q Thank you.

CHAIRMAN HALL: Dr. Shepherd, Captain Green was paying attention, so --

DR. SHEPHERD: That's good to hear.

CHAIRMAN HALL: So, now I just -- I think what I would like to do is see now if we could take a break. We will take a little longer break than normal, come back at 11:00, and then we will see if we can't complete this hearing by 1:00 p.m.

I don't want to rush anything. I want the

parties to have whatever time they need to ask their questions and -- and, so, we will try to be -- summarize up here, but we want to be sure we cover the subject well.

But, that will be what we will attempt to do. So, we will stand in recess until 11:00.

(Whereupon, a brief recess was taken.)

CHAIRMAN HALL: We will reconvene this public hearing of the National Transportation Safety Board which is called for the purpose of looking into the accident investigation of TWA 800.

Mr. Anderson, would you like to proceed?

MR. ANDERSON: Thank you, Mr. Chairman.

FURTHER DIRECT EXAMINATION

BY MR. ANDERSON:

Q Mr. McSweeney, on a different subject, we heard during an earlier testimony two days ago a Boeing witness talking about the standards that they used for protecting the -- I believe it was bonding protection of the fuel tank area. That would be in respect to preventing static electricity build-up and also arcing from stray electrical voltages.

We heard that the specification that was used was a military specification, and I think that we also heard that that specification was in the process, or actually had been cancelled by the Department of Defense.

We also understand that the Department of Defense, as a matter of policy, is cancelling many of the specifications that, like this one, will affect the design of new aircraft.

Could you tell me what the FAA is doing to assure that this information -- and that is what the specifications in general represent -- is accumulated experience and guidance to assure that this information is being maintained and updated for the purposes of insuring the integrity of the commercial aviation fleet?

A I will be more than happy to. There are several bodies, SAE being one, who have taken on the challenge of the mil specs of being obsolete to pick up some of those mil specs and make them industry standards.

I happen to be a member of the Aerospace Council of SAE. That is the body that basically manages the cooperative engineering program which produces all of those standards and specs.

We have been, over the last -- I think it is about three years, regularly briefed on the progress of converting those into SAE standards. Certainly, the material in those needs to be retained and improved and modified.

There really is a process by which SAE standards are updated on a regular basis. This particular effort is to just take the mil standards verbatim and move it into an SAE standard.

I believe there are other standard-setting bodies that are trying to do the same thing, and we are a part of that because we are on a lot of the teams that help develop those standards.

Q Yes, sir, I understand. In addition to that, to just further clarify it, you are talking about one route where a standard which is being cancelled is

passed to an engineering society, would that be correct to say, that you mentioned?

A Yes, I would call SAE an engineering society.

Q I would ask you if in your opinion the -- all specifications should follow that route, or should there be specifications that perhaps should remain under government control?

A Oh, I don't think I am an expert to talk about what the military's needs might be and what should be under government control and what shouldn't. I think the real focus of the FAA is our rules and regulations, and most of our rules and regulations provide for a level of safety that we are trying to achieve.

It is up to the manufacturers to, using whatever means and methods they believe are appropriate, show us that they do, in fact, meet that level of safety that we have identified.

I think there is a very good argument that the burden of maintaining those industry standards ought to be borne by the industry, not the taxpayers of the United States.

Q When we use the term "standard," don't we imply that everybody is following the same script, so to speak?

A You have to, I think, understand the difference between the military use of standards and the civil use of standards. Standards are acceptable to the FAA. There are ways of doing business.

Certainly there is a benefit to having an industry standard. It is -- there is certainly a benefit to everybody to have people doing things the same way. That is fairly much the case in engineering, because there is not a multitude of solutions to a given engineering problem. There is usually very few.

I am not an expert in the military, and maybe some of the other people on the panel can address this, but in the military case the military is also the purchaser, and some of the standards I believe are used to make sure that the military gets the product that they, as the purchaser, are paying for.

I would say having spent some time on the other side of that military civil equation working at Northrup Aircraft I am at least familiar with some of the standards that dealt with flutter vibration and acoustics which was the area I was working in.

I am not an expert, though, in that.

Q I understand. I really have two other questions in that area, though, and that is, who in the FAA is monitoring this process and making sure that

cancellations do not affect your regulations.

In other words, I think we can find instances where the most either specifications or standards are cited as possible or acceptable means of achieving a goal.

A Well, if a mil standard that has been cancelled is an acceptable means of compliance with a regulation, the fact that it has been cancelled wouldn't change that fact. The real issue, is the process contained within that mil spec one that still is appropriate for a particular regulatory compliance.

Q My -- I believe my point would be, sir, that if the specification is not being reviewed by a competent technical authority within the FAA, perhaps the specification becomes obsolete or inappropriate.

A Well, you have to remember that we review every application of a standard during type certification of a product. Well, every -- in the sense that the ones that are really critical to the design, because some we delegate to the designees to review in our behalf.

So, if there were a standard that were heretofore acceptable for use on an airplane, and the design of that airplane was so radical from previous designs, that would cause us to look at the continued

applicability of that standard. So, we do, in fact, on a regular basis look at them.

Q I understand, and the last point I would want to ask you about is that looking at the options available here, which are of course the DOD can -- is no longer funded to maintain these documents, and therefore the only alternatives are other government agencies or the public, the commercial public or the engineering societies.

The question I would ask you is, who will pay for this effort?

A For the SAE effort that is ongoing, and it is a very significant effort, the government, I believe. The FAA is now contributing $85,000 a year to the SAE Cooperative Engineering Program. From that we figure we get millions of dollars of benefit, because many of their standards are referenced in our technical standard orders.

I think it is also important to point out that for military aircraft that are carrying passengers only, and even for some of their training aircraft, they have chosen to accept the FAA standard.

Q Thank you. I think it is a very important point, and I am glad to hear that there is provision for maintaining these one way or the other.

The next thing, Mr. McSweeney, that I wanted to cover is basically the -- we had talked about it just a little bit earlier, which was the FAA solicited public comments.

Could you give us just an overview from your point of view personally of what you were attempting to do by asking the questions in terms of -- you probably felt that you would get both technical information and opinions. Could you just, you know, clarify that a little bit?

A Well, when we issued the notice to get comments on the NTSB recommendations we had several objectives. First was we wanted to obtain answers to specific questions. Those specific questions are in the notice.

But, we also wanted to frame as best we could a background of history so that when those questions were answered there was some framework around which we would get those answers.

So, we also included things in our notice of what we felt the published information was on fuel properties, what the FAA had done in the past about explosion hazards, past activity in nitrogen inerting by the FAA, complete history to what we had of civil and military accidents, and we realized we would get

both very good factual data and we would get a lot of opinions, as well.

We did receive over a thousand pages of comments. There was comments from the general public, comments from academia, comments from manufacturers, operators, et cetera, other safety organizations like the FAA, and clearly some of those had opinions and some of those had some substantive data to I think help in the debate of this whole subject, whether it be in the FAA arena, or in an arena like this.

Q I understand. The length of the document that went out for -- and we have entered it in the record. It is about twenty-two pages. It is an excellent coverage, I believe, of the major issues involved and the complexities.

What I would like to just ask you a little bit now about in that document, which I know that you are generally familiar with, is the history which, as you have alluded to, the FAA has said in this document that some of the testing goes back to the 60's.

We get up to 1971 and I quote, "NTSB recommendation A 71-59 requested action to require fuel system fire safety devices which will be effective in prevention and control of both in flight and post-crash fuel system fires." It goes on to explain the action

and the considerations that were done in that time frame.

Were there any reports, or any formal engineering documents that came forward from that time frame that would be available?

A I don't -- I guess I can't recall specific ones off the top of my head now. I do remember extensive documentation of the anti-misting kerosene program.

Q Just quickly, the other question I have is -- reading on it says in 1972 the FAA document informs us, "the Aviation Consumer Action Project Petition for Rule Making requesting action to require nitrogen fuel tank inerting systems on all transport category airplanes," and based on these requests the FAA issued Notice of Proposed Rule Making Number 74-16.

The final note we are getting here at the comments received from the public on that Notice of Proposed Rule Making opposed this proposal because it was argued that the explosion prevention system would have little or no effect on reducing the fire and explosion hazards of impact survivable accidents.

Did that also include the NTSB's concern about the in flight phase?

A Well, as I said before, that particular

effort and what is referred to as the Safer Committee which was a full advisory committee that met for a couple of years, I believe -- and it, by the way, has tons of documentation.

They looked at -- after the notice went out they looked at the history of accidents. My recollection is that at that point they concluded that there wasn't an in flight history as significant as there was of a post crash fire history.

So, they believed the most appropriate thing to do at the time was to create a post-crash fire scenario as the scenario, or as the goal that everybody was trying to protect against. Quite frankly, I think we have been fairly effective in doing that.

Q Yes, sir. Essentially what has happened is that there is new information and new experience contributed since that time, would you agree, to somewhat change our view of these incidents?

A Well, I think I clearly made that statement earlier in this testimony that our opinion of the past -- and it is just like anybody else -- our opinion of the past is certainly likely to be different today than it was back then, and we have gone on the record many times to say everything is on the table, including nitrogen inerting.

Q I understand. This gets me to the next area that you commented on. I know it is an important subject, so I wanted to ask you several questions in the area of fuel selection.

The NPRM talks about the use of JP-4 during the earlier time period in the late 60's and early 70's, and it was believed because of what we now know is the flammability characteristic, so that may have been a major factor in some of the earlier accidents.

Could you comment on that and give us your opinion?

A Yes. When you look at -- at least when I looked at the history of the accidents, they tend in my mind to group into three clumps. The first clump was JP-4. It certainly is a different fuel than used today, and we all know what its flammability parameters are.

The second kind of group of accidents is external threats to the airplane, and I was happy to see that the Board even broke it up as external and internal threats because I think they are possibly -- you might be able to look at solutions differently whether it is an external or internal threat.

Then the third group was the internal threat. In the internal threats I would say that probably the

history that is most significant is the history with Jet-A fuel.

Q How would you carry that forward today in your evaluation of the JP-5 versus those other fuels, JP-8, Jet-A-1, Jet-B? Is there some way that you can draw a line between those as safe, safer, safest?

A Well, certainly the JP-5 fuel offers advantages in solving the flammability of ullages, and it makes that much easier to solve if you are using JP-5 fuel. Quite frankly, if you --

CHAIRMAN HALL: Does it cost more at the pump, Mr. McSweeney?

WITNESS McSWEENEY: From the statistics, the data that I have from the military, the difference between JP-5 and JP-8 -- JP-8 is equivalent to Jet-A -- is two pennies.

Now, the fuel cost itself is much higher, so you can't just look at the price per gallon because there are reasons having to do with how it is delivered to the source that make it a little bit more expensive.

But that the JP-5 is presently produced in very small batches, and what we have to look at when we deal with the ARAC group and what we want the American Petroleum Institute to look at is, what is that cost likely to be if it actually replaced all of the

millions and billions of gallons of Jet-A that we use today?

The price is not trivial, but is also is not enormous, and we just -- it is just something we have to look at.

Q The last thing I want to talk about with the NPRM's comments was the itemization of the accident record both in the commercial world and in the military world, and as I look through that with the caveat that was given in the NPRM, that many of these were related to the use -- or thought to be related to the use of JP-4 fuel.

We count thirteen commercial accidents from the early 60 -- well, actually, the earliest being 1959, and on the military side of non-combat airplanes, which in this case are two types. One is the Boeing 707 and the other is the B-52-H which were both manufactured by Boeing.

Could you comment on that list in terms of what, if anything, that signifies? Is there anything that the FAA suggests, any trend?

A Well, maybe I was trying to look at the table, but I didn't quite understand what significance you are trying to get me to comment on.

Q Well, we have heard -- there has been a lot

said and written about the probability of fuel tank flammability occurrences, and I think this listing --

CHAIRMAN HALL: If I gather it, it is the issue of the change in the fuel having impact on the number of accidents. When you went from -- what is that jet?

MR. ANDERSON: JP-4.

CHAIRMAN HALL: JP-4 to Jet-A.

MR. ANDERSON: Yes.

WITNESS McSWEENEY: I think in the general sense you can get a trend like that out of that data. But, you have to really go back and look at each and every accident. Some of the fuel tank explosions were maintenance induced. I don't think you should in any way count that as an issue relative to one kind of fuel or another.

One was a boost pump that was put in a tank where the wiring was actually put in the tank. Well, you know, you can't say that that was a problem with the fuel. It was a problem with the maintenance. So, you really have to go back and look at it.

I think the real key is not to look that much at the past, but recognize we had a tragic accident and we need to make sure we never have another one.

CHAIRMAN HALL: Excellent.

MR. ANDERSON: Thank you, sir.

BY MR. ANDERSON: (Resuming.)

Q My last question would be, could you share with us some of your impressions, rather than going through individual responses -- but, we can do that if you like -- to your NPRM. Could you just share with us your feelings on what was received? -- and feel free to give examples if you like.

A Okay, as I said, there were about a thousand pages of comments. We received comments from the industry, nitrogen inerting, system manufacturers, foreign regulatory authorities, universities and such.

There was admittedly a lot of people who though there wasn't even a problem that needed to be solved, and there were others that thought we should go well beyond what we were doing right now. So, there was a full gamut of comments, which I think is very positive. I mean, that is the kind of input we like to get.

There was comments about temperature, controlling the fuel -- temperature, comments about ventilating, insulating the tanks, nitrogen injection to cool the fuel on the ground. There was a lot of comments received about nitrogen inerting. Quite frankly, those people that had a system felt their

system was the right system to use. We are certainly going to have to look at that and see if we agree with that.

But, things like nitrogen, OBIGS and cryogenic liquid comments were received. CO_2, dry ice, charcoal generation generators were used -- were submitted as comments. Increasing the flashpoint of fuel was submitted as comments.

So, in a general sense we really, I think, got the breadth of comments that we were looking for. I think we got the depth to make a decision that there are solutions out there, and what we are asking ARAC to do is give us specific -- first, by regulatory criteria, and then that has to be based on specific known ways of getting there.

So, we think it is not a unique thing that we have issued comments, or asked for comments and NTSB recommendations, but I don't think you can count the number of times on more than one hand that I am aware of.

But, in this particular case, the comments we received -- and I think it was alluded to before -- the comments from the U.S. -- well, I shouldn't say just U.S. industry because it was more than that, but from the manufacturers and the operators, far exceeded my

expectations.

Q Thank you, Mr. McSweeney.

MR. ANDERSON: Mr. Chairman, I have no more questions.

CHAIRMAN HALL: Well, I think we will move to the party table, unless there are any of the Technical Panel. We will give the Technical Panel a chance after we go through the parties. In fairness, let's go down to the parties.

I believe we begin with Mr. Liddell, the International Association of Machinists and Aerospace Workers.

MR. LIDDELL: Thank you, Mr. Chairman. I just have a couple questions for the military representatives. In regard to the foam use, has -- is there or has there been any summary or records made of maintenance problems with the use of foam?

MR. LAUZZE: I am not personally aware of any detailed history of it, but we could look into it. But, I am not aware of one.

MR. BALL: That is really out of our realm. These gentlemen are testers and I am an educator, and I have heard comments, as we heard yesterday, that it is removed for maintenance problems.

If I were a pilot and I was going to go into

combat and heard the maintenance offer removed my foam before I flew in there, I might be a bit upset about it. So, I think you have to look at the maintenance versus the survivability issue from our perspective. But, it really is -- it is not something that we are familiar with.

MR. LIDDELL: Also, are you familiar with what type of fuel tanks this foam is used in? Is it in a bladder tank, or is it just a fuel tank?

MR. BALL: Most of the foam is in the wing. Most of the foam applications are in the wing tanks. There are some applications in the fuselage. The F-15 is in the fuselage, and I believe the F-15 fuselage has a bladder.

But, generally speaking, the foam is most applicable to us in the wing tanks because that is a large, exposed area. That's a (inaudible) mentioned yesterday, and those wings take a lot of hits.

Also, those wings -- that wing field is, generally speaking, used first. So, that is our most vulnerable area. That also gives us a minimum fuel penalty because we don't carry that much fuel in the wing.

MR. LIDDELL: Thank you very much. No further questions, Mr. Chairman.

CHAIRMAN HALL: Thank you very much. Trans World Airlines, Inc. Captain?

CAPTAIN YOUNG: Thank you, Mr. Chairman. At this time, no questions from Trans World Airlines.

CHAIRMAN HALL: Thank you very much. The Federal Aviation Administration? Mr. Streeter?

MR. STREETER: Yes, Mr. Chairman. For Mr. Tyson and maybe also for Mr. Lauzze; on the reticulated foam, again, is reticulated foam being used in any new installations, or is it being supplanted by the OBIGS, or how is that going right now?

WITNESS TYSON: Yes, it is used in new installations. The latest upgrade to the Navy F-18 -- FA-18, the EF version is using reticulated foam in the wings.

MR. STREETER: Okay. Has the product itself changed over the years? -- and I am speaking of the composition of the product for whatever purposes.

WITNESS TYSON: Yeah. I think the answer to that is yes, but my aspect of it, it is testing what they give me as opposed to designing it.

MR. STREETER: I see.

MR. BALL: Yes, if "over the years" you mean since 1965, the answer is yes.

MR. STREETER: Oh, definitely.

MR. BALL: It is significantly changed.

MR. STREETER: Yeah, yeah.

MR. BALL: Also, there is a study of pore size versus solid content, and we have gone from the polyesters which broke down to the polyurethanes which do not break down.

In the F-18 the wing's skin is literally bolted -- or, attached -- and they don't want to take that off, and this foam is in there and it is going to last, as we hope, for a significantly long time.

MR. STREETER: Okay, and that -- that was really the issue I was after. There were situations with the earlier product where there was break-down, is that correct?

MR. BALL: Yes. I wasn't there at the time, but that is what I heard.

MR. STREETER: And the impression is that that has been addressed with the later product improvements?

MR. BALL: Switching from the polyesters to the polyethers.

MR. STREETER: Okay. Then, I guess for Mr. Anderson, I would have a question in that I believe Mr. Anderson stated that he had a letter, or some information from McDonnell Douglas indicating that they

had removed material from an F-4 which showed no deterioration, and yet in questioning from the Board Mr. Liddell responded that material had been removed from an F-15, and I believe that involved some deterioration, although I am not certain.

Is there some way we can look into this, because it appears that the later airplane is the one that has the deterioration, and the earlier airplane didn't.

MR. LAUZZE: Are you referring to me, sir?

MR. STREETER: Yes, sir. I was wondering if we could possibly look into the information that came out from these two pieces of testimony to see if we could find out whether there is the situation.

DR. LOEB: Mr. Streeter, I can answer that. We definitely will.

MR. STREETER: Okay, thank you very much, sir. For Mr. Tyson or Mr. Lauzze, do you know if the Air Force has used reticulated foams in any large air frames?

MR. LAUZZE: Yesterday I believe I referred to the C-130. The Navy is using it in the P-3. I think those are probably the two largest systems.

Going back to one of your earlier questions on new aircraft, the Air Force is in the process of

buying the C-130 J. It is going to be in the C-130 J, a brand new system.

Going back to the other question on the F-15, the earlier versions of the F-15 use the polyester foam that Bob referred to earlier, which did have a hydrolytic stability issue. It has since been switched over to polyether, and that degradation issue has pretty well gone away.

MR. STREETER: Okay, so it really is a product type of situation that you have to deal with?

MR. LAUZZE: Yes, sir.

MR. STREETER: Okay. Again, for either Mr. Lauzze or Mr. Tyson, the discussions on OBIGS. You had some schematics up there that I felt gave a fairly good break-down of how the system worked, but it doesn't give me -- never having worked with one of those, it doesn't give me a reference as far as weight or size.

Is this a large -- physically large system, or heavy, or what does it entail in the aircraft?

WITNESS TYSON: It really depends on how you interface it to the airplane. I can give you -- and I am going to be drawing deep into my memory for some of this.

I can give you some numbers for tactical airplanes. If I am remembering correctly, a retrofit

system on an existing airplane has quite a bit of penalty associated with it. I want to say on the order of 1,000 pounds.

Now, you have got to remember that tactical aircraft has some incredibly high gas demands when it does its climbing and diving to keep the ullage of the fuel tanks inerted. The transport aircraft don't have that same high demand as a result of the new grade, but they have larger tanks.

A system I am aware of that was designed along with the design of the fuel system weighed on the order of 100 pounds.

MR. STREETER: That was initial design? In other words, went into initial production with the aircraft? Is that what you are saying, or retrofit?

WITNESS TYSON: The aircraft program was cancelled.

MR. STREETER: Oh, okay. So, then, there appears to be a trade-off between the tactical demands and the capacity between your tactical aircraft and your -- is there a possibility that a similar size system could be used in a much larger aircraft in a transport category?

WITNESS TYSON: Ralph might be able to add some more to that, because they have the larger

aircraft that have been protected. But, certainly the larger fuel tanks would demand a larger system than a 100 pound system.

MR. STREETER: Okay, understood. How about the -- is this a high maintenance system, is it a system that requires servicing every time it is on the ground, or a calendar servicing, or what?

MR. BALL: I will step in here and excuse these two gentlemen. They are testers. They basically determine the effectiveness of the system and the size of the system that is necessary.

The design of the system for reliability, minimum impact on maintenance, minimum impact on other aspects of safety is really not something that we are aware of. I apologize for that.

MR. STREETER: Okay, understood. Do you have any background on operational requirements? Is it a system that requires pilot input, or is it a passive system, or do you know?

MR. BALL: Again, sorry, we don't know.

MR. STREETER: Okay, understood, sir. Again, let's try another line here. Again, I understand that you may not have this, but I am -- there was -- you gave us a list of various tactical and transport aircraft that carried the systems.

Does either the Air Force of the Navy use some type of inerting system on board all their transport category aircraft?

MR. LAUZZE: The answer is no.

MR. STREETER: Okay. What -- or, if you are aware of it, what kind of factors go into the decision as to whether or not a system would be put on an airplane?

MR. LAUZZE: I can't really speak to some of the systems that don't have protection. Many of them were designed long before I, you know, was involved with the Air Force. But, with any design, you know, you need to look at what the -- particularly in the military, you need to look at what the mission is, what its predicted exposure rate is, what the threat is.

You know, is it going to come up against missiles, is it going to come up against gunfire, is it never going to see combat? All those things play into the equation, and obviously, you know, we want an optimum low weight solution.

So, there is no single answer, and I think that is one reason why we see things like foam, we see things like Halon, we see things like liquid nitrogen, as well. We need a whole bag of tricks, because everything -- you know, each system is different.

MR. STREETER: In the list you showed up there, I noticed that the -- you had both the C-130 and the C-5 listed as having protective systems, and if I understood correctly the C-5 was a retrofit due to situations it had run into on the ground.

The C-141 wasn't listed, and since it sits right in between the two, I am wondering if there was some reason that -- or, does it have a system, and if it doesn't, what is the reason it doesn't?

MR. LAUZZE: That was a system I was referring to as the answer to the earlier question. I really don't have any knowledge on the 141 specifically. It has been around for a long time. I really can't speak to it.

MR. STREETER: Since we are dealing with a Boeing product here, although we are dealing with a concept that covers everybody's product, and I believe while I am not sure I have all the designators right, so I will stick with the civilian designator, but I believe the Air Force is using the 747 for command and control purposes, 707 derivatives for various AWACS and theater operations and so on, and the 737 for navigation training and personnel transport.

Do you know if any of those systems have inerting aboard?

MR. LAUZZE: No, sir, I do not.

MR. STREETER: I guess for the Navy the equivalent question on the C-9, or -- well, actually for the Navy and the Air Force both, the C-9?

WITNESS TYSON: I have no idea. I am with tactical airplanes.

MR. STREETER: I understand. Okay, thank you, sir.

Mr. Thomas, you mentioned -- I believe you said in the triple seven that there is a sonic transducer that is used now for fuels?

WITNESS THOMAS: For fuel (inaudible), correct.

MR. STREETER: Okay. Now, even though you said that system has wiring in the tank, my presumption would be, based on my understanding of a system like that is that this system would also be immersed for the majority of the time it is operation, wouldn't it?

WITNESS THOMAS: Yeah, the sensor itself is at the bottom of -- each position we have multiple sensors out along the wing and in the center wing tank.

MR. STREETER: Okay. So, unlike the capacity probe system, you shouldn't have any wiring that is necessarily exposed to vapors?

WITNESS THOMAS: I can't say that, because

obviously as the tank empties the wiring and eventually the sensors will become exposed.

MR. STREETER: Okay, would you --

WITNESS THOMAS: The wing has a dihedral.

MR. STREETER: Oh, correct.

WITNESS THOMAS: As the fuel drains in board, the outboard sensors will eventually become uncovered.

MR. STREETER: Okay.

WITNESS THOMAS: But, the system is designed for exactly the same load --

MR. STREETER: Same function?

WITNESS THOMAS: -- requirements as we have described in the capacitive type of systems.

MR. STREETER: Okay, and is it -- since it is a bottom-mounted system, is it a fair assumption that there is far less wiring exposed inside the tank?

WITNESS THOMAS: I can't answer that question without actually doing the details, looking at that system.

MR. STREETER: All right, thank you, sir. That is all I have, Mr. Chairman.

CHAIRMAN HALL: The Boeing Commercial Airplane Group? Mr. Rodrigues?

MR. RODRIGUES: Yes, Mr. Chairman. First, to answer one of Mr. Streeter's questions, the C-17 system

weighs 2,000 pounds.

One question for Mr. Thomas. The Chairman asked the question earlier on, what work Boeing has done so far since the TWA accident. Could you respond to that now?

MR. THOMAS: Yes, certainly. I believe the question was two-part, what service bulletins we had published and what additional work is going on. As far as service bulletins, there is a fuel pump conduit service bulletin which is the inspection the FAA mandated through an AD. That is in your docket, I believe, at this point.

We have the scavenge pump connector service bulletin, we have the series three terminal block that we discussed at length. That is -- as we said, is due to be released in January/February of next year.

We have the center wing tank inspection bulletin which is also in the public docket. That was released in -- the updated revision is going to be released in January of '98.

Another one which is not connected directly with TWA 800 is the override boost pump connector inspection design improvement service bulletin we released simply because we had a connector problem. I believe that is also in the docket.

We discussed a little bit on -- I think it was -- I am not sure which panel it was. I believe it was the Monday panel. We kind of ran through things that we are doing.

I want to make a point here that -- I guess Mr. McSweeney made the point earlier. We have a very large fleet of airplanes that is out there. There is 13,000 airplanes out there in the fleet. 9,000 of those, or more than those are now Boeing products as a result of the merger.

We really need to look at ways to reduce flammability, as we said in that Monday discussion. We need to work on that. We need to make sure that the system is retrofitable in a relatively easy fashion. The simpler, the better, if you will, the KIS principle.

JP-5, as I said earlier in the discussion, was one of the obvious extensions of that. If you move the flammability over and if you are focused on tank flammability, that is an obvious thing to go after. Center wing tank cooling; we discussed it at length in discussions with the NTSB.

We flew -- when the NTSB was flying the Evergreen airplane, as was discussed a couple of days ago, we took the opportunity to fly three flights of

our own, piggy-backing onto that experience using the flight test and all the instrumentation.

We used that flight test data to build a computer model. In fact, we have now two computer models that we can use first of all to cross check how well the models are behaving, but also to study all of these things. So, we are very actively looking at those.

If you look back in the response to the FAA back in August, one of the things we did say was the insulation concept would look very promising, and we were continuing to work on them. We are still doing that work. We use the flight test data. We are now looking at concepts of slot cooling, as I think I described briefly on Monday.

We are also doing laboratory testing of ullage sweeping. That is a very simple concept. It is very appealing in terms of trying to blow air into the tank. The issue really is what do you do with the light ends that get blown overboard, or is there some way of collecting them somehow, and that is the next step we want to go to.

The other point that I think is very important is we are designing -- we are reviewing our designs on the bonding and grounding issues as we try

and create the service bulletins.

We are going through all our airplanes very carefully to look at all the bonding and grounding requirements we have imposed on the airplane to see that they are correct, first of all, and to make sure we want -- then we go out and look and create the service bulletins on each of the airplanes so we have the right measurements.

So, it is -- the very act of creating the service bulletins is forcing a design review. It is an interesting process. We have to go through drawing after drawing, and going through a 737 that is -- whatever it is, almost thirty years old, to pull out all those drawings and look at very carefully how we created the bonding design in those airplanes and then invent and create a test in the service bulletin, that is really why the 747 service bulletin is a hundred pages long. There is an awful lot of work going into that service bulletin.

In regard to all the questions on the -- and going back to your question earlier, Mr. Chairman, on the military side of the house. As I said earlier, we had our own military people involved in this. We have also talked to the foam manufacturers, we have talked to the inerting manufacturers.

So, we -- and most of this is in the response to the FAA. I think there is an awful lot of very good work that was done by the industry. We discussed the weight of foam, we discussed the design of the fuel tank inerting system. I was involved i that.

It was very important. I think we spent a lot of time doing trade studies. We weren't simply putting a system together to get a rough weight. We actually did a lot of design trade.

We spent a month and a half doing design trades on the size of the gas separator unit versus the compressor system that we needed to feed it, because some people were saying, well, if you just fed the air into the gas separation unit it would be a very simple thing to do, it would be very reliable.

Yet, the weight of the gas system went up phenomenally because of the low pressures available. So, then you trade that against the compressor cooling system required to feed the gas separation system the correct pressure and temperature.

What we have in this document is that optimized system, and it still weighs something like 2,000 pounds. We used a lot of the C-17 experience in that, by the way. So, I would refer you to the document for a lot of this information.

CHAIRMAN HALL: Well, thank you. That is a very complete response. Thank you very much.

MR. RODRIGUES: No additional questions, Mr. Chairman.

CHAIRMAN HALL: The Air Line Pilots Association? Captain?

CAPTAIN REKART: Yes, sir. I think the first question would be for Mr. Lauzze and Mr. Tyson. Yesterday in your presentation you used terms like "successful" and "effective" when referring to different remedial systems, reference being made to successful use of inerting and the fact that foam had been effective.

Can you give an idea how that success and effectiveness is measured?

WITNESS TYSON: Yeah, I can. When we conduct a test it is based on -- and we are evaluating a system like that, it is based on a pressure in general below the design limit load of the structure that it would be installed in.

If we can keep that pressure below -- for example, eighty percent of the -- our goal would be to keep the pressure in our test in using these protection systems at eighty percent, the design limit load of the structure it will be installed in. That would be -- if

we can achieve that, that would be considered a success.

CAPTAIN REKART: Okay. Of the various inerting systems -- and I shouldn't say inerting system, I should say the remedial systems that are available -- which system is or has been the most reliable in every day operation?

WITNESS TYSON: You know -- sorry.

CAPTAIN REKART: Okay. I understand that there are questions you can't answer from the operational side of things, but they still have to be addressed, and I hope you understand that.

MR. BALL: You ask and we'll answer.

CAPTAIN REKART: Okay, we will keep on going. With regard to the remedial systems that we have discussed, some questions regarding the role of the crew.

As you are well aware, we don't have load masters, we don't have mechanics and we don't have the luxury anymore of flight engineers. So, all the monitoring and all the work has to be done by the captain and the first officer.

Who is responsible for monitoring the systems that you develop for the different -- for the different aircraft?

WITNESS TYSON: I am going to try to take a shot at that. Again, I am not -- the foam doesn't require anything in the installation, particularly in the wings, as Dr. Ball mentioned, where it is installed for the life of the aircraft.

I am really trying to -- there has been another -- other questions that have asked a similar thing, and I am really trying to recall how we intended to interface the OBIG system to that cancelled program I mentioned.

I believe there was a bit check done on start-up of the airplane.

CAPTAIN REKART: Okay.

WITNESS TYSON: That would let the pilot know the status of that system. Other than that, I don't believe he had any -- it was a completely hands-off system.

CAPTAIN REKART: Okay. Mr. Chairman, that question is followed up with what indications to the flight crew are available to show that the ullage space in the tanks are in fact non-explosive, and are crew actions required to either activate, re-set, trouble shoot any of these systems.

Since there is no other members of the panel that are able to address those, I was wondering if

there was a way that we could get the answers to that for the record?

CHAIRMAN HALL: Well, I would -- I would request that, and I do add that Mr. McSweeney has said that he would include on the ARAC subcommittee working group representatives from the military.

I know there are operational concerns, and that might be the appropriate forum for them to be addressed. But, if -- I will ask Dr. Ball and Mr. Lauzze if you can take that information back and provide something for the record we would certainly appreciate it.

CAPTAIN REKART: Okay, the next question is still a little bit more of a follow up on that, and it is sort of a clarification question. It is hard to follow the FAA, because they have been using the same questions that I had all day.

The military uses a variant of the DC-9 as a Med-evac airplane. The 707 and the DC-10 is tankers, which are really airborne fuel tanks. The 737 and the 747 as V-aircraft, and also in other support roles. They also have a very extensive craft fleet that they call upon in time of emergencies.

Again, has the military considered or actually attempted to employ inerting or any other

remediational technology in these activities? I realize this is sort of close to the question that was asked previously by Mr. Streeter, but I would like to ask it again.

MR. LAUZZE: I really can't speak to that.

CAPTAIN REKART: Okay. That being true, the statement was made earlier that these are systems. In talking about the remedial system, a statement was made earlier that these systems are -- these are systems that the military already uses.

That isn't really a true statement. It is true that you do use these remediation systems in combat aircraft that are -- that are in a very exclusive threat environment, but you don't use these systems in any of the aircraft that we use in everyday operation in the civilian world that I know of. Is that a more correct statement, perhaps?

MR. BALL: Maybe if I try to explain how we get involved. We are in a sense invited in at the invitation of the Program Manager. Each aircraft project or program has a manager, and theoretically there would be a mission threat analysis done for each aircraft.

If, in fact, in that mission threat analysis it was revealed that that aircraft could come under

hostile fire, with the frequency of occurrence that it became something that -- to seriously significantly consider, then our community would be brought in and our -- what would -- the mil standard 2069 that we had would be imposed upon -- and they would look into that.

These aircraft that you mentioned, I don't know who the Program Managers were and I don't know exactly how much they looked at that. Probably, it may just have been a sense that they thought they were not going to get shot at at the time.

CAPTAIN REKART: Okay, and these aircraft, then, are certified in the normal method of certification that we have been talking about the past three days, with the assumption that the fuel tanks are always containing an explosive mixture and that all ignition sources must be removed from that environment, is that correct?

I know the word "certify" doesn't exactly fit what we are talking about right now, but it is the closest word that I can come to in making that -- in making that question.

MR. LAUZZE: We are way out of my field. One thing I do know is that as part of the Joint Aeronautical Commander Troop which is composed of the three services, as well as representatives from NASA

and the FAA, they are working that FAA certification issue as we speak.

In fact, there was a meeting last week, or the week before last, where that was discussed. So, I really have nothing to add other than we are working the issue.

WITNESS McSWEENEY: Mr. Chairman, or ALPA, would you care if I add to that?

CHAIRMAN HALL: No, please proceed.

CAPTAIN REKART: I would be happy to add -- have you add to it, but they are nice questions for you, and I think it will probably answer the question, so if you would like to, go ahead, Tom.

WITNESS McSWEENEY: Well, I think it is really not a fair question for the military to really be commenting on, on our certification. When we certify an aircraft that is for use in military, that it has got a civil derivative, that aircraft first and foremost must meet the regulations.

There must be created a type design, or a design of that aircraft that is in full and absolute total compliance with the regulations. Many times, though, what is delivered to the military is different from that configuration, and what the military normally gets from us is a statement of conformity of that

aircraft that says it complies with its civil type certificate, except for these deviations.

Most of those deviations are in the area of military unique equipment required for military unique environments. That is basically the process we use.

CAPTAIN REKART: Okay. We will stay right where we are. Yesterday Mr. Crow addressed the MEL. How do you see these remedial possibilities that we have discussed being addressed by the MEL, or getting into the MEL.

Needless to say, to get into the MEL you have to either be -- there are two areas that are addressed by the MEL, things that are so fundamental to flying that they have to be on the airplane. You have two wings, therefore you need them both. The other side of the equation is down at the other end, stuff that you don't need like the -- perhaps soap and towels in the lavatories.

But, in the middle of that we have the other systems that through redundancy or through a secondary system can't be inoperative under certain situations. Can you address what you see as a necessity of these remedial systems being involved in the MEL?

I am thinking about the poor guy that is flying a DC-9 or an MD-80 across West Texas in the

middle of the summer and it is 108 outside and it is 105 on the tarmac and all of a sudden something goes wrong. How is he going to get his airplane out of there?

WITNESS McSWEENEY: Yeah, I can certainly address that. The basic premise behind any MEL item is that the aircraft is in full compliance with the regulations.

There is a dilemma that has to be, I think, debated in the ARAC group, and that is that if we decide -- whether we decide that we have an unsafe condition and we need to correct it, or whether we want to simply raise the safety bar higher, we define a new level of safety.

If that level of safety can only be achieved with that system on full time, then it is going to be very difficult, if not impossible to conceive of an MEL restriction, although there are some that are possible that would allow you to achieve that same level of safety with the system on.

Some of the possibilities are, you know, changing the -- I mean, you would really have to change the physical parameters within the fuel system. If with that OBIGS -- let's say you had an OBIG system that was suddenly inoperative.

If you are going to say that at some point -- if you have decided that there is a level of safety, then it has to be achieved through the MEL process. You cannot let that level of safety be violated.

CAPTAIN REKART: Do you think -- do you feel that the present certification requirements of always considering the explosive mixture and always removing the ignition sources is adequate to allow the -- one of these remedial sources to be -- or, remedial fixes to be used, and then allow it to be inoperative?

WITNESS McSWEENEY: I would just as soon not bias the ARAC group. I think that is the issue that they are supposed to be dealing with.

CAPTAIN REKART: Okay.

WITNESS McSWEENEY: I would hazard to guess that if I made a statement here, they would come back and give me exactly what I asked for. I want them to go through that thinking process.

CAPTAIN REKART: Okay, thank you. I have no more questions, sir.

CHAIRMAN HALL: Thank you, Captain. Honeywell, Inc.?

MR. THOMAS: Honeywell has no questions, Mr. Chairman.

CHAIRMAN HALL: Crane Company Hydro-Aire?

MR. BOUSHIE: Crane has no questions, Mr. Chairman.

CHAIRMAN HALL: Okay, do any of the parties have any additional questions for this panel?

(No response.)

If not, does the Technical Panel have any additional questions? Dr. Birky?

MR. BIRKY: I do; a couple of real short questions, I think. In response to Mr. Streeter's questions of Mr. Thomas, you referred to the triple seven gaging system. My question -- as I understand it, that gaging -- the gage sensor is in the bottom of the tank, is that correct?

WITNESS THOMAS: Correct.

MR. BIRKY: In light of what we heard about the build-up of the sulphur compounds, does that cause you concern? Is it possible to move those sensors at the top of the tank so they wouldn't be in the fuel?

WITNESS THOMAS: I would have to look at the detailed design of the system and the wiring and everything associated with it. Again, it is not -- it is a pinging system, if you will. It is not a full-time continuous frequency system.

If you -- if I understand from the testimony of some day ago, you know, some -- the voltages

involved in this thing are part of the deposition of the sulphur. So, we need to look at it. It is a good question. We have added it on our things to go and look at. But, I cannot answer you from here.

MR. BIRKY: Excuse me. From what I heard, I wouldn't want to hang my hat on that the voltages contributing to that without some chemical experimental proof, would you?

WITNESS THOMAS: As I say, we need to go and look at it.

MR. BIRKY: Okay.

WITNESS THOMAS: Absolutely.

MR. BIRKY: The other question I had relative to that is, you indicated on the 747 the more recent versions have shielded wires going to the center tank, correct?

WITNESS THOMAS: I believe that is correct, yes.

MR. BIRKY: Does Boeing have any efforts or consideration on board to change that in the older versions that don't have shielded wire?

WITNESS THOMAS: The FAA has proposed through their NPRM action to do just that. We are in the process of evaluating that in order to respond to the FAA. So, the answer is yes, we are looking. But, it

is in order to respond to the FAA.

MR. BIRKY: Okay, thank you. That's all I have.

CHAIRMAN HALL: Any other questions from the Technical panel?

(No response.)

If not, Mr. Sweedler?

MR. SWEEDLER: Just one short question for clarification. Could we put in perspective the various size of these military airplanes that have some of these systems on board; the C-131, the C-5A and the C-17? How would they compare to civilian-sized aircraft?

MR. LAUZZE: Well, I believe relatively speaking the C-5 would be in the same class as the 747. The C-17 is a little bit smaller, but it is still classified as a wide body. The C-130 obviously is much smaller.

MR. SWEEDLER: Thank you. That is all I have, Mr. Chairman.

CHAIRMAN HALL: Dr. Ellingstad?

DR. ELLINGSTAD: Thank you. Mr. Thomas, recognizing, as you had indicated with respect to the flight test, that both Safety Board and Boeing engineers are wading through mountains of data on those tests, do you feel that we have sufficient information

on the environment of the 747 center wing tank and the surrounding components that might transfer heat to this tank?

WITNESS THOMAS: I would say we have a very good understanding of this at this point.

DR. ELLINGSTAD: You say that we do?

WITNESS THOMAS: I quite believe we do.

DR. ELLINGSTAD: So, you don't believe that there are any additional flight tests, or on ground tests that would be useful to develop a better understanding?

WITNESS THOMAS: I think at this point we have, as I said earlier, two computer models, one of which is, quote/unquote, "a simple model" that allows us to look at alternatives. We have a more sophisticated model that is a closer representation of the 747.

As we try and develop alternative ideas such as some kind of cooling system, we think we may find that there is a part of the system where we need more detailed information where we would have to go run that test, whether it is a ground test or a flight test.

DR. ELLINGSTAD: Because, as that --

WITNESS THOMAS: Part of that is just the development process.

DR. ELLINGSTAD: Has any of that kind of testing under operational environments been done on any other aircraft in the Boeing fleet, other than this 747?

WITNESS THOMAS: To develop temperature data?

DR. ELLINGSTAD: Yes.

WITNESS THOMAS: We have -- in the course of our investigation we took some very limited data off the 737-700 because it was in flight test and we had some small instrumentation set up on that airplane.

DR. ELLINGSTAD: Okay, so Boeing doesn't have any --

WITNESS THOMAS: We do not have a lot of --

DR. ELLINGSTAD: -- immediate plans to do any additional testing in this area?

WITNESS THOMAS: It would be a factor of what system we came up with. If we -- again, if the process we have described this morning of looking at what is the requirements through the ARAC process, as we start seeing what solution we are going to go to, it will drive us to do the testing we need to do to develop the system.

DR. ELLINGSTAD: Mr. McSweeney, do you feel that there is sufficient empirical data describing the operating environment of the center wing tank in the

747 and the things around it that transfer heat to the tank?

WITNESS McSWEENEY: That is my impression, also, that there is sufficient data to give us a good feel for what is going on in that tank.

DR. ELLINGSTAD: Dr. Shepherd, do you have a view on this?

DR. SHEPHERD: Yes, I do. I believe that we need to gather some additional information. Perhaps there is other information that Boeing has access to, but based on the information I know of from the flight test, I think our knowledge is still incomplete.

DR. ELLINGSTAD: Thank you. Dr. Shepherd, while we have you there -- and, again, taking the risk of asking whether additional research is needed to an academic, could you make a similar comment with respect to the flammability characteristics of Jet-A? -- and while you are on that topic, we may as well also treat JP-5.

DR. SHEPHERD: We started our evaluation of Jet-A this summer, and our work has really been ongoing only for the last five months, I would say. Our evaluation has necessarily been limited because of that short period of time.

We have been able to examine Jet-A, fresh

Jet-A from LAX, and we have done a limited examination of Jet-A that was used in the flight test sponsored by the NTSB in July.

I believe that it is necessary to get a much more complete picture of this, particularly with regard to the range of ignition energies that would be found if you looked throughout the fuel supply in the world.

In addition, if we are going to propose using JP-5, I believe that it is also necessary to get a much more complete understanding of the ignition characteristics of that fuel, also.

DR. ELLINGSTAD: Okay, thank you very much.

CHAIRMAN HALL: Dr. Loeb:

DR. LOEB: I don't have any questions, Mr. Chairman. I do have a point that I would like to make. A couple of points, I guess.

The first one that I believe we have made significant progress in having our agreement that we certainly need to look very strongly at means to reduce or eliminate altogether the flammable mixtures in the fuel tanks.

But, that brings into question the timing of events, and I think we need to look at both short term solutions and long term solutions, and our recommendations of a year ago do go to that. Indeed,

there were short term -- recommendations for short term solutions and recommendations for long term solutions.

I recognize that the parties have raised some questions about the process by which we collected a lot of the research and data, and what I want to make clear is that as quickly as possible after this hearing is adjourned, we are going to get all the parties together and also the researchers with whom we have been working to determine the answer to some of the questions that Dr. Ellingstad just raised, and that is what more we need to do to develop quickly short term solutions to the problem while the process of developing the longer term solutions go on.

So, you will be hearing from us quickly after this hearing. We will be meeting just as soon as we can.

CHAIRMAN HALL: I have a few clean-up questions. I went over my notes last night to try and be sure that all the things I thought should be briefly discussed on the record were brought up, and there were some things that we do not have any idea whether they had anything to do with the TWA 800 accident, but there was some things on the inspections that -- regarding the O-rings and ruse on some of the components in the tank.

Mr. Thomas, is there anything Boeing is doing following up on that? I believe your folks were part of those inspections. Were they?

MR. SWAIM: Yes, sir, the Boeing people were with us every step of the way. We do it as a party system, as you know. We found that there were a number of rubber O-rings in the fuel tubing connections in the accident airplane, and in other airplanes we looked at that had a lot of cracking, and how that is checked right now --

Well, let me ask Mr. Thomas, rather than testifying myself. How are the integrity of the O-rings checked in service, sir?

WITNESS THOMAS: It is checked in two ways. One, the airplane flies daily. The fuel system, the lines through the fuel system are all internal to the fuel tanks, so if an O-ring starts to leak, if it is in its own tank the fuel simply returns to the tank.

If it is in another tank in a cross-feed line, then you will see some cross tank to tank transfer of fuel, which will show up on the gaging system and, as we heard yesterday, the pilots have the option of writing -- or, will write a pi-rep, a pilot's report, to make sure that maintenance is aware of that tank to tank transfer, and they can go and investigate

it.

Also, when we functionally test the system problems, for instance during an -- after an engine change, we will check the -- what's the right word? -- functionality and integrity of the engine feed system.

MR. SWAIM: Would that include the O-rings in the engine pylons?

WITNESS THOMAS: Yes.

MR. SWAIM: Okay, but those O-rings in the engine pylons are outside of the fuel tank?

WITNESS THOMAS: Yes, and -- yeah, and as we discussed yesterday afternoon, an O-ring leaking in the pylon will become very obvious very quickly.

MR. SWAIM: Because that fuel will go where?

WITNESS THOMAS: It will drain -- it will drain down the pylon through a drain line to the bottom of the cell and overboard.

MR. SWAIM: Okay. Is the opinion of yourself or the Boeing Company that leakage within the fuel tanks is acceptable in those types of cases?

WITNESS THOMAS: Minor leakage inside the fuel tank that doesn't cause major pilot concern or a tank to tank transfer is acceptable. Obviously, the pilots themselves have that discretionary option of saying, "I really don't like what is happening; it is

causing me to do too many corrective re-balances of the airplane."

As we described yesterday, a fuel leak in the cell -- or, rather in the strut itself, would be noted by the maintenance people and appropriate action taken.

MR. SWAIM: Okay. We know that in some cases fuel hoses and other rubberized components have a set life for the rubber, especially for the package life in that -- I am thinking of other airplanes, especially flexible braided fuel lines -- but, in the case of a transport airplane such as this, what is the life that you expect out of an O-ring, or the whole series of O-rings? Is there a set life?

CHAIRMAN HALL: Mr. Swaim, I don't want to cut you off.

MR. SWAIM: Okay.

CHAIRMAN HALL: But, I really -- the only question I wanted to know is that you are aware of it and are you looking at it.

MR. SWAIM: Very good.

WITNESS THOMAS: The short answer is yes, and yes.

CHAIRMAN HALL: Okay. You know, a leak is a leak, and I assume even though it is acceptable for a short period of time under some situations, it wouldn't

be for a long period.

You mentioned, Mr. Thomas, that you -- that in some of your later 747's that some of the low powered wiring was shielded?

WITNESS THOMAS: Correct.

CHAIRMAN HALL: Could you explain the difference to me between the later model 747's and the earliers in regard to that, the shielding?

WITNESS THOMAS: As we described yesterday, I believe it was, there is two -- the reason for shielding is low energy EMI, or coupling between other wiring.

We have shielding on the Honeywell gaging system because when we introduced -- I forget what particular feature it was, onto the airplane, it introduced some low level noise.

On the 747-400's and 757-67 airplanes, the gaging system works on a slightly different principal. The Honeywell system works on sending a -- basically, a high frequency signal to the probes, and you can filter out noise on that high frequency by -- just like you tune a radio. You can have filtering on the system.

The newer systems in effect pulse the probes, and there is a lot of information on that pulse. We look for resistance, we look for capacitance, we -- in

effect, it is almost to the point where we can tell the crew where a break in the wire is by this pulsing technique, a measurement technique.

So, that is very open to noise. So, it is very -- for performance reasons, we have to shield that wiring.

CHAIRMAN HALL: That is not done for any safety reasons?

WITNESS THOMAS: No, sir.

CHAIRMAN HALL: Now, given the information that TWA 800 and looking back at the Philippine accident in retrospect, is that anything that you all are going to look at as to whether those wirings should be shielded and whether the low voltage and high voltage -- is that the correct terminology? -- should run together?

WITNESS THOMAS: Yes, sir. As I said in a question that somebody else posed just now, the NTSB -- excuse me, the FAA have proposed doing that by their NPRM, and we are going to address the NPRM.

CHAIRMAN HALL: Mr. McSweeney, could you maybe just briefly give us where the -- where you are in regard to the -- or, the FAA is -- in regard with the service bulletins that Mr. Thomas went over, and how long you would anticipate once those service

bulletins were put out that it would take to put them in effect?

WITNESS McSWEENEY: We are working with Boeing in understanding those service bulletins as they are being drafted. Our intent is to be prepared when the final service bulletin is issued to immediately issue the airworthiness action.

CHAIRMAN HALL: Mr. Thomas, you mentioned that -- earlier, that there were two types of AD's, or one of these on colored paper and one on the white paper, and one was an alert? I believe TWA said they treated an alert as an AD.

When you issue the service bulletin will -- do you know at this point in time whether that will be an alert, or just a -- I mean, a service bulletin -- but, it would just be an alert?

WITNESS THOMAS: This is for which service bulletin, sir?

CHAIRMAN HALL: Any of the ones you are putting out that you just went over.

(Pause.)

WITNESS THOMAS: I do not believe any of them are alert at this point, although the fuel pump conduit service bulletin was an alert service bulletin followed up with an AD.

CHAIRMAN HALL: So, in other words, prompt response by the FAA if they think those need to be AD's would be needed for them to -- we see the action in the industry? Mr. McSweeney?

WITNESS McSWEENEY: Yeah, I just might want to add that we really make a determination and look at service bulletins on a regular basis, and we -- historically, even AD service bulletins that weren't alert service bulletins, and at other times we have AD'd the alert service bulletin, but we have disagreed with the timing in it and, so, we have come out with our own timing in the AD.

So, it is -- we look at them independent of what they recommend.

CHAIRMAN HALL: Very good. I would like to now go and call on the panel and see if you have any closing comments. This is our final panel. Anything else that you think that the National Transportation Safety Board should be exploring or looking at, or any other thoughts that you have in regard to this whole matter that you would like to put on the public record?

Dr. Shepherd?

DR. SHEPHERD: Yes, sir, thank you. I would just like to second Dr. Loeb's comments. We have heard a lot of discussion yesterday and today about fuel

flammability reduction techniques. It is gratifying to hear that reduction of fuel temperature is included in that.

However, the bureaucratic process that has been outlined to evaluate those techniques does not promise to be short, and I think it is important that we consider simple interim modifications to the -- either operation or hardware in the current fleet, the commercial transports.

I believe in this regard anything we can do to reduce the fuel and the ullage temperature in the center wing tank should be carefully considered. Thank you.

CHAIRMAN HALL: Mr. McSweeney, we appreciate your twenty-three years of public service at the Federal Aviation Administration. Is there anything that you would like to add?

WITNESS McSWEENEY: I would just, I guess, like to summarize in a few short words that -- starting first with our goal. Immediately after the tragic accident, today and in the future our goal will always be the same, to never again have a tragic accident like TWA 800.

I want to emphasize that we are looking at the full triangle. We are looking at fuel, we are

looking at the oxidizer and we are looking at the ignition spark.

We have, I believe, taken some action on short term solutions. The AD on wing fuel pump conduits is, in our mind, a possible scenario for this accident that we have effectively dealt with to take it out of any realm of possibility at this point on happening on any other aircraft.

Our NPRM AD on the fuel quantity indicating system deals with three failure modes that possibly could be considered as scenarios in this accident. So, I think those are short term actions that we have taken.

I appreciate the opportunity to make those comments.

CHAIRMAN HALL: Mr. Thomas, thirty-one years at the Boeing Company, a Chief Engineer and now a veteran of four panels at this public hearing. I think you deserve a raise.

(Laughter.)

I noticed on your experience that you worked as a designer on the Concord fuel system.

WITNESS THOMAS: Yes.

CHAIRMAN HALL: You know, in your closing comments, is there anything of that system that is done

that would be -- we could learn from?

WITNESS THOMAS: On that airplane, it is -- that is an interesting airplane, because the very act of going supersonic raises its temperature, and in reality that airplane goes from lean through the flammability region out into rich every flight every day.

It is obviously designed to exactly the same standards that we use. It is a very much more complicated fuel system. That is probably why I am still in fuel systems. If you can do the Concord one, you can -- the rest are relatively easy until you get to something like the B-2.

First of all, I would like to thank the Board for the opportunity. It has been a long, hard week. I have learned a huge amount. We were talking about it at dinner time last night, and the young panelist with me on the electrical system made a comment that it was such a sobering reminder of what safety really means.

We talk about safety daily, but to come to this hearing and really talk about it in terms of this accident is a very powerful influence on our lives. Jerry was saying we really need to figure out how we take a ten-minute synopsis of this and make it available to our employees to get the message over, and

tell them over and over again.

I think the hearings has given the American people an opportunity to see everybody who is involved in this and to hear everybody and the concerns that we all have about safety. I think this is very important.

Lastly, I would like to say in a sense we may not ever know what occurred on TWA 800, and in some respects had we have known if it was an arc-external threat and we knew about it six weeks after the accident, we wouldn't be here holding any of these discussions on reducing flammability.

What we really have is an accident where we may not know the cause, but it has forced us -- everybody in the industry -- to sit back and really evaluate all our fundamental premises for designing airplanes, and in the long run, even without knowing the cause of TWA 800, the end result will be much safer airplanes.

It is a great opportunity to go forward and do that.

CHAIRMAN HALL: Thank you very much. Well, Captain Green, as a pilot in your profession, as those of us in the travelling public look in that cockpit every time we get on the plane and trust our safety to you all, I appreciate very much your -- as well, of

course, as the mechanics and flight attendants and all the others in the industry.

But, the most visible thing to the individual are the pilots, and they are well respected and highly regarded, and we are pleased to have you participate. Do you have any closing comments?

CAPTAIN GREEN: I think, Mr. Chairman, there are two things relative to the panel that I would like to mention. One is just to reiterate that we are dealing with a different ignition source than the military deals with, and the importance of identifying that ignition source and the susceptibility that it presents remains paramount to us because of the potential threat and other matters.

Secondly, this hearing has made me even more aware, tremendously aware of a number of bodies of knowledge that are actively developing very, very rapidly, beginning with the work that the Safety Board has done in flammability and in aircraft wiring, the work that Boeing has done and the work that the FAA has done and the flight tests that the Safety Board conducted.

The thing I would like to emphasize again is the need for timely and effective and thorough communications between all of these working groups as

quickly as we can as we run up to these ARAC processes and so forth.

It has been a very, very long and interesting experience this week. We would really like to thank the Board for the opportunity to be on the panel and participate in the investigation.

CHAIRMAN HALL: Thank you very much, Captain.

Mr. Lauzze, I want to thank just you and Dr. Ball and Mr. Tyson all at the same time for your contributions on the military side to aviation safety, and give you three gentlemen an opportunity to make any comments that you would like to make.

MR. LAUZZE: Thank you very much, Mr. Chairman. From my position, one thing I would like to walk away with is a new spirit of cooperation, I think, among the different agencies that are involved.

The Army and the Navy and the Air Force have formed a committee that Dr. Ball mentioned yesterday, the Joint Technical Coordinating Group on Aircraft Survivability. We share planning, we share resources, we share data.

We have a couple of years ago signed an MOU with the FAA Atlantic City Tech Center to also share data. I would like to see that continue and expand, and maybe even share some more resources in the

planning exercise, as well.

We, for example in the military community, have been trying for over twenty years to get some flight test data, and the data you collected just recently on the 747 is going to help us immensely. So, I would like to offer our facilities and our support and our cooperation.

Thank you, sir.

CHAIRMAN HALL: Thank you. Dr. Ball?

MR. BALL: Just one final comment, Mr. Chairman. I would like to thank you for giving us the opportunity to participate in this very important public hearing.

You have given us a chance to show the public what we can do, and we hope that what we have presented here will be helpful to you in coming to your final solution.

CHAIRMAN HALL: And Mr. Tyson?

WITNESS TYSON: I would just like to second Ralph's offer for cooperation both in our facilities and exchange of data, and thank you very much for having the opportunity to be here.

CHAIRMAN HALL: Thank you. Before I move to my closing statement, I would like to go down the parties and see if any of the -- I would like to

acknowledge each of the parties, and if any of the parties have closing comments they would like to make.

We will follow the usual order and begin with Crane Company Hydro-Aire. Mr. Russell (sic), thank you for your presence and attendance at this hearing.

MR. BOUSHIE: Thank you, Mr. Chairman. It is somewhat redundant as we go through the panel and the witnesses and listen to everyone's comments, because I think that it exemplifies basically all of our feelings.

I would only like to say that I share in lots of the spirit that has been expressed here, and I think we will all go away with a different attitude and a different perspective toward air safety.

Thank you very much.

CHAIRMAN HALL: Thank you. The International Association of Machinists and Aerospace Workers? Mr. Liddell?

MR. LIDDELL: Thank you, Mr. Chairman. We would like to take this opportunity to thank you for our participation in these hearings and the investigation, and to also state that we stand back to further assist you in this effort.

CHAIRMAN HALL: I appreciate your presence. While the public may see the pilot, I am sure the pilot

sees the mechanic and is counting on his good work to keep the plane safe, and you represent a very important group of people that both work on the planes and design and build them.

Trans World Airlines, Inc.? Captain Young, thank you very much for TWA's participation in this hearing.

CAPTAIN YOUNG: Thank you very much, Mr. Chairman. I would like to say on behalf of Trans World Airlines we appreciate the ability to participate in the hearing, and we certainly will continue to devote our utmost support for the continuing work of the Board.

Thank you very much.

CHAIRMAN HALL: Thank you. The Federal Aviation Administration? Mr. Streeter, thank you, and thank you for bringing Mr. Donner to sit at the table.

MR. STREETER: Certainly, sir. He needs to keep an eye on me. Other than that, the FAA looks forward to continued cooperation and participation with all the parties in the investigation.

CHAIRMAN HALL: Thank you, sir. Boeing Commercial Airplane Group? Mr. Rodrigues?

MR. RODRIGUES: Thank you, Mr. Chairman. I think Mr. Thomas pretty well expressed Boeing's

opinion. We have thoroughly enjoyed all of the exchange of information that we have received here this week, and we will just continue on two paths, the first being continue to try and find what the cause is.

It has been pretty frustrating for us who have been putting in long hours for many months and still not have a cause. So, we will continue there, of course.

As Mr. Thomas said, we are doing many other things, and we will pursue that. Thanks.

CHAIRMAN HALL: Well, your company is a leader in the aviation industry and I think all Americans are proud of the 200,000 employees. It is one of the flagship companies in our country, and we appreciate the commitment you have made to help us in these matters that have been discussed here today.

Captain Rekart with the Air Line Pilots Association?

CAPTAIN REKART: Well, sir, we have all been here for seventeen months so far, and we have covered a lot of ground, and we are looking forward to being a part of the continuing investigation and taking it to the conclusion, sir.

CHAIRMAN HALL: Thank you very much. Honeywell, Inc., and Mr. Thomas?

MR. THOMAS: I thank you, Mr. Chairman, for the opportunity to participate in this hearing, and Honeywell will be available to assist in any way possible in the future.

CHAIRMAN HALL: Well, thank you. Well, with the last witness having been heard, we have concluded this phase of the Safety Board's investigation into the crash of TWA Flight 800.

In closing, I want to sincerely express my deep appreciation to all the participants in this hearing. I believe we have had a very productive week.

As I said when we began, the National Transportation Safety Board serves as the eyes and ears of the American people at an accident site, and these hearings are an exercise in accountability.

In holding this hearing seventeen months after the TWA 800 tragedy, we were seeking to explain to the American public just what we -- where we are in the investigation and describe in some detail what has been done to date not only by the National Transportation Safety Board and its contractors, but also by the parties, by industry and the federal regulatory authorities.

We have presented all of the factual information available at this time, and I want to take

this opportunity to thank the technical staff, some of whom are represented to my right, for the work and commitment they have brought to this investigation.

The technical expertise of this Board is something the American people can be proud of. I am proud to be associated with these men and women and have an opportunity to serve as their spokesperson.

I hope that we have been successful in demonstrating the breadth and depth of the effort to determine exactly what happened to TWA 800. We have sought to take a careful, objective look at all conceivable ideas and theories and have called on a wide array of experts from around the world to assist us i this endeavor.

We are by no means finished. Our work will continue, and we will spare no effort to determine the cause of the crash of TWA 800. I am confident that in the process we will learn a great deal more that will help make our air transportation system even safer.

This hearing also represents what I believe is a milestone in forging a broad base systematic approach to dealing with the dangerous vapors that can accumulate in fuel tanks. The acceptance of a two-track approach to this problem is an important safety advance for the travelling public.

As testimony this week has shown, dangerous conditions in fuel tanks occur more commonly than had been believed, and when the tank is heated, the amount of energy needed to ignite the vapors drops significantly.

I welcome the FAA's willingness to take another look and re-evaluate the recommendations on fuel/air mixture volatility made by the NTSB one year ago.

I also welcome the Boeing Corporation's expressed openness to examine additional ways of dealing with the dangers of fuel tank vapors suggested by the Safety Board. I hope this hearing has demonstrated the extensive work that has already been done by the Boeing and the FAA in this investigation.

The NTSB has long advocated a two-track approach to the fuel tank problem, pointed up by the crash of TWA 800. This position is derived in part from the lessons learned over the years. Thirty years of accident investigation experience has taught us the value of not relying on a single approach to resolving a serious safety problem.

We applaud the work that has been done to remove all potential ignition sources for fuel tank explosions, but as has been stated frequently at this

meeting, we can never be sure that all possible ignition sources can be eliminated. Therefore, the Safety Board strongly believes that additional measures to stabilize fuel tank vapors are necessary and prudent.

The Board certainly recognizes the need to proceed carefully in making changes to systems that on a whole have performed safely and reliably for extended periods of time.

Let me say again, the 747 aircraft has a very safe record, and we have the safest aviation system in this country of the whole world, and that is as a result of a lot of work that is done -- good work that is done by the individuals that design the aircraft, manufacture the aircraft, people that maintain the aircraft, the people that fly the aircraft and the government regulators that try to oversee those processes. It is a record all Americans can be proud of, and I think that is one of the reasons we see the dramatic growth in aviation today in our country.

We do want to be sure that the fixes that are made are the right ones and that no new problems are introduced, but these concerns should not immobilize government and industry and inhibit us from acting vigorously and with dispatch when, as in the case of

the crash of TWA 800, a problem is uncovered.

It is only through prompt, effective and sustained action that the aviation industry and the government's regulatory system can retain the confidence of the American people.

Let me emphasize that this investigation will remain open to receive at any time new and pertinent information concerning the issues discussed this week. The Board may at its discretion again reopen the hearing in order that such information may be made part of the public record.

The Board welcomes any information or recommendations regarding this accident from the parties or the public that may assist us in our efforts to insure the safe operation of commercial aircraft. Any such recommendation should be sent to the National Transportation Safety Board, Washington, D.C. 20594, to Mr. Al Dickinson's attention.

Normally, submissions should be received thirty days after the receipt of the transcript of this hearing. However, since there are still investigation activities open in this case, Mr. Dickinson will notify the parties when the final submissions are due.

All the evidence developed in this investigation and hearing, and all recommendations

received within the specified time will be presented and evaluated in the final report on TWA 800 in which the Board's determination of the probable cause will be stated.

The record of the investigation, including the transcript of the hearing and all exhibits entered into the record, will become part of the Safety Board's public docket on this accident, and will be available for inspection at the Board's Washington office. Anyone wishing to purchase the transcript, including the parties to the investigation, may contact the Court Reporter directly.

On behalf of the National Transportation Safety Board, I want to thank again the parties for their cooperation, not only during this proceeding, but also throughout the entire investigation of this accident.

Also, I would like to express sincere appreciation to all those individuals, groups, corporations and agencies who have provided their talents so willingly through this hearing. Specifically, the members of the National Transportation Safety Board administrative staff who assisted through this hearing.

In closing, I want to thank the family

members who have been with us this week. It is good that so many of you all were able to attend. I know that in many ways this has been a very difficult week for you and I hope, though, that what you have seen of the work underway to solve TWA 800 and the effort by everyone here to learn how to prevent such tragedies in the future, that this may give you some degree of comfort and will serve as a legacy to those who lost their lives on that flight.

I have received a very gracious letter from the families thanking the Safety Board for their hard work. I am going to make that letter available for all of my technical staff and the others that have worked so hard on this investigation, as well as the parties, and I will submit that letter for the hearing record.

Thank you very much again, and I want to assure the families that, of course, we will continue to stay in close touch with you as the investigation proceeds and, as we have in the past, share all information with you.

I finally want to thank C-Span for covering this hearing gavel to gavel. There has been so much attention both in this country and around this world on this accident, I am glad that the American people had an opportunity to view these proceedings, and I want to

again thank C-Span for that opportunity, being here and being able to show to the nation one of our hearings gavel to gavel.

Therefore, I will now as Chairman of this hearing declare this hearing to be in recess indefinitely.

(Whereupon, at 12:30 p.m. the hearing was adjourned until further notice.)

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