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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

MARCH 15, 2000

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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MEETING: HUMAN FACTORS

U.S. Nuclear Regulatory Commission
Two White Flint North, Room T-2B1
11545 Rockville Pike
Rockville, Maryland

Wednesday, March 15, 2000

The subcommittee met, pursuant to notice, at 1:05 p.m.

MEMBERS PRESENT:

GEORGE APOSTOLAKIS, ACRS, Chairman
JOHN J. BARTON, ACRS
JOHN D. SIEBER, ACRS
NOEL F. DUDLEY, ACRS
MARIO V. BONACA
DANA A. POWERS

PARTICIPANTS:

JACK ROSENTHAL, RES, Chief of the Regulatory Effectiveness Assessment and Human Factors Branch

BRUCE HALLBERT, INEEL

DAVID GERTMAN, INEEL

JOHN O'HARA, BNL

VICKI BIER, University of Wisconsin

ISABELLE SCHOENFELD, RES

J. PERSENSKY, RES

DAVID TRIMBLE, NRR

P R O C E E D I N G S

MR. APOSTOLAKIS: The meeting will now come to order. This is a meeting of the ACRS Subcommittee on Human Factors. I am George Apostolakis, chairman of the subcommittee. ACRS members in attendance are John Barton and John Sieber.

The purpose of this meeting is for the subcommittee to review the NRC program on human performance at nuclear power plants, the status of international activities, the quantitative analysis of risk associated with human performance, the safety issues report on economic deregulation, status of control station review guidance, and planned activities by the Office of Nuclear Regulatory Research and the Office of Nuclear Reactor Regulation.

The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and action, as appropriate, for deliberation by the full committee. Mr. Noel Dudley is the cognizant ACRS top engineer for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting, previously published in the Federal Register of June 1, 1999. A transcript of this meeting is being kept and will be made available, as stated in the Federal Register notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so they can be readily heard.

We have received written comments from Mr. Barry Quigley, a licensed senior reactor operator. I will read his statement into the record.

Mr. Quigley writes, "The ACRS is currently reviewing the impact of human error on reactor safety. To date, the role of fatigue has gone largely undetected. It stretches the limits of credibility to believe that only one percent of the errors listed in the human factors information system are due to fatigue.

"Contrast this with National Transportation Board data that shows about 30 percent of consequential errors are due to fatigue. A comparison between NTSB data and nuclear plants is not inconsistent. Control room crews have similar dynamics as airline crews and personnel working alone in the field compared to truck drivers.

"My experience as a root cause analyst allows me to review LERs and determine that fatigue or other causes are not found to be the causes of events simply because the reports don't look deep enough. The reports stop at personnel error or slightly deeper at inattention to detail. True root causes for the human errors, such as mind set, task too complex, or fatigue, are rarely reached.

"Utilities also rely on supervisory operation to detect fatigue and impairment. Given the reductions in numbers of supervisors and dramatic increases in their workload brought on by deregulation, observation is a poor barrier to fatigue. Attempts to take credit for observation at the briefings at the beginning of a shift are deceptive. Personnel are being observed when they have had the most rest. They are also being observed outside of their normal work environment. Even when observation occurs, detection of fatigue is not easy. Recently, one large utility admitted that it had not trained personnel on detecting fatigue.

"I ask that when the ACRS discuss the causes of human error, fatigue be considered as a potentially significant contributor. I am uncertain of the protocol for dealing with the ACRS, so I hesitate to provide large amounts of information that might otherwise distract from the planned discussions today. Further information can be found in a proposed rule making to 10 CFR 26, fitness for duty programs (PRM 26-2), and the Union of Concerned Scientists report, overtime and staffing problems in the commercial nuclear power industry.

"I can also be contacted directly. Sincerely, Barry Quigley, senior reactor operator."

This is the end of the statement.

The ACRS last reviewed and commented on the human performance plan on February 19, 1999. Today the staff will update the subcommittee on its revision to the plan and on the status of ongoing activities.

We will now proceed with the meeting. And I call upon Mr. Rosenthal, Chief of the Regulatory Effectiveness Assessment and Human Factors Branch to begin.

Jack?

MR. ROSENTHAL: Thank you. I am Jack Rosenthal, chief of the Regulatory Effectiveness Assessment and Human Factors Branch. That is a mouthful.

J. Persensky is the team leader of the human performance. And he will be assisting in the presentation. And David Trimble from NRR is responsible for human performance at NRR. And he will have comments to make later. This is a joint plan of RES. RES is lead. And NRR, NMSS would ideally be another participant. They are reorganizing their own risk efforts right now and so did not participate in this version of the plan.

I am going to give some introductory remarks and talk mostly from a paper that we wrote to the Commission and was provided, which actually presents the plan to the Commission, and make some comments myself about risk work that we did at Brookhaven with the in-house staff.

Then Hallbert from INEEL is going to talk about their quantitative accident sequence precursor work. And then John O'Hara will talk about control stations, Vicki Bier about economic deregulation, Isabelle Schoenfeld of the staff about international work, Dave about NRR activities, and then Jay for where we are going from here.

Last time there was a meeting on the plan itself, Steve Arnt (phonetic) was the presenter, and I got to sit in the audience. We paid a lot of attention to the comments that were made. Not all the things that we are talking about today span all of your concerns.

You wanted us to have close ties with NPO, and we have had contact with NPO and EPRI to ensure that we don't duplicate efforts. We have done that.

You asked about what other federal agencies were doing, and we compiled the list of those activities. And we provided that information to you last week in writing. So we will not be discussing them today. But I think that we were faithful to your concerns. And the agenda is based on your current concerns.

We have been working on the human performance plan since 1995. I was in AEOD at the time. And it was just originally an attempt for the three branch chiefs to get together to ensure that activities were coordinated and we were not duplicating efforts. And it grew into a formal plan.

In 1998, we described what work we were doing to attempt to risk inform the plan. We had a meeting in February of 1999 that I just referred to. And we just roughly on an annual basis came out with rough versions of the plan.

We want to stop doing this, because it is a very small effort. And if we could do our planning biannually instead of annually, or something else, we could actually put more resources into work.

I will be getting to the substance in a minute. The section that we presented to you talks about the status of prior meetings, gives a mission statement. I don't want to dwell on it. And the program.

Ideally, if we were to truly risk inform, we could take all the program elements and do some sort of risk achievement worth and calculate just what each thing is worth and truly risk base all our activities. But the reality is that we can't risk base our activities. We can risk inform our activities.

In research, user needs from the program offices are very, very important. And some of the work that we do is based on user needs.

MR. POWERS: Can you give us a feeling for about what fraction?

MR. ROSENTHAL: About 80 percent. It varies from year to year in terms of the money that is being spent. And

I will get into that.

In the SECY that we provided you, there is a table of each of the activities. And you will see one, two or three asterisks next to each item, which explains which are formal user needs or anticipated user needs or RES-sponsored work. So what I will say is that the plan is risk inform, but it is not risk base in the sense that we just cannot go to every bubble and come up with a formal risk achievement worth.

We are also mindful of what industry is doing. We know the European effort. And we know what other agencies are doing. And last, we have to fit what we are doing into overall agency programs. And I will get back to that. Let me just dwell on the risk side.

What we did, one of the things was that we -- actually, we asked Brookhaven to look at what PRAs have to say about is the human contribution to risk. And that is one of the documents that we provided you last week. And it is not that there is a table of risk worth of various actions, but there is a table in that document of reports that include risk worth.

In other words, we have been over this issue time and time again. And depending on which PRA you look at, what are the dominant sequences and what people choose to call human performance or not, you are going to end up with numbers of the order of 10 to 50 percent of the risk is due to human performance. And I will get back to that in a moment.

What we also --

MR. POWERS: One of the questions that come back is, is 10 to 50 percent too much, too little, about what you would expect?

MR. ROSENTHAL: I don't know. But I will get to that in a moment.

What we also decided to do is to look at the accident sequence precursor data in some detail. And there were roughly 50 events in the last five years in which the conditional core damage probability exceeds 10 to the minus 5. And that was our focus for events.

Like your earlier comment with respect to PRA, is that too much or too little, the agency really doesn't have a position now. And it is one thing we ought to figure out. Is 50 events over a 5-year period and a declining trend acceptable or not? Because we know that events will continue to occur. And yet plants still meet the safety goals, et cetera.

We do have a performance element that says that we will not have an event in the 10 to the minus 3, that exceeds 10 to the minus 3, as a formally set goal. But this is a rich source of information to look at.

The staff compiled the events and qualitatively examined those events. In parallel with that effort, INEEL also looked at the events -- the timing was different. And you will hear from them at length -- and tried to do some quantitative work to quantify the human contribution.

Now we will get into some of why I don't know. If I look at the risk in such reports, NUREG-1560, things like manual depressurization, containment venting, standby liquid control, UCCS switchover to recirc, feed-and-bleed are dominant human actions. And you see them time and time again in IPEs.

If you accept this as true, that this is where the risk is, then it would tell you to go look at their training for severe accidents, go look at their EOPs, go look at simulators, but don't look at the operating experience, because you won't see these kinds of events in operating experience.

So it would lead you, it would push you in the direction of the simulator and the EOPs, et cetera. Much of that work we have already done. And NPO has an active accreditation program, et cetera. So if this is the reality, we should be backing off from human performance, because we have all these things that we have done in the past, all the work that NPO is doing.

MR. POWERS: In following that logic, you would say, okay, we have done everything we can think of doing here. This is just the base that you are going to have to live with. Humans are fallible creatures, but we still have not found a better thing to run a nuclear power plant.

MR. ROSENTHAL: Well, we have chosen in the U.S. to have automatic actuate manual run plants. I had a briefly with RSK, the German equivalent of the ACRS -- I am not quite sure what RSK stands for -- in which the discussion was the Germans chose to have their plants far more automated than we do. So these are choices that we made. This is one viewer reality. Okay?

And this says don't bother looking at a day-to-day operation. And don't bother trying to develop a performance indicator for human performance in the plant assessment process, because that would not be --

MR. POWERS: It would never get to trigger.

MR. ROSENTHAL: It would never get triggered. And it doesn't tell you that which is risk important by looking at that.

Another view of reality is to look at the dominant accident sequence precursors. And depending on how you count, two-thirds, three-quarters, 80 percent, depending on who is doing the sorting, all involve human performance. And these are important aspects. Sometimes positive and sometimes negative.

For example, the event at the top, Wolf Creek was caused by human actions and ameliorated by the operator. So you are looking for good and bad. So if you accept this as a view of reality, then this says that yes, you can look at the plant assessment process to extract human behavior, or your plant assessment process can do that.

It is conceivable that you could develop a PI, some sort of numerical performance indicator, if these are the kinds of things you are worried about.

Well, the reality is that right now we are, I won't say schizophrenic, we are just of a dual mind. We have not yet sorted out how much we should rely on the ASP, how much we should rely on the PRA. As I say, they lead you in two different directions. What is an acceptable contribution to the PRA rests on maybe deciding how many of these kinds of events I am willing to tolerate.

Now in these events, it is not -- okay. In the PRA, what I showed you was actions by the operators, ECCS switchover. Will they do slick? Will they go to feed-and-bleed before the steam generators dry out? Here in operating experience space, I have a much more complex thought process.

Let's take the Wolf Creek event. The plant management decided to do the quickest refueling outage they had ever done in their history. That was their decision.

They decided to do maintenance in mode four, when there is still both latent heat, as well as the K heat.

They decided to do multiple maintenance operations at the same time in order to speed their processes. And the maintenance organization, rather than the operators, actually opened valves, and the operators saved the day.

Catawba chose to be doing maintenance of an EDG with the plant on line. This Oconee event is a very interesting event, in which they do burn -- they are again in mode four or, I'm sorry, a high mode. And they end up burning up two of three high pressure injection pumps. And they would have burnt up the third one. They actually damaged the two pumps, not a maybe, because the operators were smart not to allow the third one to automatically come on.

And what underlies it is that even though you do quarterly testing of the ECCS pumps in accordance with your in-service testing program and your text specs and all of this other stuff, they were not -- they were testing the pumps. And what was wrong was the level indicators on the refueling storage tank, which caused the common mode.

So if you take this as a reality, then you are going to get into not only the operators, but the operating organization. You are going to get into maintenance. You are going to get into latent failures in the Jim Reason (phonetic) sense of the latent failures.

And it is going to drive you to look at how the place is organized, et cetera. That is another view of reality.

MR. POWERS: Well, maybe you can come up with the answer, that both are correct, that on the first slide you say operators are trained, tested, folded, spindled, mutilated, and they do pretty well. The rest of the organization maintenance doesn't have that kind of intensity associated with it. And that is where we see problems arising. And safety culture is something we don't how to enforce or police or do anything with.

MR. BONACA: And I don't think you get two different stories. I mean, simply in PRA you model what you know happens and then assigns some likelihood of success or failure. And, of course, the point Dr. Powers is making is true, whether there has been intensive training and so on and so forth, that probably -- or whether there was not.

Here, however, you have actual events taking place. And, you know, I would like to hear about the characterization in the report of 90 percent, of average contribution human performance to the event importance was 90 percent in these latents events. That is very significant.

MR. ROSENTHAL: We are going to -- I am going to go fast, so we can put Dave up for more time.

MR. APOSTOLAKIS: Yes. I want to -- well, the statement that you have two views of reality and that they lead into different directions is not quite accurate, I think, because there is a third message from this that perhaps the PRA models are not reflecting operating experience.

I think you would be hard pressed to find a PRA that would have something similar to the Wolf Creek incident, where the operators created a situation, and then they managed it well. But they created it.

In fact, in our letter on Athena we recommended that that become a major part of the Athena effort. So I would say there is a third message here. In fact, I would call this really the reality. The PRA, I would say, is a model. And if there are any lessons in this kind of evaluation or assessment of real incidents, then PRA should benefit from those.

MR. BONACA: What I thought was the most challenging thing is the PRA assumptions that you make and failures of operators are understandable. And you can deal with them quite -- much more challenging, because these are random occurrence out of tens of thousands or more. This is equipment.

MR. ROSENTHAL: Some of my management will repeatedly ask: You have been working on human performance since Three Mile Island, so many millions of dollars have been put into this, when is enough enough? When do you declare success? When do you stop?

Now I had an opportunity to at least brief at the DEDO level, the Deputy Executive Director of Operation level, to say that the activities that we are doing now are different than the ones that we did post-TMI. We are not advocating more work on EOPs. We are not advocating more what I call paper taping label. We are reliant today on imposing accreditation. And we are looking at other things.

MR. APOSTOLAKIS: Now you also gave the impression, Jack, if you look at the PRA results that you showed earlier, that perhaps we have done the best we could there, maybe this is a situation we have to live with, these kinds of errors during recovery and so.

Well, it seems to me that we are doing more than just accepting the situation as being, you know, that's life. Athena has followed the change in paradigm. And now that we are talking about the context and all that, so if we understand the context, maybe those numbers will go down, if we understand it better than we used to.

So there is still hope, I think, that these numbers will improve. And we are not there yet. We have not settled on any of these numbers.

The last question I have -- actually the first question; the others were statements -- of these 11 events that you list up there, I think we have all agreed that the first one is not the type of thing a PRA analyzes. Are there any others from 2 through 11 that a typical PRA would not include? I mean, that would be an interesting lesson from this.

MR. ROSENTHAL: I think that the PRA analyst would say, look, I have considered single failures, I have considered multiple failures, I have considered common mode. And in that sense, I picked up the Oconee event, because it involved two pumps. I would argue that no, because you didn't -- especially if you had a super component, you didn't model this level transmitter. When the tank goes to zero, it mechanistically causes both pumps to fail, because you are pumping steam.

MR. APOSTOLAKIS: I would agree with you.

MR. ROSENTHAL: The St. Lucie, the research set point, I think that that depends on the detail of the PRA. Let me just make the point. And in fact, I briefed the ACRS on this Fort Calhoun event. There are very few examples to say how well we did post-Three Mile Island. At Fort Calhoun they had a stuck open safety valve on the pressurizer from power. Okay? And they used their EOPs.

They used their sub-cooling mod to monitor. They used their thermocouples. They went by the book. They followed the procedures. And they very successfully coped with the event. And there are very few examples like that, to say that the stuff that we put in place actually work. But that is the best integral test they could possibly think of.

And there are 50 events there. I am just going over the top.

MR. BONACA: But there are things there that were pretty interesting. Take event number nine, Oconee, where you had the loss of offset power because the Kiwi facility was not under the control of the control room. Now when we were looking at license renewal, we learned that the Kiwi facility was not under Appendix B and, in fact, had a total different -- and the question is, you know, is there a link there? Of course there is a link.

This facility was being run separately from the control room. So if the control room had an expectation that they could remotely actuate that facility, the facility was doing something else at the time.

Now the point I am trying to make is that you may not be able to get the information that goes into a PRS report. But certainly, this is critical information. Certainly, when you look at events and then learn about PIs, for example, or cross-cutting issues. This is critical information.

And when I read that, I said, oh, no wonder it happened, because we were looking at that plant and being surprised that in fact the emergency power source was not controlled in the same program with the control room.

The point I am trying to make here is that if you don't focus only on trying to model these events, there are so many different uses and insights we are getting from this.

MR. ROSENTHAL: We write a very -- in my AE of D-Day, we wrote a very big report on Oconee and their electrical distribution, which I would be glad to share with you. But that is not the subject of this meeting.

MR. APOSTOLAKIS: Jack, the report that contains this information, which I assume has much more than just what --

MR. ROSENTHAL: Right.

MR. APOSTOLAKIS: Is it going to address the question of how many of these events or similar events are treated in a PRA? That would be a very useful insight.

MR. ROSENTHAL: We provided documentation last week. It does not include that. That would be a very -- I think that we have to go that way in order to start answering Dana's question about how much is acceptable. And we really haven't answered that.

Let me just stop there a second. Of course with my colleagues, I end up with a deal of wait a second, you wanted 95 percent diesels. You have 96 exclusive of maintenance out of service. You are meeting your goal, depending on how you decide to define it. Why do you care if the other 4 percent would be all due to human performance, if you are meeting your equipment goals? And I think that they are right.

However, if the problem that is giving me the four percent unreliability, which is an acceptable number, if the problem is due to underlying programs and processes and procedures, then I worry about common cause across multiple trains within a system, as well as across the plant. And I think that that is the rationale for worrying about these things and not stopping only at the equipment failure level.

MR. POWERS: And I think a general issue of problematic failure is something that we still have to wrestle with in this new plant assessment process.

MR. ROSENTHAL: I will get to that in about a minute and a half.

So you can dissect those events and look for commonalities. And you can do it in terms of knowledge, procedures, training, you know, which is the maintenance department, which is the operators. I think if you put six people together, you would end up with eight ways of cutting it. And you are going to hear more from INEEL on how they formally cut it. So I just want to make --

MR. APOSTOLAKIS: So we should not ask you.

MR. ROSENTHAL: I know. Pass the buck. Some people are more interested in programs. Some people are more interested in processes. But my only point is that we need to take it apart and bend it and see where to go. And I would assert that that effort would be risk informing the human performance plan.

I want to get into the plan itself, just two more slides. We broke up -- we have four major elements. One is the oversight process. And we should talk about the relationship of the ASP to the oversight process. Normal NRR-type licensing monitoring activities at NRR is one of the questions. We do want to risk inform the plan.

Nathan Sue (phonetic) now has the lead for -- well, not only for fire, but now he is taking over the human reliability work, of which Athena is only a part. And we need to be plug compatible with Nathan's work. And we have had some discussions.

And I want to talk about emerging technologies, for which I have a difficult time putting a risk number on it.

MR. APOSTOLAKIS: How closely are you working with the Athena folks? Is anybody from Athena here?

MR. ROSENTHAL: Nobody from Athena is here.

PARTICIPANT: We have one here.

MR. ROSENTHAL: I'm sorry.

MR. GERTMAN: I have been working with them of late on --

MR. APOSTOLAKIS: What you say doesn't matter unless you come to the microphone.

This is David Gertman. He said that he is working with Athena.

MR. GERTMAN: I am David Gertman from INEEL. The Idaho National Engineering Laboratory is working with the Athena team on pressurized thermal shock in two ways. First, Bill Galion (phonetic), one of our PRA analysts, is reviewing sequences and working with the team for the events and the modeling.

And myself and a licensed examiner have been working on a review of over-cooling events going through the LERs and trying to determine human performance influences and shaping factors that contributed to those events. That work is ongoing. And so far we have reviewed about 50 events, and we have about 15 that have a human performance involvement. I don't know if that ratio will hold as we go through the 140 that are identified as the total sample.

MR. APOSTOLAKIS: So your participation is primarily in applying Athena to issues of interest. Are you participating also in the development, in model development?

MR. PERSENSKY: I will take that question, if I may.

MR. APOSTOLAKIS: Sure.

MR. PERSENSKY: I am Jay Persensky from Jack's branch. I won't try to repeat the name of it. I actually invited Nathan to come to this meeting. But at this point, except for Dave, I think the entire Athena team is down at Oconee working on an Athena-related effort.

I was given a copy of the forward of the upcoming Athena report. And I was told I could tell you a little bit about it. Generally the direction that they are taking at Athena now is not further development directly, but they are going to try to apply it along with other techniques. The program is more an HRA-related program rather than Athena-related program. But the focus is going to be on the application.

Two major areas of application will be PTS and fire. During that process, learning from the use of it, there may be further development. But the focus is now on application as opposed to development. And as I said, we have been working with Nathan in terms of how we might better support them. And that is what is reflected in the plan document. He would be glad to be here, except he is enjoying downtown Oconee instead.

MR. APOSTOLAKIS: Okay. Thank you.

MR. ROSENTHAL: So there are four aspects of the plan. And I want to work across. The darkened and the flags are work that the agency has ongoing. And the rounded rectangles is work that is explicitly in the plan. And we are showing it this way to see how it fits together. Of course, if you are going to do inspections, RES develops tools to do inspections. And so you see the supplemental inspection on human performance and an evaluation protocol that is classic-type tool building that we do.

But I want to emphasize this characterizes the effects of human performance in the oversight process. This is an anticipated user need from NRR, where it is somewhere in the management approval process. It is almost delivered.

And this answers the -- this is an attempt to answer the question that we just spoke about. Can you -- we recognize the human performance and the plan assessment processes as a cross-cutting issue. It is a hypothesis that you can look at equipment reliability and know all that you need to know. And if the diesels are nine-six and you wanted nine-five, that is good enough.

And that hypothesis is that you could look at the outcome of the equipment performance, and you don't need to look at the underlying reasons, as long as things are okay. When things would be degrading, then you would look deeper.

An alternate hypothesis that comes out of the work that we have done on the accident sequence precursor is that there are aspects of safety which are not revealed in simple equipment reliability and outcome numbers and that get into programs and processes that you should be looking at.

And let's just say that they are both hypotheses. In a fiscal 2000/2001 activity is with some discipline is to match up the 50 ASP events against the now proposed April plant assessment process and systematically say, what would be covered within the current process of those events, what is missing.

And then we would propose how we might go forward. And that, of course, we would have to work with NRR on that. And you might go forward in the form of potentially developing a PI. I doubt it, but at least we should have that as an option. You might propose to have some sort of supplemental inspection or be part of the baseline inspection.

But rather than leaving these two things as a hypothesis, that you could do everything by knowing the outcome and the reliability of the equipment and the PIs or that you must have a separate module on human performance, let's go take the data and match it up and see where we stand. And I am sure we will end up at some middle ground.

Ideally, I would have done that work for this meeting, but we have not done it yet. Although I think that the work that we have done so far on the 50 ASP events and looking at what is in the PRAs, that puts a real leg up compared to where we were a year ago. We have --

MR. APOSTOLAKIS: So the preliminary work tends to support which hypothesis, the first or the second?

MR. ROSENTHAL: In my mind, the second.

MR. APOSTOLAKIS: In your mind, the second. Now why is the team that is developing the reactor, the revised reactor oversight process, why is that team acting as if hypothesis one were true? I mean, they state it very clearly in the report, 007, SECY-007, that safety conscious work environment, human performance and -- what is the third one?

MR. ROSENTHAL: Corrective action program.

MR. APOSTOLAKIS: Corrective action program. That they don't need special attention because there is a flaw there. We will see it in the performance of the equipment.

MR. ROSENTHAL: I consider it great success that I can stand up here and characterize the statement as a hypothesis to be tested rather than a truth.

MR. APOSTOLAKIS: And some of us are grateful, Jack.

[Laughter.]

MR. ROSENTHAL: Okay. So that is actually the bulk of the work that we would do with respect to risk informing the oversight process, with respect to human performance. Okay.

The next branch down is really NRR activities. And it does get back to saying what is reality, because if I only look at the results from contemporaneous PRAs and then go look at things like what is their training program, what is the condition of their simulator, what is NPO doing, et cetera, then those are activities that NRR does all the time.

You will see a bubble called policy review here. That policy review bubble includes the issue of fatigue. NRR has the lead for the fatigue issue. We did have a meeting, a public meeting, with interested parties, Quigley, the NEI, the PROS, NPO, UCS. It was an NRR -- Jay and I were at that meeting. So that issue is being taken on. And you read his statement. He is not being ignored. But that is part of the plan.

Let me just go on to the third led, risk informing. We have an activity to go risk inform part 50. And we ultimately get down to say, what is needed in PRA? The current thought now is that this human performance effort would provide data on requests to the HRA analysts to improve their -- so they could do their work.

I think that there is an element where the operating experience can be used to, in fact, drive the HRA and the PRA. So --

MR. APOSTOLAKIS: Sure. I don't know what data you are going to give them, Jack. I really don't. And I read in the document here that you will use Halden among other things to do that.

But maybe we can pursue that some other time because I remember Dennis Weiss (phonetic) saying clearly, when he presented the Athena work, that they will not develop tables with numbers. They will not -- I mean, everything is past specific and event specific. And you have to use the Athena to analyze it.

Maybe I am not doing justice to what he said. But basically, I don't know what kind of data you can develop. Maybe information rather than data --

MR. ROSENTHAL: Okay. Then let me --

MR. APOSTOLAKIS: -- regarding shaping factors, you know, that kind of stuff.

MR. ROSENTHAL: Let me make two points. The one that Jay made is that clearly today, we see Athena as only one of an overall HRA activity. Two, my -- and now I am going to get vaguer.

In my old AEOD days, we had done a study of events, human factors and events. A lot of them were shot down. And we had maybe like a dozen events. That work ended up being used in the shut down risk studies that were done by Brookhaven and CNDO. And it was only a dozen events. And I was sort of modest. And they said it is only a dozen, but that is the best data they had. So it got used.

Just as a vision, I think that if we could take apart the most important events, the 50 events, in some manner, that we can provide some numerical information to the HRA process and --

MR. APOSTOLAKIS: In terms of what has happened, yes.

MR. ROSENTHAL: -- for modest money in comparison, I think that that would be --

MR. APOSTOLAKIS: Now you said something very interesting earlier. You said that you view Athena only as one HRA effort. HRA stands for human reliability analysis.

MR. ROSENTHAL: Yes, sir.

MR. APOSTOLAKIS: And Athena is one? What is another one?

MR. ROSENTHAL: Well, of course -- I mean, you know, there is a whole array of tools.

MR. APOSTOLAKIS: Yes. But I mean in terms of recovery actions and so on, the name of the game is Athena, I think.

MR. ROSENTHAL: We did Wolf Creek with a time dependent recovery model, HCR.

MR. APOSTOLAKIS: Yes. But I think --

MR. ROSENTHAL: We did. I mean, that is what we did the numerical --

MR. APOSTOLAKIS: Right. The human cognitive reliability model?

MR. ROSENTHAL: Yes. Yes. We looked at the integral over how much time he had to react before he tried it.

MR. APOSTOLAKIS: When did you do this?

MR. ROSENTHAL: That is how we quantified the Wolf Creek event.

Emerging technologies: I want to say -- okay. This is an area in which we can risk inform again, but I cannot put a risk achievement word on it. You are going to hear about the contribution hauled into that effort, because we know that you are interested in it. And you are going to hear a whole presentation from Brookhaven. So I am going to stop very shortly on it.

And you are going to hear -- you will not hear today about a digital INC plan, but we keep talking about the back of the panel and the front of the panel, where the electronic guys have the back of the panel and inside the box.

But to the extent that there are information systems, the performance guys have the front of the panel. So there will be some work that we pick up there.

We had a meeting where Halden made a presentation to EPRI and U.S. Utilities in Rockville a few months ago. And I got to sit next to one of the guys from Calvert Cliffs. And what became very apparent was that Calvert Cliffs will go into live extension with a hybrid control room and with old-fashioned pistol grips to run equipment.

And up above are going to be flat panel displays of new information. And it will not simply be the information we have now displayed in a fancier form. But it will be more and better information, more hierarchy, more structure, more levels of abstraction.

We had an event maybe six months ago at Beaver Valley, where they lost an electrical box. And 130 alarms go off. That is not fair to the operators. That event was important because they did not trip the reactor cooling pumps, and they lost cooling at the pumps. Well, okay. It is a setup.

So alarm prioritization is happening or will happen at plants. You will have these displays. These are information systems. And you can argue that that is the utilities business.

Alternately, one could argue that if we review it -- that we are going to review it. And so it is our business, and we are prepared to review it. Or if we choose not to review it because they make the changes under 1559, then we are tacitly giving approval. It is either explicit or tacit. But we know that it is going on.

And I would assert that we have to be in a -- if we find something that is not safe, we should not approve it. But if we are not prepared to review it because we have not anticipated the needs and done things in a timely fashion, then shame on us. And so that this emerging technology block is trying to prepare for the future.

Okay. The last thing I want to pick up is, we are interested in economic deregulation, the changing of what this grid will look like. We will hear a presentation from Dr. Bier in just a little while on work that has been done to date. Clearly we know that we -- well, we believe that we are going to have six to eight merchant producers that the organization will be different. There will be economies of scale. There will be financial pressures on them.

The paradigm of being a base-loaded plant may well change. If you had an extra megawatt last July or August, when it was $2,000 per million BTU in the Midwest for a few days, that might be the time that you make the profit on your plant for the year. And all the time that you are base loaded at a penny a kilowatt hour doesn't matter. So even the paradigms may change.

We know that the legal situation is changing, because everything is being bought up and sold. And we believe that we should be out in front at least to understand what these pressures are and how it might change the regulatory arena. That is an RES sponsored, not -- it is a very modest effort, but it is an RES sponsored effort rather than a user need.

The digital INC work will be concurring with NRR. I mean, it is being developed jointly by both staffs. And that will be user need. The control station design is all user need.

Okay. In the presentation are tables that -- it is just tabular form of the bubbles. And I would propose that I not discuss them, that you hear from the experts that we brought in today. And then after that, Jay will pick up and talk about where we go in the future.

MR. APOSTOLAKIS: This is nitpicking, but is the top box accurate reading nuclear power plant safety? And you have reactor oversight. Are you maintaining nuclear power plant safety or something like that?

MR. ROSENTHAL: Maintain safety. In fact, we have four cornerstones. And for the RES prioritization about work, which is a different activity that I have responsibility for, we rank our programs in terms of maintain safety, burden reduction, public confidence and efficiency and effectiveness.

When we were thinking about this, we said -- at least in my mind, we are doing very little for public -- directly in the public confidence arena on this chart.

I have a different activity that is not on this chart to develop tools for risk communication, because I think the NRC very much needs to be able to do risk communication. So it is a branch activity that is not part of this plan.

Okay. So that is a confidence. And then we were thinking many of our activities are burden reduction, I mean in RES. And when we thought about it, in fact very little of the things I am showing you are burden reduction. I don't think that they are.

I think that really all fall within the maintain safety vector. And after a fair amount of discussion, that is why we decided to label it, I should have labeled it maintain. But we think, in fact, that is what we are doing.

MR. APOSTOLAKIS: What else do you want to do?

MR. ROSENTHAL: Okay. The next --

MR. APOSTOLAKIS: Do you have the future activities? You are skipping that?

MR. ROSENTHAL: We are going to get back to that at the end.

MR. APOSTOLAKIS: Okay. Now I have a series of comments, minor comments, on the SECY itself. When should I tell you about them?

MR. ROSENTHAL: End.

MR. POWERS: He is liable to break. I mean, holding that pressure in to make those comments.

MR. APOSTOLAKIS: So we will take a different kind of break, then. I promise that we will take a break every hour.

Who is next? Maybe we can take the 10-minute break now. Okay.

[Recess.]

MR. APOSTOLAKIS: The meeting is back in session.

We will hear from -- tell us who you are. There are two ways of stating this. One is, please give us some of your background. The other is, what is it that qualifies you to stand up there and talk to us?

MR. HALLBERT: I think I am going to talk about my background.

I am Bruce Hallbert. With me today is David Gertman. We are here from the Idaho National Engineering and Environmental Laboratory. We are here to talk about a program that we are carrying out for the U.S. NRC on the quantitative analysis of risk association with human performance. A program manager back here at the NRC is Gene Trager (phonetic).

The objectives of this work is to study how human performance influences risk at commercial nuclear power plants. In addition, as part of our work, we have been working to identify and characterize how human performance influences significant operating events.

We are doing these things to support and provide a technical basis for the human performance program plan as part of other efforts that are also being conducted for that reason.

This afternoon David and I are going to change back and forth in the presentation. I am going to talk a bit about the method and the approach of our work. He is going to talk then about the finding or the analysis and some of our findings. And then I will conclude with the summary.

For this program, we use significant operating events from the accident sequence precursor program being conducted at the Oak Ridge National Laboratory. The criterion for significant operating events means that from the ASP program the conditional core damage probability was identified as 1E minus 5 or greater. That was our criterion for selecting events for analysis.

We selected events from the time period 1992 to 1997, 1997 being the most recent period for which our reports were produced in that program. The analyses focused -- two kinds of analyses were performed. One what a quantitative type of analysis. And this analysis involved human factors, people working with people from our PRA departments at the laboratory. We used existing PRA methods and models, specifically --

MR. POWERS: What do you mean? Existing PRA methods and models could be the things that are ancient and horrific back to the farmer curves and times like that, or they could be the most modern and up-to-date things.

MR. HALLBERT: This is -- I will tell you right now what we are using. We used the ASP SPAR models.

MR. POWERS: I don't think my question has changed.

MR. HALLBERT: Okay.

MR. POWERS: It could be the most ancient thing in the world or it could be the most modern and up-to-date thing.

MR. HALLBERT: My understanding is that the SPAR models, which are the standardized plant analysis and risk models, are very modern standardized plant risk models. Beyond that, I am not in a position to talk about the PRA and the SPAR models specifically.

MR. POWERS: So you just used whatever somebody handed you.

MR. HALLBERT: No. We used -- David, would you like to address -- you have to come up here.

David Gertman will speak to that question.

MR. GERTMAN: I am David Gertman. We went to our PRA analysis group. And the SPAR models are state-of-the-art, the most recent version with significant detail. They are the Rev 2QA models that contain the super components.

And they have been a development effort with NRC and Oak Ridge National Lab and the Idaho National Engineering Laboratory. These were the most recent and available with software libraries PRA models for the plants.

MR. POWERS: If you were doing thermal hydraulics and told me you used a RELAC (phonetic) code, I would know where to go and read a review, peer review of those. Where would I go to read a peer review of these SPAR models?

MR. GERTMAN: Peer review, I am not sure. If you went to referred international proceedings, you could go to PSA, I guess, 99 or the last PSAM conference. A lot of the development work has been out of RES under Ed Roderick (phonetic). And that has been an NRC effort ongoing for some years.

It is fairly well-known and internationally documented. Beyond that, I cannot respond more than that technically to it.

MR. HALLBERT: It is our understand -- and we are not PRA practitioners, PRA experts, we work with the PRA analysts -- it is our understanding from them that these SPAR models are very current, very up to date advance models for conducting risk analysis.

MR. POWERS: you a licensee making this presentation, and you came in and told me "I used a model, and I haven't got a clue whether it was peer reviewed or has any pedigree to it or not," you probably would not even get a chance to give a talk.

And I can -- I remain -- I know exactly what the SPAR models are. And I remain distressed that they are not -- do not have the kind of peer review that has been accorded to the phenomenological models, including those from INEEL.

We demand that the licensees' probabilistic risk assessments have some sort of certification or comply with some standard, but our own work doesn't have that.

MR. HALLBERT: These were the models that we did use, notwithstanding those issues. We used these models to calculate importance measures. And the importance measures that we used were basically the CCDP-CDP values, which is the risk increase from the events. We used these to determine the contribution of human performance to event risk.

Specifically, we would run the models. We would look at each of the individual human actions in there, look at the increase and look at the associated amount of risk increase that was represented by those human actions. That comprised the quantitative portion of the analysis and its program.

There was also a qualitative analysis performed. We worked with licensed operator examiners and those kinds of people, plant operations specialists, to review events, the same events that we analyzed quantitatively to try to determine how specific human actions and processes -- and we will talk about what those are -- in the plan influenced the events.

And I guess in the simplest terms, we were trying to identify the causes, what caused the events to occur.

I would like to now hand over the presentation to David, who will talk about the analysis and some of our findings to date. I also want to stress that this is work in progress, and we have not completed the program. SO what you are getting is where we are right now.

MR. GERTMAN: Thank you, Bruce.

As Bruce was saying, we have reviewed 35 operating events to date. Our primary source of information for these events has been LERs and, where available, augmented inspection team reports, AITs. And we might have one IIT in there as well.

We went ahead and we determined that 24 of these events has significant human performance involvement. And the criterion we used for significant human performance involvement included the following: Did human performance contribute to an unavailability, to a demand failure, to an initiating event, or were operator actions taken that were improper or failed to be taken post-initiator? So that was our definition of having a human performance involvement.

Eleven of these events indicated no such involvement to that extent. Looking at those, we did not see any other types of differences within the events. If you took those out and said, what is unique about these, there wasn't any discernible pattern. We did do that with those.

Then the importance for the 20 events, which was the conditional core damage probability minus the core damage probability, that was importance measure that we took from the red guide, 1.174, range from 1E-6 for one of the millstone events to 5.2E-3 Wolf Creek. This was not the Wolf Creek event that was mentioned earlier. This the Wolf Creek frazzle icing event that I am sure you are familiar with.

Three of the events were in the E-3 range, the significant events. And the way we assessed the contribution, in general, if you look at this equation, it really boils down to the ration of the conditional core damage probability due to human error when compared with conditional core damage probability for the event.

And we went ahead and we looked at those components that were not available or failed on demand, and we saw what proportion of the variance did they account for. And that is how we were able to determine that range of the human performance.

In some cases, it was more than one or two components that were not available because of that human factors involvement.

MR. APOSTOLAKIS: So, David, CCDP sub HE, what exactly is that?

MR. GERTMAN: That refers to those components that were not available or that failed due to a human factors involvement. For example, if the breaker was unavailable because of the way it was maintained, either the verification process failed or the procedure used was not up to industry standard. So it was really going back to the component basis.

We had very few errors that came from following emergency operating procedures, which is a lot of what the post-initiator research in HRA looks at. In fact, what we found is, if you went to operator actions that were in error, they tended to be operators following either normal or abnormal procedures. And this is where the errors came from. So that was an interesting detail from the data.

And the contribution ranged from 10 percent for just one event up to 100 percent for 16 events, which means that the components that were unavailable or if you have the initiating event that the components afterwards, they were unavailable due to human error, due to problems with procedures and maintenance, that sort of thing, failure to follow trends in industry, pay attention to internal engineering notices, that sort of thing.

MR. APOSTOLAKIS: Now when you say human error, it is not necessarily one error, right?

MR. GERTMAN: No. That is --

MR. APOSTOLAKIS: It is a number of little things.

MR. GERTMAN: Yes. That is precisely the point. If we look at multiple smaller failures in the events analyzed, they tended to range from 6 to 12 per event. For example, if we took a look at Wolf Creek in the frazzle icing incident that occurred, that one that was 5.2E-3 that we mentioned previously, there were a number of things. There was a latent failure.

The design error was latent, where they thought the warning lines were undersized, but they thought they were adequate. It was an engineering decision that the pump house could not be subject to frazzle icing that was in error.

There was a latent failure, also, in terms of ignoring the Army Corps of Engineers notice that said frazzle icing conditions were possible to affect the moving trash screens under the water.

In addition to that, you have had some active failures. You have operators who are trying to do a procedure that sort of decoupled the ESW, emergency service water, from service water. And they did it without a procedure. Now at that utility at that time, you could it without a procedure. But what you had to do is you had to have verification behind you, if you went by skill of the craft. And they didn't do that.

So see what happens is, it really quickly escalates to between 6 and 12 smaller failures. And that was a fairly large finding for this dataset. And that was consistent. There is only maybe two or three that only had four small errors, as opposed to seven or above.

MR. APOSTOLAKIS: Coming back to the equation, that will be different from 100 percent only if there were some other things that happened, like a pump was unavailable due to maintenance or something. It has nothing to do with human action.

MR. GERTMAN: That's right. It had nothing to do with --

MR. APOSTOLAKIS: Otherwise this is 100 percent.

MR. GERTMAN: Yes. If it was the insulation failure on a transformer, and it would not have been easily observed, it would be close to random hardware failure, yes.

MR. ROSENTHAL: Note that, you know, on my list earlier of things like the pressure locking of gate valves, we did not -- that is a design problem. We just did not want to exaggerate. Now, of course, you could always say, well, the design is a human -- but we just didn't want to put it on -- I want to make another point. And that is, I know that the ACRS is another activity on measures. And I know that you are doing some work on that.

MR. APOSTOLAKIS: Measures for what?

PARTICIPANT: Ordinance?

MR. ROSENTHAL: Measures. Okay. We did not want to use terms like fossil-vesly (phonetic) or risk achievement worth, et cetera, which are traditionally associated with core damage frequencies, when here we are talking about incremental changes in conditional core damage probabilities. So we are still using still another term, because we thought it would be -- you know, it just wouldn't be proper to use those terms.

And if you want to pursue that, I would recommend that you do it within the context of the points measures work, if you are interested in it.

MR. POWERS: I got the impression from the speaker that this is a simplistic idea that we talk about, that we just do a rollout or a fossil-vesly (phonetic) analysis on the human. It just would not cover 90 percent of the things that he found in here. I mean, he just doesn't address it.

MR. ROSENTHAL: Oh, you mean going back in a PRN.

MR. POWERS: Yes.

MR. ROSENTHAL: Right. But even to use the concept of RAW when looking at decrements in CCDP, I think would not be true. So we didn't want to use the -- so that is why we are phrasing it this way. But I would assert that if you want to explore that more, you have that other forum to talk about how do you measure on events rather than on CDFs.

MR. APOSTOLAKIS: Well, there is a similar measure. This is very good, by the way. You avoided the debate here by not going to the other two. Not the way you have structured it here, but if you want to look at the CCDP of the event, due to the event, then this is very similar to the incremental core damage probability that is used in Regulatory Guide 1.177, which deals with temporary outages or equipment out of service. And this is on solid ground. This is good.

MR. GERTMAN: Most of the errors that we identified were latent. And we agree with Jim Reason's definition. He had first called attention to this in -- I guess back in 1990 in his text on human error, where we say that latent errors have no immediate observable impact. Their impact occurs in the future, when you give it the right circumstances.

And again, the ratio we found of these multiple small errors was a ratio of four to one. So latent errors were predominant. I think the exact numbers were 82 percent and 18 percent. But every time you add an event, it changes slightly, obviously, with such a small sample size.

The large actors within latent errors, there were three problem areas. The first had to do with failure to correct problems. This is known deficiencies, failure to perform trending, failure to perform to internal, as well as industry notices, figured in events, engineering problems with design and design change and design acceptance tests, and maintenance.

These are maintenance practices, post maintenance testing, work package preparation following QA, work practice sort of issues. These are what were prominent in latent --

MR. APOSTOLAKIS: David, in the first one, when you say failure to trend, were they expected to trend and they did not, or they just didn't bother to establish an activity?

MR. GERTMAN: I think it is a combination. In some cases they would find similar problems with feed regulating valves or MSSVs over a period of years or a period of months. And there didn't seem to be any acknowledgment of this. The failures kept occurring. There seemed to be no trending program. And the language for that really came out of the AITs and LERs. It was beta driven.

MR. APOSTOLAKIS: So this is then, I suspect, that the insight group would call this failure to -- to do what, have a questioning attitude? This is a safety culture issue, is it not?

MR. POWERS: it is. It is also an effectiveness of a corrective action program, because good corrective action programs will trend. And they will look for repeat failures. And they will really chase those down to get to the root cause, so you don't end up six years later with the thing showing up again in an event.

MR. APOSTOLAKIS: But it is a matter of culture, is it not?

MR. POWERS: Yes.

MR. GERTMAN: Active errors. For the most part, these were post-initiator errors. The interesting one, the dominating problem area there, was failures in command and control. We think of the incorrect operator actions in following EOPs and maybe even abnormal procedures.

But the command and control kind of issues, if we go back to the Wolf Creek frazzle icing incident -- well, no. If we take the sale and river grass intrusion, excuse me, you go to the situation where the NSSS is going ahead and giving vague instructions how to control reactivity to one of the board's operators.

Then you have somebody leaving the boards when the reactivity is unstable. You have communication coming in from the field where the river grass is.

You have two supervisors plus a cadre of six other people in constant communication back and forth with the control room, which adds a disruption that takes away from the situation awareness. So there are some aspects of command and control that came up in these events as well. And we find that to be fairly important.

And these others --

MR. BARTON: The interesting thing about that is, when you look at utilities training programs and practicing in simulators with crew teamwork and interaction, command and control is always a big issue.

And you are always looking for some senior, the shift supervisor or shift foreman, to take over that role to assure that things are done right, and there is command and control, and it doesn't get like this Salem event.

So there is no mystery here, Joe. I mean, this stuff is already supposed to be in place. And people are trained in it and practice it. So you ask yourself, why on certain days doesn't this all come together? And you end up with a Salem event. It is all there.

MR. APOSTOLAKIS: Well, on the other hand, you know, we do have random occurrences of things. Maybe we have to live with the fact that some of these violations with occur.

MR. BONACA: And then you have unevenness in the crews. At times you find that if you have all things coming together and you have a crew that is not the best, and you have some people in the crew that in fact are the weaker elements, that may combine to give you this kind of situation. So you have also the randomness.

MR. GERTMAN: That is a good point about you expect it to be there. If we look at the Oconee and Kiwi hydro event, we had problems. They had a loss of phone communication during the event.

We had operators in the hydro station taking actions unaware it was going to impact the staff at the power plant. You had a lot -- and you had supervisors out in the switch yard performing actions instead of being back in the control room.

All of these things are aspects of command and control which figure rather prominently in the event, which are not typically the kind of things that we model in the

HRA community. In fact, for a comparison here -- and this is not about second generation models. But just going back to the IPE PRAs and some of the level ones, if we look at pre-event and human errors, pre-initiator, very few are explicitly modeled. There is some consideration of mis-calibrations and restoration after maintenance that come up. But it has always been assumed that when you determine a hardware failure rate, that somehow you have implicitly captured many of the latent human errors. It doesn't help you reduce the risk, though, because unless you specify the distribution of these errors, the percent contribution, or know where it is hurting you, you cannot do much about it.

So we think this is open. Empirically we don't know what the contribution to a particular component is from the human performance work process latent error area is, and we think that is an important area.

Post to that, if you look at a lot of the IPE generation, it is limited to active areas of omission. And again, they seem to be EOP based. What we found was abnormal and normal operating procedures. And we found commissions in both the latent case, as well as the active case. That is just a very quick comparison.

I return you to Bruce to summarize some of these findings.

MR. HALLBERT: Thanks, Dave.

For some time, people have talked about what the contribution of human performance is to accidents and safety. In this study, we were asked to look specifically at the human contribution to risk. One of the points that Dave made earlier, looking over all those different events, averaging over them, what we see is that the average contribution of human performance to these events, to event importance, was about 90 percent of the event importance.

Another observation from the study is that most of the incorrect operator actions that cause these events to occur, occur during normal and abnormal operations, not during emergency operations, where we see people using EOPs. It was different in many respects than most of where HRA has focused in the past.

Latent errors figured very prominently in these significant events, a ratio on the average of four to one latent active errors. And some of the kinds here are just reiterated again. And these are the insidious kinds of errors.

These are the ones where they occur at one point in time. They may sit there dormant like a trap for months, many months at a time, before a system or component is demanded and simply is unavailable or fails.

MR. APOSTOLAKIS: Your third paragraph there, Bruce --

MR. HALLBERT: Yes.

MR. APOSTOLAKIS: -- put in different words is saying that the problems are really organizational and cultural related, safety culture related. Inadequate attention to owners group and industry notices, I mean, you can put a fancy term there and say this is organizational learning, and it has failed. You know, they don't have good learning. So organizations and culture. And it is interesting that the agency is not really investigating those things at this time.

Are you going to inform the Commissioners about these things? I guess you will.

Jack?

MR. ROSENTHAL: What? You want to send a letter that says I told you so?

[Laughter.]

MR. APOSTOLAKIS: I want Jack to send a letter like that.

[Laughter.]

MR. ROSENTHAL: You will more about it as the afternoon goes on.

MR. APOSTOLAKIS: That was a very good response.

MR. ROSENTHAL: What we need to is take the facts and display out the facts from the real events, and then you have made a factual case for how you should proceed.

MR. APOSTOLAKIS: Yes. But --

MR. ROSENTHAL: But what we have not done in the past is lay down all the bricks, put in the rebar in that wall.

MR. APOSTOLAKIS: And I think that is a good point. Maybe the case was not made to the Commission that these are important issues. And maybe what you are doing now is you are beginning to build a case.

MR. POWERS: I think, George, it falls under the category of leadership and organizational behaviors. And it is an area that -- you know, we thought the Commission would need to look at also, we were told. And we went up and looked at that.

But that is -- you look at the human performance program, that is the two categories that this whole stuff falls into. Leadership and organizational behavior characteristics are failing when you get into these issues.

MR. BONACA: Now, of course, the Commission never said that these are not important. The commission said it is none of our business. It is the industry's business to take care of these. So we have to be careful that we interpret correctly what they said. I mean, they never said that these are not important issues for the safe operation, I guess, of the plant.

The unique value of this presentation somehow is the fact that there is a quantitative assessment of the contribution of these issues. And this is based on events which have occurred. And so it has more bite than things I have seen before because of that.

MR. APOSTOLAKIS: There is nothing like data, Mario.

MR. BONACA: Absolutely.

MR. APOSTOLAKIS: When you talk to engineers, you better have your data.

MR. HALLBERT: So it is true, these things we are saying. Of the operating events that we were able to analyze that had human performance involvement, approximately 90 percent of the increase in risk was due to human performance.

Now, the current means by which human performance, or the means by which human performance influence hard run available and other failures in these events was somewhat different than how it has been explicitly modeled in the IPE generation of PRAs and level one PRAs of that generation. And by that, I mean that we don't see a preponderance of latent errors and pre-initiating events in identified models. Rather, as David said, these things have been typically addressed by saying that we assume that these latent contributions are in the unavailabilities.

BY APOSTOLAKIS: By the way, this has been the argument ever since I remember years ago, that the first argument of people who do not want to see research on organizational issues is exactly that. The failure rates capture it.

Why do you want to worry about it? And I think the answer is what Jack said earlier today, that if it was only one piece of equipment, we would not really care. The concern is that you may have an underlying cause that may affect a number of equipment or actions. And that is really very different from saying that the failure rate is captured.

MR. HALLBERT: And it is a number of events. And it is common patterns across events and events that are all significant.

MR. APOSTOLAKIS: Yes. And the last one is saying something nice about PRA, Bruce?

MR. HALLBERT: Well, no. I think that the next point I want to make, and this is just to underscore what David was saying earlier, which is that these events all involve between 6 and 12 smaller failures, none of which were sufficient in and by themselves to cause these larger events. That was somehow also a little bit in contrast to how we have, being the HRA community, looked at human errors in the past but fits very well with what Jim Reason has talked about earlier when he discussed organizational accidents.

MR. APOSTOLAKIS: Swiss cheese, right?

MR. HALLBERT: The Swiss cheese model.

MR. APOSTOLAKIS: That all these holes were -- and we are in trouble.

MR. POWERS: Well, it seems to me that this has interesting ramifications on the inspection process. And if I go through and I find a lot of green findings, the sum of all green findings is still green. But in reality, it may be red. I think it is programmatic failures that are being missed in the inspection program.

MR. HALLBERT: The last point is getting back to the issue of how this work relates to PRAs. Now, for all the failures that we were able to model in SPAR, we were able to identify those human actions. So we did not identify any new initiators or event sequences in the process of doing this.

Rather, what we found were different ways of conceptualizing how these initiators and accidents could occur. But in effect, we didn't identify new initiators or event sequences.

So one of the issues, that relating to the completeness issue of PRA, was not really effective.

MR. APOSTOLAKIS: Well, I don't know about the no new initiators. I mean, the Wolf Creek event, the organization itself took care of it. So in a sense it was a new initiator.

MR. HALLBERT: Yes. And part of this is also that we are working with the PRA groups and the licensed operator examiner groups in our company right now, reviewing this work that we are presenting now to try to determine some of the issues and impacts.

MR. APOSTOLAKIS: If you are talking about the PRA, I don't think anyone ever will come up with new initiators, because the PRA has been structured now in a way that the list that you have is complete. One way or another, you have either a local or a transient, right?

MR. HALLBERT: Yes.

MR. APOSTOLAKIS: Now there was an interesting table on page nine of Jack's presentation, which I think comes from your work. And I would like to talk about it a little bit.

MR. HALLBERT: Okay.

MR. APOSTOLAKIS: Jack, do you have the transparency?

MR. ROSENTHAL: Yes. Let me say that Gene Trager and Paul Lewis, who are here, quickly went through -- well, they identified the 50 events. And they went through them qualitatively. And that work was just provided to you. It was done earlier on. And this table is from their part.

MR. APOSTOLAKIS: This is not from INEEL?

MR. ROSENTHAL: This is from the staff. Then INEEL has --

MR. APOSTOLAKIS: Can I make a suggestion here? I would like to make a suggestion to this, to help improve it, to improve something that is already very good. How about that? Jack, you are not listening.

Now, I read in the report that work processes are a prominent part of the work. And what I would suggest in the future is, instead of saying, for example, that knowledge -- this is the fourth from the top -- is important.

Since you are now in the work process space, perhaps you can tell us which task of the work process suffered because of the lack of knowledge. Because if I take maintenance, for example, there is a prioritization task. And then later on, there is the actual carrying out of the maintenance.

It seems to me that when you say knowledge, you mean different things when you talk about prioritization and when you talk about actually doing maintenance on a valve. Different kinds of knowledge. In the prioritization, you have to have a global view of the plant. And you look at the other requests, and you make a decision.

This is the ranking because this is more important than that for such and such reason. Right? It requires a certain body of knowledge.

The journeyman who actually implements the thing requires a different kind of knowledge. So that has always been my concern about not only this, but in other places where you see things like communications, knowledge. Well, that doesn't mean anything. If you have the plant manager, he doesn't tell you anything.

But if you say, look, we have observed that in the prioritization process there were issues with the knowledge of the people whoa re doing it, then you are specific now. You are telling people that, look, maybe there is a room for improvement there.

Same thing with communication. Communications between whom and whom, between departments, between the members of the same team, between the organization and outside identities? See, all these organizational factors really don't mean much unless you place them in context. And the context is the work processes.

MR. HALLBERT: Some of these are described in more detail in the report, George. The taped one is kind of

MR. APOSTOLAKIS: Okay. Yes. I think that is a positive step forward. But I would still go to specific tasks within the process and say, this is what was important for that reason in that task.

MR. HALLBERT: Yes.

MR. APOSTOLAKIS: Because then management, risk management, can be more effective that way.

MR. ROSENTHAL: Let me respond. Gas and fiscal 2001.

MR. APOSTOLAKIS: Well, let me respond. Thank you.

[Laughter.]

MR. APOSTOLAKIS: I think it is an important point to be made, because we have seen a lot of this. And I don't want to criticize this, because I like what you guys are doing. But this is an opportunity for me to put it on the record. You know, you look at papers in the literature, people give papers and say, oh, knowledge. Well, what knowledge? What do you mean, knowledge? Everybody at the plant? Are you talking about vice presidents' knowledge or whose knowledge?

So I think that is an important -- I'm sorry.

MR. LEWIS: May I comment?

MR. APOSTOLAKIS: Of course you may, Paul.

MR. LEWIS: No place on the list do we see the peak.

MR. HALLBERT: That is mainly --

MR. LEWIS: It is not important? Oh, okay.

MR. HALLBERT: These were in the report that we gave you. You don't see -- we worked with the information directly from the AITs. If it was not called out in the AITs, then --

MR. APOSTOLAKIS: It seemed to me that it is not really critiquing the organizational factor that is of relevance here. It is resource allocation.

MR. LEWIS: I am Paul Lewis. I was the one who worked on --

MR. APOSTOLAKIS: Because that is what they say. I mean, that is what Mr. Quigley said, that with deregulation, you know, there is a reduction in staff. And people work longer hours. That is what he says, I think. This is a statement of fact, Mario. That is what he says.

PARTICIPANT: It is in the eyes of the beholder.

MR. APOSTOLAKIS: It is never in the eyes of anybody else.

Paul, you want to say something.

PARTICIPANT: Paul did the work. Then John O'Hara, and then we will be back almost on schedule.

MR. LEWIS: My name is Paul Lewis. I was the one who created these tables, so maybe I can answer part of your question. You are referring to Table 3?

MR. APOSTOLAKIS: It is the table that is on page

9 of Mr. Rosenthal's presentation. No, that is not the table I am talking about. I did not ask any questions, Paul. I just made a statement. So you are adding to my comments.

MR. LEWIS: We provided this to you last week. There is a different table.

MR. APOSTOLAKIS: There is a different table.

MR. LEWIS: Yes, which you can correlate the events where a PSF was knowledge with the actual task that was failed. So if you look at the -- on Table 3 it says Wolf Creek task P was -- a negative PSF was knowledge. Then if you go to Table 2, you can see exactly what Wolf Creek task 2 was.

MR. APOSTOLAKIS: Okay. That's good.

MR. LEWIS: So you can determine exactly which task was failed because of lack of knowledge.

MR. APOSTOLAKIS: That is exactly what --

MR. PERSENSKY: Paul is referring to Table 3 in the Attachment 2 to the memo to Larkins (phonetic) from Jack, dated March 6.

MR. APOSTOLAKIS: Table 3?

MR. PERSENSKY: Table 3.

MR. APOSTOLAKIS: Oh, this is the attachment. I see. I see. Anyway, I believe you. I didn't mean that you didn't know how to do it.

[Laughter.]

MR. APOSTOLAKIS: But all I am saying is that this is exactly the kind of information that should be emphasized. That is all I am saying.

Who are you? And why are you there? You notice that Dr. Hallbert ignored me completely when I asked him to give some background.

MR. O'HARA: My name is John O'Hara. I am from Brookhaven National Laboratory from the systems engineering and safety analysis group. I have been working for a long time with the NRC on control station technology. And I am the principal investigator for the projects that you had asked to hear about today and which I will tell you about today.

MR. APOSTOLAKIS: And you are a psychologist or an engineer?

MR. O'HARA: I am a Ph.D. cognitive psychologist. I have been working in the engineering fields for about 20 years now. I've been working at Brookhaven Lab for 11 years, a little over 11 years.

Prior to that, I was head of workstation development at Grumman Space Systems and worked on NASA projects for the space station.

Prior to that, I was the head of research for the Department of Transportation's simulated -- transportation simulated, you know. Prior to that, I was a college professor.

PARTICIPANT: Do you need --

MR. APOSTOLAKIS: Thank you very much. But this is -- is usually very comfortable.

[Laughter.]

PARTICIPANT: Okay.

MR. APOSTOLAKIS: It's very comfortable.

[Laughter.]

MR. O'HARA: Okay. Today, I am going to report to you on several projects that have been ongoing, related to what Jack introduced as emerging technologies.

I have been working -- my NRC colleagues on this project have been Jerry Wachtel (phonetic) -- on these projects -- Jerry Wachtel and Joel Kramer, both who -- who work for Jack.

And my Brookhaven colleagues are Bill Brown, Bill Stubler (phonetic), and Jim Higgins. And together, we have pretty much done this work.

Okay. What I would like to do -- you had asked about three particular programs, but I would like to put them in the context of -- of the larger picture in which they fit.

So I would like to give a little bit of background to this area of work -- and I will give background to each one of the individual projects -- a background to the area; and then how we have gone about guidance development, you know, what process and method that we followed, to give you essentially a status report on the three project areas you had mentioned, the alarm system research, hybrid human system interface work, and interface management, which is our more recent one.

And then, I will conclude by giving you the current status of each one of these and the bigger, you know, effort in which they are -- they are feeding.

Okay. By way of background, as you very well know, plants are in a continuous process of modernizing. It is modernizing in the I&C area that has -- it's -- the biggest impact on the control room, development control room design and the human-system interfaces that are in the control room.

But plants do not only change the human-system interfaces. These are the displays, controls, things like that, that are in the control room. On the basis of I&C modifications, sometimes there are modifications that are made to that equipment itself.

So, for instance, it is -- you may have trouble replacing components or maintaining the equipment, so it gets replaced. And typically, when it gets replaced, it is replaced with a digital system.

A lot of -- for instance, the older alarm systems, it is very hard to maintain them with the old equipment, so there are replacements that take on a digital flavor.

So new -- new human-system interfaces are introduced into -- into the plant. And they bring along with them, you know, characteristics, functions, features that are different than the old equipment.

In addition to that, the complexity or the complexion, I should say, of the control room changes. It becomes one of a more hybrid control room where there is a mixture of both the old equipment and -- and the new equipment.

And as we know, the extent of the modifications can -- can range quite widely. It can be a, you know, relatively small scale replacement of a particular component; or in many plants, it is the introduction of numerous new systems, and numerous new computer systems that work their way into the plant over -- over time.

And then in the case of some plants, like Calvert Cliffs, the control room modifications can be much more extensive.

Okay. The -- the overall focus for our work has been, first and foremost, since it is largely our areas of the emerging technology, to try to understand what those technologies are, you know. How is the technology changing?

You know, how is -- how are display systems any different today than they might have been, you know, 30 years ago?

Also what -- when these newer types of systems are introduced, what kinds of problems might they create, particularly those problems that might be different from the problems that we were familiar with with the older technologies?

Okay. Since there are many, many areas in which the plants are changing, to try to look at which ones we ought to be focusing on and which ones might have greater safety importance, and then since the research project could not address everything, to try to prioritize them and look at those which were more important; for those areas that guidance development was identified for, to develop that guidance; and then ultimately these individual efforts result in -- in design review guidance.

The NRC already has design review guidance for control rooms and -- and general human-system interfaces in NUREG-0700. That document was revised a number of years ago to address very general changes in human computer interfaces, but not many of these trends that we will talk about now.

So the repository of -- of the guidance that is developed will be ultimately to be factored into NUREG-0700, so it is all in one place. Okay.

PARTICIPANT: It's one of your favorite documents. I mean --

MR. APOSTOLAKIS: Mr. O'Hara, do you expect the introduction of digital to change the requirement on the length of the cord of the telephone?

[Laughter.]

MR. O'HARA: Well, if you could show me that requirement in NUREG-0700, I would like to see it.

MR. APOSTOLAKIS: Twenty-seven inches, I think it was.

MR. O'HARA: I don't think there is.

MR. APOSTOLAKIS: The emerging technology emerging issues box is really intended --

MR. PERSENSKY: Excuse me, George.

MR. APOSTOLAKIS: J.

MR. PERSENSKY: You brought that up several times. And I would like to get this on the record.

MR. APOSTOLAKIS: Okay.

[Laughter.]

MR. PERSENSKY: There is no requirement for the length of the telephone cord in 0700, Rev 0 or in Rev 1.

MR. APOSTOLAKIS: So where did that number come from?

MR. PERSENSKY: I have no idea. But there has never been such a requirement.

[Laughter.]

MR. APOSTOLAKIS: Okay. Maybe it was a goal. Was it a goal perhaps?

[Laughter.]

MR. PERSENSKY: It may have been some -- some --

MR. O'HARA: The goal is to go wireless.

[Laughter.]

MR. PERSENSKY: But -- but to have it on the record, because it has been brought up several times in the ACRS, and it is not true. So --

PARTICIPANT: Don't try to dispel our favorite myths.

[Laughter.]

MR. APOSTOLAKIS: The -- the box on this big picture that Mr. Rosenthal presented, you are working -- you are contributing to the last one on the right that says emerging technology, emerging issues, correct?

Now, it seems to me we have a box like that because we really want to -- to support the other three, don't we? Like reactor oversight process, plant licensing and monitoring and risk informed -- so this should be then one of the objectives of this -- of this work, to see what new insights we are going to gain from this evaluation, so that the other three boxes will benefit.

And you are addressing -- you will be addressing that, or is too soon in the -- in the --

MR. ROSENTHAL: I -- I think it's implicit, you know, I mean, the second from the left is the NRR activities.

MR. APOSTOLAKIS: Right.

MR. ROSENTHAL: This is a direct user need to provide review guidance to NRR so that they can do that work.

MR. APOSTOLAKIS: Okay.

MR. ROSENTHAL: And the reason, we broke it out as emergent technology, we look at the RES's vision statement that was prepared for the Commission, we said that we would prepare the -- preparing the agency for the future, and that --

MR. APOSTOLAKIS: Yes. But I mean, preparing the agency in the other three areas; that is really what preparing the agency means, right?

MR. ROSENTHAL: Well -- well, I'm not -- primarily, it is --

MR. APOSTOLAKIS: I mean, you don't care about emerging issues unless they affect --

MR. ROSENTHAL: Safety --

MR. APOSTOLAKIS: -- the risk informed regulations, NRR activities and so on.

MR. ROSENTHAL: Yes, sir.

MR. APOSTOLAKIS: Okay. Thank you.

MR. O'HARA: Okay. Just to give you a sort of a high-level summary of the kinds of things we observed: The trends -- the trends offer changes in -- in almost every aspect of human-system interface technology. And many are the very key -- very key interfaces that the crew uses, both operations and maintenance crews.

It is -- it is -- it is the displays, the plant information system, the way information is organized, the way procedures are presented. It is the way controls can be implemented.

So the changes, the -- the digital changes and upgrades that are occurring really impact on the very key resources that personnel use to monitor and control the plant.

We also observed, based on lessons learned from both the nuclear industry and -- and other industries, these technologies certainly have a great potential to positively impact performance. You can do a lot with these technologies. They are very flexible, that you can do much with them.

However, they also have potential to severely degrade human performance, to confuse operators, to make it very difficult to complete tasks. So what we see is that this technology, you know, has benefits, and it also has significant drawbacks.

MR. POWERS: Now, your -- your -- your words and the words on the view graph are different. You -- you -- you were careful to say that it had a potential to enhance, and it had a potential to degrade. And up on the view graph, it says it can --

MR. O'HARA: Yes. Well --

MR. POWERS: -- as though there were some real data that supported that.

MR. O'HARA: Yes. There is data that supports the "can," and -- and if a new system is implemented in a power plant, it has the potential to, depending on how it is implemented.

So this is a finding, but I am sort of saying that as these technologies become, you know, implemented in control rooms, we certainly want to be sure about the -- that they do not degrade human performance in any way.

MR. APOSTOLAKIS: Has this been observed in other industries?

MR. O'HARA: Yes. Yes. As a matter of fact, it was just -- I think it was last year, there was several issues of Aviation Week and Space Technology that went into the class cockpit problems, the problems with, for instance, navigation errors with flight management systems that are digital.

Digital systems, because of the way they operate, typically create different ways you could make mistakes. And oftentimes, they are not realized until they actually get implemented in the systems.

So, yes, they -- this has been, you know, observed in -- in many industries, and we drew a lot from -- from that work.

MR. POWERS: I think there is a psychological effect, which probably has somebody's name associated with it, where something new comes in, things improve, and then they degrade afterwards, familiarity breeding contempt or something like that.

Is that -- is that something when you are saying they improved -- you know, are we just looking at that effect or --

MR. O'HARA: Yes, we did look at -- we did look at the way technology is introduced in terms of temporary changes, because as you can imagine, there is lots of different ways you can do this.

You can develop a new system. You can put it into a plant. You can run it in parallel with an old system. You could put it in a training simulator first, have operators, you know, get -- get thoroughly familiar with it, and then at some point have a change-out.

We were looking at these things. In fact, we continue to look at them, because there are many nuclear plants right now, which are doing this. But, yes, there is -- there is definitely, more often than not, the opposite effect of what you have just described.

It is that there is an initial lack of familiarity, even if you introduce them into a training simulator first. You know, operators can get familiar with it, but it is the day-to-day use that they do not have. And it is a day-to-day use.

So you might see some errors in initial implementation, not only by the human operators, but by the implemented systems, you know, not being, you know -- bugs creep up as things become actually used.

So I think the -- the greater concern is not so much an improvement in performance initially and then a tapering off, but rather an initial when it is introduced a potential to degrade that performance for some period of time until the familiarity and -- and bugs work out of the system.

Okay. With that as a backdrop, we had developed a -- a methodology or, probably maybe better put is a process, to develop guidance in -- in the various areas that -- that I will tell you about.

And really key to trying to -- to establish this process is to establish or to develop guidance which has -- has some validity. Now, I define validity in the context of this work in two ways.

We talk about internal validity. Internal validity refers to the -- the -- literally, the technical basis on which guidance is developed. So if we are developing guidance for, for instance, soft controls, you know, what is -- what are the research studies? What is the operational experience that we are using to formulate that design review guidance?

So that is internal to the guidance itself, its technical basis. So for the lack of a better term, I will call that internal validity.

External validity has to do with getting some kind of sanity check on the guidance. And that can be done in several ways, tests and evaluations of that guidance through field testing in actual power plants, by designing a system using that guidance and then testing it, you know, in a -- in a facility, and peer review.

We extensively use peer review, and I will elaborate on that in a second.

But what that does is, if you can imagine especially in areas of emerging technology -- I mean there may be a lot of research talking about, you know, the different design characteristics of a soft control, for instance.

And, you know, we analyze that and we go out and we look at these systems and implementation, and we extract out of that general principles. Well, those general principles reflect our interpretation of that information, so that is the internal side of it.

What we are trying to do then is we try to get the external validation, to have this field-tested, reviewed, so that to -- you know, basically to bounce it off -- off real world systems, to try to assure that the guidance is pretty much as good as we can -- we can get it.

MR. POWERS: If I --

MR. O'HARA: Yes.

MR. POWERS: -- come up with a -- with an approach on guidance and I'm convinced of its internal validity and I happen to be on Long Island and so I get a bunch of Long Island people to peer review it, and what not --

MR. O'HARA: Yes.

MR. POWERS: -- and I take it down and apply it in Georgia, am I going to run into a problem?

MR. O'HARA: If that is the way you did it, you might very well run into a problem. But that is not the way we do it. We try to get a more broad peer review than just people from Long Island. As a matter of fact, it is not people from Long Island.

[Laughter.]

MR. O'HARA: It is -- I will talk a little bit more about that. I have a slide on the test and evaluation for --

MR. POWERS: Well, I mean, it comes into a question that: Why is this -- in thinking about how we do our research programs.

MR. O'HARA: Sure is.

MR. POWERS: I mean, these things get very expensive to do. And some get very interested in doing international efforts, especially in this area. You've got the possibility of testing things at Halden --

MR. O'HARA: Yes.

MR. POWERS: -- where you can get a bunch of Finnish operators come in -- or Swedish operators working on a Finnish control room or something, some permutation of that, with perhaps Italians doing the observation and -- and British guys writing up the report.

The -- the question is: Is the information transferrable, or is it just -- just hopeless?

MR. O'HARA: I do not think it is hopeless. And I think what you have to do is you really have to look at what your questions are.

I mean, there are certain aspects to control room operations which -- which do not really change a whole lot, whether you are dealing with the Halden type of control room or -- or a control room here.

For instance, monitoring detection, you know, you have resources that you use as an operator to monitor the plant. You've got an interface that supports you with that. You have an alarm system. The alarm system that is in a plant in Lavisa (phonetic) is a lot like an alarm system in a plant here.

Now, there may be significant differences between them. But if -- if you can establish on the basis of the problem that you are trying to look at, and for instance, we did that. We did a study in Halden on alarm systems.

Alarm systems -- the use of alarm systems is very similar in the two places. The types of technologies that are available for power plants, both for what exists in the plant today, as well as for upgrading, are very similar.

So for that, I would say, yes, you know, that kind of generalization if you do it thinking about the different ways in which the results could be -- could differ, you know, you can put it on the table. You know, you can, you know, evaluate it and see if you feel that it's a -- it's a worthwhile piece of data to factor into a -- into a technical basis.

MR. O'HARA: I guess I don't understand how I go

-- how I make that step. I mean, I -- I got a result from Halden. And then you say, I don't know whether this is -- is so overwhelming affected by culture, you know, the -- just the fact that the educational systems and the social interaction styles within the Scandinavian countries are very, very different than they are in the Western part of the United States.

MR. O'HARA: Yes. Yes.

MR. POWERS: I want -- but I want to apply to the Western part of the United States. How do I decide what to --

MR. O'HARA: Well, as a matter of fact you have that problem for every single study you look at. I mean, any given study constrains the real world parameters in certain ways.

You -- you draw, you know, participants in a project from a certain population. You are going to put them, let's say, if it's a simulated state, you're going to put them in a simulator. Well, that simulator has a certain model.

You're going to constrain other aspects of the design, the interface itself. You know, you may be interested in the alarm systems, like we were. But you maybe try to hold everything else constant.

Well, that's going to be different than if I went to -- to a simulator at TTC, or if I went to a simulator in Korea.

I mean, I -- I think -- I think what you try to do is you try to interpret information research results in the context of all the other research results you're looking at, what the field is -- is evolving, you know, the field itself.

You know, alarm system research as a -- to use the Halden example for us, we did do a study of Halden. And there is work going on elsewhere. So I mean you got to look at the meaningfulness of that work in -- in the context of the other findings that are out there. And then I think you look at the operations.

If that -- if the part of the operations you're looking at and the technologies that they're using, let's say, for monitoring fault detection are similar, then I think generalization is supported.

If they do something -- if you're trying to do a study on symptom-based procedures, and you grab operators that have never seen a symptom-based procedure, and now you're going to do a study and draw conclusions, then I say, "No. You can't."

That -- you know, you're now dealing with a fundamental way that they operate that is different than the population to which you want to generalize.

But I think you have to -- you know, in any given study, you have to look at the parameters that can affect the results and those include the operators, you know, what their modes of operation are, where they come from, the types of interfaces that they're working with; and you have to consider all of those things, underlying process models and their complexity.

I would rather do an alarm system study with Finnish operators at Halden then I would with university students at a light box simulator, you know, with just lights going on and off, for a process that they learned in two weeks, you know, on a simple simulation.

And I would rather do that, because it -- because I know the problems with alarm systems involve alarm avalanche, you know, a -- they're mounted alarms. I mean, the key problems are alarm avalanche, numbers of alarms, and linking that alarms to process information. That is what the alarm system problem is all about.

So to understand that, you've got to look at how operators receive this high-volume information and -- and -- and make fault detection -- take fault detection actions on the basis of that.

So I think when you think of doing a study like we did -- how are we going to do this study? I mean, those are the kinds of considerations that we went into. And for our work, Halden did seem like a -- a reasonably good place to do it.

MR. PERSENSKY: In fact, for that experiment, we went through a very formal process, that takes months to select the location for the study.

MR. O'HARA: I mean, one of the driving factors is we wanted to manipulate the alarm system in real time. I mean, we wanted to be able to change out, so I mean Halden provided a good facility to do that kind of work.

MR. WACHTEL: Let me just add a comment. I'm Jerry Wachtel, the principal investigator, project manager for the work that John is doing for us.

We are talking now about the research that was conducted and the alarm system and -- and John and Jay have talked specifically about the reasons we went to Halden.

The other side of this is the independent peer review, the alpha testing, the beta testing that was done for the development of Rev 12-0700 and will be done again for the development of Rev 2.

I would argue that we have brought together international experts, not just from Halden, but from EDF in France, from Japan, from Korea, from many folks here in the U.S., from Canada, and that the -- the robustness of the guidance that we've developed is greater as a result of the international diversity.

We're not limited to one nationality or one culture. We've brought our own culture as well as that of several other nations and operating systems to bear on this. And I think our results are stronger as a result.

And I also think that the international -- I mean, the standards world, in general, is going that way. I mean the standards have more and more contributions from, you know --

MR. APOSTOLAKIS: Yes, I suspect that we've exhausted this issue for today.

[Laughter.]

MR. APOSTOLAKIS: And now you have to rush a little bit.

MR. O'HARA: Okay. Okay. This is the overall process. As I said, I want to say a little bit more on the guidance development itself. Okay. I'll just step through this very quickly.

We tried to use lots of sources of information, many different sources of information. The reason they're arranged in a sort of flowchart here is because we really made a great effort to do it as cost-effectively as possible.

As you go down the steps here, the guidance development process becomes more and more effortful. You know, if -- if you could adapt and modify, you know, existing standards, they're already in -- in guidance form and -- and the process of -- of converting it to review guidance for our application is relatively easy, than if we've got to analyze, you know, individual research papers and things like that.

So that -- so basically, we're trying to establish validity. And we're trying to do it as cost effectively as we can.

MR. APOSTOLAKIS: HFE is Human Failure Event?

MR. O'HARA: No, I'm sorry. Human Factors Engineering.

MR. APOSTOLAKIS: Oh.

MR. O'HARA: I apologize for that.

Okay. The test and evaluation phase, which addresses the external validity part of it has multiple layers to it. First of all, we have gotten feedback from users internationally of NUREG-0700 and tried to collect information from them about guidance use.

Each of the individual guidance development efforts such as for alarm systems, for soft controls, each one of them gets peer-reviewed itself. So as part of our process, we send the original technical reports out for peer review.

When the guidance eventually gets integrated into NUREG-0700, there will be a field tested evaluation, similar as I've described before.

It will then go to a subject-matter expert panel, which will include representatives of a cross-section of the nuclear industry, utilities, vendors, et cetera; and then ultimately, as you know, for public comment.

Okay. Okay. Now, I'm going to try to touch briefly on each one of the projects that you had asked about. Each one of them interestingly had a slightly different origin, you know, a slightly different beginning, although I believe every one of them, if I'm correct, were tied specifically to user needs.

Alarm system work: We had an alarm -- a project to look at computer-based alarm systems and we published some preliminary review guidance from that in this document, which is listed here, NUREG-CR-6105.

However, there were certain -- several areas that we felt were very significant and were not being addressed -- or were not addressed adequately. And those -- those areas dealt with the key issues that I've described before.

You know, the -- the really key human problems with alarm systems are the numbers of them, how quickly they come to you, and relating them to what's going on in the plant.

So the focus of the work that we're currently doing is on alarm processing methods. These are the -- the algorithms and processing that is done on the alarm information before it gets presented to the operators. And most of those processes are done in an effort to reduce the number of alarms.

How the alarm information is displayed: If you go and look at any new alarm system, you'll see it is displayed a lot differently than the old ones were in terms of the light -- you know, the lighted tiles sweeping across the control room.

Alarms now are presented as combinations of message lists. They may be integrated into process displays.

And the other is alarm availability. If you're using alarm processing routines -- I mean, if you're analyzing that alarm information to reduce the number of alarms, you've got to decide what you're going to do with those alarms that are lower priority. Do you take them out completely? Do you present them? And that deals with the issue of availability.

Okay. To do this phase of the project, we relied largely on two sources of information. One is a source we always use, which is to look at all of the technical literature available to us.

But in this case, we also did the simulator experiment that I described before at Halden, where we systematically manipulated these alarm system characteristics and measured their effect on -- on operator performance.

And we tried to interpret those results in the report we wrote in the context of the other literature that's available; again, not looking at it in isolation of everything else.

The results of that were basically that we developed a characterization of alarm systems. The characterization is an important step in the process. Let me just mention quickly what that means.

When we say alarm system characterization, as you know the staff is -- has to review many different types of alarm systems. So what we try to develop for each technology area is a description of the generic characteristics and functions of that system that the staff would want to -- to look at. So we developed that for alarm systems. It includes processing and things like that.

We also used the opportunity to do some confirmatory research on the existing guidance, as we actually used some of the guidance that we have developed in -- in the 6105 document, and used it to help design alarm features for the -- the Halden tests.

We were able to use the results to clarify and revise some of that guidance that we used as part of the confirmatory aspect. And we were able to, using the results, develop some new guidance in the area of -- of alarm prioritization display and processing.

Okay. In the area of the hybrids -- okay, the hybrid project grew out of a number of the technology gaps that we identified for the first revision of NUREG-0700.

There are a number of technology areas that we looked at that we didn't feel at the time there was a sufficient technical basis for us to develop guidance. It included topics like the ones listed below.

However, it included a lot -- several additional topics as well. So what we did is we went through a process of trying to look at how we, you know -- to prioritize these in terms of what potential impacts they could have on plant safety.

To do that part of the analysis, what we did is we took all the original topics and we tried to evaluate them using an approach very similar to what EPRI recommended for the licensing of digital upgrades, which was a 5059 type of process.

And what we constructed was a baseline plant condition, which was the plant, you know, unmodified. And then we assumed that we made certain modifications to the plant, such as the introduction of a new computer-based information system, a new display system.

And then we -- we provided descriptions of those systems. And we also described -- identified the typical types of human performance problems that one can have, if those systems are implemented, you know, poorly, you know, "What kinds of human factors issues are there?"

We then had those questions, you know, from the 5059 process looked at using PRA analysts, system analysts and operations analysts.

Then we used that process to try to identify which of these topical areas that we might consider developing guidance, but which were most significant. And these were the ones that emerged as being the most important. And these are the ones that we eventually undertook guidance development efforts for.

Information systems has to do with the ways in -- the new ways in which information is portrayed to operators. It was Jack, I think, who mentioned before higher optical, higher level displays.

There is also a lot of use of graphics to try to portray information in graphical terms so operators can more readily understand it; computerization of procedures including emergency operating procedures; soft controls, operation of equipment using, you know, display type of controls, going through your computer; maintenance of digital systems; and then the whole modernization process, how the -- how operators input factors into the development of a modernization program, and how those systems are integrated into the existing equipment, which is now very different than it is, and how it's introduced into operations.

Okay. The most recent one for us and, I guess, the last one is the interface management area. Let me just explain what this is for a second.

You know, operators are in the control room to monitor and control the plant. That is what they are there for. They monitor. They detect disturbances. They do situation assessment if things aren't quite right. You know, they plan responses and they take actions if actions are necessary.

Okay. We would just for the sake of argument call those primary tasks. Okay. To do that, operators have to do other things. They have to do what we call secondary tasks.

With these new types of systems, computer-based systems, those involve things like navigating to information. They involve things like specifying what parameters you might want on a trend graph; configuring a work station; manipulating windows.

It's doing a lot of tasks at the interface, which aren't really involved in -- in monitoring and controlling the plant.

Now, these -- these types of activities, which increase in number with -- with new digital systems became a specific concern to NRR.

Through tests and evaluations that were done with some of the advanced reactors that employed a lot of these systems, results were showing that operators were spending lots of time, 40, 50 percent of their time just doing these tasks, not concentrating on -- on the plant.

So we set out to look at whether or not this had a -- an effect, and what those effects were. Okay. We used a variety of lessons learned from -- from other work we had done, plus we conducted a number of site visits, walk throughs, interviews with operators of systems, you know, these computerized systems.

And one thing we tried to do was model human performance. We tried to see, "Well, what would the effects be if -- if this were to negatively impact human performance?" and then to identify "What are the key design features in these new digital systems that create these effects?"

Okay. Okay. In terms of modeling the effects, if you think of yourself as having a certain amount of attention, which you do -- it is not infinite; it is finite -- you need to allocate that attention to the various tasks you have to do. Okay.

So the way I divided up the operator's tasks into primary and secondary, operators have to think to some degree about what's happening in the plant, and they also have to think about what they need to do at the work station and at their interface to get the information that they need. Those are -- the -- the secondary or the interface management tasks.

Okay. Given that people only have a certain amount of attention -- it's not infinite -- you can look at the trade-off that occurs when I allocate my attention one way or the other.

The NRC's original concern -- and I think the original concern of many researchers in this area, is that because we have designed, or we're beginning to introduce systems that provide vast amounts of plant data, you know, maybe thousands of display pages, and they get to look at them through maybe three, four, five CRT's, it's a lot of time that they spend going and getting out that information and -- and bringing it up.

Okay. So what we're trying to look at is what -- what are the effects of the allocation, the trade-off the operators have to make between, you know, getting that information and -- and monitoring and controlling the plant.

Well, the original concern was this end here.

Now, if you just look at this, it's -- you have so much cognitive resource, you can supply them to the primary task where you're not going to do interface management at all. Okay? So it's low here, high here. (Indicating)

Or you can allocate all your resources to fishing around for information and not really a lot towards monitoring and controlling the plant.

And so what we hypothesized is that there were a number of different effects that could occur. This is hypothetical now.

Operators could allocate no -- very little resource to manipulating the work station, go with what they have on the screens. Even if they know it's not the best information, they just may go with it, because they're trying to diagnose or do something like that.

On the other hand, operators may feel, "Well, gee, I don't really have the information I need." And now, they go off on a hunt to get it and to set it up and to configure their work station to do their tasks where they're way up here.

Now, performance can suffer at either of those ends. Performance can suffer down here, because you're working with a limited set of data. You don't have the right information you need. And I -- we call that the data limited effect.

Okay. They could also allocate all their resources to interface management or an exorbitant amount where plant performance suffers because they're no longer aware of what is going on in the plant.

To real operators, there is a happy medium between where the plant performance is probably optimal, where they have to share some of their time getting -- you know, doing these interface management tasks and some not.

Now, the original concern in most of the literature was this area here. (Indicating) To have all of the flexibility and presenting the information in these things is going to drive operators to spend so much time on that, they can't pay attention to the plant.

Interestingly enough, when we looked at the literature, we found evidence in both areas. In fact, we observed in our own studies and then there was a big study done in Europe by Herzlinger (phonetic) and Herbert where they looked at digital upgrades to many kinds of plants, not just nuclear, but fossil plants.

And one of the findings that comes out of that is that operators very much realize this trade-off that they have to make. And very often, when things get busy, they cease doing the interface management tasks. They just don't do them anymore.

They -- they know there is additional

alarm -- alarm information they could get, but they don't get it. They stick with what they have, because they're trying to concentrate on their tasks at hand; or they may know, "There is a better display I can get, one that is more appropriate, but I don't want to take the time to go and get it."

So operators sort of work their way, you know, back and forth this curve based upon, you know, their judgment of how good a fit the information is.

Now, what's also interesting is this has a lot of design implications, because you ask almost any designer of a power plant, "How did you decide how many displays to put in?"

Well, that's usually something they decide right up front. "You know, I'm going to -- I'm going to provide six CRTs."

If you ask the question, "Is six CRTs enough," there is really -- they don't -- haven't really thought that through.

But if operators do and -- and by the way, the reason they don't worry about how many CRTs is because they've provided the pictures in the information system. All the operators have to do is go and get them. So they don't need a lot of display area. But, in fact, what we're finding is that operators won't always go and get it. And they know it.

Now, we -- in two of the studies we did, our alarm system study and our -- and -- and our -- well, I didn't mention it, but we did a study of control and modernization program that is going on now.

Operators don't get this additional information, even when they know it's there. So -- and it turns out the key design characteristics that drive these interface management effects are the volume of information. You know, how much is really in there that you can go and access, how it's organized?

This is a very interesting thing, too. Information has tended to be organized in these computer systems like they were organized in the old plants. You know, when the designers went to computerize them, they took the boards and they stuck them in the computer.

But, in fact, if all you have is three of four CRTs to look at, and your task required you to go across systems, there is a tremendous amount of fetching displays and -- and stuff that you have to do.

So we in some ways have made jobs a lot harder. And this was a -- a prominent result of the upgrade study I mentioned before by Herzlinger and Herbert, that operators found these information systems often very difficult to work with.

Okay. The feature display area, I mentioned; navigation design, like the features that are in the system for the operators to get additional information.

And this last one is interesting, too. And you all probably work with PCS that have tremendous flexibility. You can do tons of things with them. How much of the flexibility do you use? Operators are no different.

They don't use -- a lot of designers say, "Well, I'm not going to make this design decision, because I'll let the operators do it. The operators know what they'll need at a certain time. We'll let them construct the display."

So that's like allowing the operators or wanting the operators to finish off the design process. Well, that's overhead and workload that a lot of times they don't want. I mean, they may want it, for not time critical things, but the amount of HSI flexibility that is built into the system can often be a real problem for the operators. So -- so their -- some of the effects are very, very interesting in this area.

Okay. Just to give you an update as to where we are, the hybrid studies I mentioned before, they are all done. Those reports will be out, I think, in March, this month.

The alarm system reports, they're in final NRC review and should be -- and they've already been peer-reviewed. They're now just in the final NRC review. They should be published in a couple of months, I think.

The interface management work, we're still working on the -- the guidance development part of it. What I showed you was some of the technical basis information. We're still in the last few efforts of -- of trying to develop guidance from that.

And then in terms of the bigger picture, when all of the guidance comes out of these documents and into the NUREG-0700 document, that's a process that actually has started to happen already. And we expect a draft of that document to be available this summer for field testing and then the workshop and things to follow after that.

MR. APOSTOLAKIS: Thank you.

Any comments from the members?

MR. POWERS: I just wondered a -- a study was mentioned by the speaker just right at the end. I can't reproduce the names --

MR. O'HARA: Oh, Herzlinger.

MR. POWERS: Herzlinger. Do we have a copy of that?

MR. APOSTOLAKIS: Let's make sure that Mr. Dudley gets --

MR. O'HARA: I can send you a copy, sure.

MR. POWERS: I think it will be useful to examine that one. It sounds like --

MR. APOSTOLAKIS: Yes.

MR. O'HARA: Yes. It's a very fascinating study, because it's a case study.

MR. POWERS: There was some interesting -- interesting events in the Dewie (phonetic) Complex when we were still running reactors that illustrates both extremes that you -- you talked about there --

MR. O'HARA: Yes.

MR. POWERS: -- both getting so absorbed into -- into the paging process on the computer screen that you don't notice that they had a reactivity incident going on --

MR. O'HARA: Oh, it -- it really is

MR. POWERS: -- though it's hard to miss.

MR. O'HARA: It really is very interesting. The Herzlinger study, they didn't even set out to look at this. I mean, it -- this was a by-product of -- of just looking at lessons learned from these things.

And -- and we kind of saw it at the right time, because we were just thinking of these. So it's -- it's a -- it's a good study, because it's -- it's a field type thing.

MR. APOSTOLAKIS: Okay. We'll take a short break.

(Thereupon, a short break was taken, after which the following proceedings were had:)

MR. APOSTOLAKIS: So would you tell us a few things about yourself first?

MS. BIER: Sure. I'm -- I'm a faculty member at the University of Wisconsin with a joint appointment in industrial engineering and engineering physics, which is where the nuclear power -- nuclear engineering program is housed. I have an extensive background in risk analysis.

I also would like to introduce the -- and acknowledge the members of my project team. James Joosten, who is here back in the corner, is a consultant with extensive experience in the nuclear power industry who helped us with the United Kingdom case study that you'll hear about.

The other three individuals here are with Christensen Associates, which is a leading economics consulting firm.

PARTICIPANT: And your team won the Rose Bowl. You forgot to tell us that.

MS. BIER: That's true. And my team won the Rose Bowl.

[Laughter.]

MR. APOSTOLAKIS: Do we have a copy of your --

MS. BIER: You should. There were copies around.

I don't know whether they still need to be distributed. But, yes, you do have copies.

Also, I want to acknowledge the NRC folks who have supported this effort, Paul Lewis, Jerry Wachtel and, back a couple of years, J. Persensky was also involved in getting the initial idea for this study underway.

To lay a framework of what we actually did and what the purpose was, when the study first got started, we decided that it made sense to take a historical case study approach to looking at deregulation in order to maximize the reliance on empirical information about what actually happened in other deregulated industries.

So we based our studies on a combination of literature reviews and interviews, depending on the availability of the information in each industry.

We chose three case studies, basically for their relevance to the U.S. nuclear power industry and the safety significant issues involved in those industries.

Those were deregulation of the U.S. air and rail industries, back about 20 years ago, which were extensively studied; and restructuring of the U.K. electricity industry, which involved both deregulation and also privatization.

The purpose in our scope of work was essentially to develop a complete list, or as complete as possible, of the changes that were observed in these case study industries that were relevant to safety -- so we weren't limited to human factors or human performance issues, but also organizational and equipment reliability issues -- but with a charge to emphasize those changes that had possible negative impacts on safety, recognizing that some changes could also be beneficial to safety.

First with regard to the time scale, I wanted to point out that adjusting to deregulation is a lengthy process. Even though the air and rail industries were deregulated by now more than 20 years ago, by many views, they are still evolving in response to deregulation today.

And there is a lengthy learning curve associated with deregulation. Companies do not emerge immediately after deregulation knowing how to compete effectively and safely in a deregulated competitive market.

One example, although it's not safety critical from the airline industry, one of the -- our interviewees told us that in the air industry, the major airlines used to turn over their aircraft after six or eight years, sell them at bargain basement prices, typically into secondary markets, either cargo operations, third-world passenger service, that type of thing.

After deregulation, for several years, they continued selling their aircraft after six or eight years at bargain basement prices, but now were selling them to their direct competitors who were using them to pound them into the ground economically.

And there was apparently a luncheon speaker talking to an airline executive's group at that time who commented that the airlines would have actually been better off taking their planes out into the desert and blowing them up than selling them to their competitors. But it took awhile for established ways of doing business to change in response to deregulation.

With regard to overall safety performance, economic deregulation does not necessarily lead to a decline in safety overall. In fact, both the air and rail industries in the U.S. had, by many standards, better safety records after deregulation than before.

In the U.K., it's a little harder to judge, because fortunately we don't have nuclear accidents that we can count up in our estimators, but there is evidence that plant managers in the U.K. did focus more intently on issues such as regulatory compliance and equipment reliability after deregulation.

However, the magnitude and speed of the changes associated with deregulation pose substantial challenges to safety management; and as a result of those challenges, there were safety problems identified in all three of the case studies that we looked at.

One thing that one can expect in response to deregulation is major reprioritization of expenditure and investment from the traditional patterns within the industry.

Several examples of that, in the airline industry, the airlines substantially lengthened the intervals between engine maintenance after deregulation. In that particular instance, they did not experience a higher rate of engine failures, so that suggests that they appropriately reoptimized their maintenance policies.

There were dramatic changes in investment in the rail industry. They cut staffing by about a factor of two after deregulation, and used both the savings from staff reductions and other profit improvements to plow more money into track maintenance, increased their track maintenance by a factor of five.

And it's generally accepted that the better track quality resulted in significant reductions in major collisions, derailments and that type of thing.

The nuclear power industry in the U.K. also downsized dramatically after deregulation, I believe, an order of magnitude of factor of two again. Coupled with increase use of contractors, there the safety picture is maybe a little more complex.

So one can expect to see major changes in patterns of expenditure. Not all of those changes will necessarily be adverse to safety.

But there is certainly the potential for adverse consequences if companies go too far in cutbacks in safety critical areas, especially where they may not get immediate feedback that they've gone too far or may have a hard time correcting the changes after they've been instituted.

We also found in all three case studies that deregulation creates major challenges to the maintenance of an effective safety culture within the industry.

In both the aviation and rail industries, there were a number of safety problems associated with corporate culture in the aftermath of major mergers and acquisitions. And we certainly seem to be seeing a lot of those in the nuclear power industry today.

The most dramatic of those was the merger of Union Pacific and Southern Pacific Rail a few years ago. It resulted in several fatal accidents in the few months after the merger.

Also, a lot of freight -- if people were reading the Wall Street Journal around that time, a lot of freight was sitting around idle on railroad tracks not being delivered on a timely basis.

And Peter Passell, the -- a New York Times economics writer, specifically attributed that to clashes in the safety cultures and philosophies of the two organizations involved in the merger.

In the airline industry, new entrant airlines, Sukipeeco (phonetic) Express and Valuejet type also had significantly worse safety records, roughly in order of magnitude worse than the established airlines. Many of those problems appear to be corporate culture problems.

For example, a new airline might know that it needs to have a training department, because that's an FAA requirement. But it may not have a full understanding of what characteristics an effective training program really needs to have. So it may have a training department that exists largely on paper.

There is also some evidence, although obviously, it's very hard to document, but in the rail industry interviews, several individuals suggested that there is greater pressure to under-report minor accidents and injuries after deregulation than before, things like personnel injuries.

And there, again, I think we can see some possible analogues in the nuclear power industry today. For example, the incident-free clocks that are being established at some power plants, while they provide a positive incentive to achieve safe performance, they also provide a disincentive to report minor problems.

If I caused -- if I made a mistake that didn't have any severe safety consequences, nobody saw me do it, I'm not going to want to report on myself if that's going to set back the incident-free clock after nine months of incident-free operation, for example. So there are some possible issues involved in reporting.

In the U.K. nuclear power industry, the major corporate culture concerns raised by the regulators there had to do with the use of contractors, things like loss of institutional memory, also the fact that contractors did not necessarily have the same safety culture as the licensee's own employees.

And as a result of these kinds of problems, safety regulators in both the U.S. rail industry and the U.K. nuclear power industry have found it advisable to begin requiring prior regulatory review of major organizational changes.

In fact, that's already official in the U.K. in their license condition number 36. And I'm not sure whether it's official or -- or still just proposed in the Federal Railroad Administration.

In both the aviation and rail industries, there were significant statistical studies on the association between safety problems and financial difficulties, which generally suggested that, yes, there was a correlation, that companies in financial difficulty tended to have worse safety records.

The link appears to be strongest for small companies and companies that were actually unprofitable, as opposed to only marginally profitable.

Nancy Rose, who did probably the best work in that area in the aviation industry, actually concluded that more intense regulatory scrutiny of financially marginal air carriers would, therefore, be advantageous from the point of view of safety.

And because companies in financial distress may have an incentive to cut corners, it's possible that financial distress would be a leading indicator of safety problems in the nuclear power industry as well.

Significant concerns were raised regarding downsizing and fatigue in both the rail industry here and the nuclear power industry in the U.K.

In the rail industry, many of the problems surfaced as a result of major accident investigations in recent years that attributed causes of those accidents to inadequate staffing, inadequate supervision and fatigue. Again, many of these problems surfaced in the aftermath of major mergers and merger related downsizing.

In the U.K., regulators raised concerns that downsizing led to loss of institutional memory and excessive reliance on contractors. In some areas, the utilities may no longer have had any in-house expertise in a particular area and be entirely reliant on contractors, which raised questions about whether they could really be intelligent customers and adequately supervise the work of those contractors.

It's interesting how that came about. According to the interviews that Jim did with British Energy, it appears that they were anticipating work load reductions due to efficiencies, economy of scale, integration of safety functions; announced various severance packages and agreements; and then found out that the efficiencies, even if they may be realized eventually, did not come about quite as fast as they anticipated. In the meantime, they had key personnel finding other jobs and got themselves into a bind that way.

MR. POWERS: May I ask you a question about this?

MS. BIER: Yes, absolutely.

MR. POWERS: When you say federal investigations have identified inadequate staffing and fatigue as contributing factors, how do you know that fatigue is a contributing factor?

MS. BIER: I would have to go back and look at the details of what's done. In the rail industry, the fatigue problems are actually really dramatic relative to what they are in most other industries.

Rail freight operations have no fixed schedules whatsoever. People work entirely on call and around the clock. So they may work, you know, from 2:00 a.m. to 10:00 a.m. on Tuesday, then from 8:00 in the morning till 4:00 in the afternoon on Thursday, and, you know, with -- with only two hours advance notice. So the fatigue problems are much more dramatic probably in the rail industry than in some others.

But I would have to go back and look at the details of the investigations to know how they determined that fatigue was a contributor.

MR. POWERS: Well, may I ask the same question?

MS. BIER: Yes.

MR. POWERS: You have "excessive reliance on contractors," how do I know that reliance is excessive?

MS. BIER: Jim, do you want to take a stab at that? How did the NII determine that reliance was excessive?

MR. JOOSTEN: Well, I'll tell you roughly how they --

MR. APOSTOLAKIS: Excuse me.

MS. BIER: I'm sorry.

MR. JOOSTEN: I'm sorry.

MR. APOSTOLAKIS: Come up here.

MR. JOOSTEN: Okay.

Jim Joosten. I'll tell you roughly how they sort of got tuned into it was through a series of interactions with the licensee, in which case the regulators would sit on one -- on one side of the table, and the licensees were on the other.

And they asked a series of questions and almost every question that they asked the licensee, he had to turn around and ask his consultant what the answer was. And at that point, NII started to get suspicious that -- that the licensee was no longer an intelligent customer for the services.

And so they've gone through a process of trying to evaluate just what constitutes an intelligent customer. "What -- what does the licensee need to know in order to uphold his responsibilities as a licensee?" because ultimately he holds the -- the responsibility for an accident. It can't be waived off to a third party.

MR. POWERS: What I'm interested in is what "excessive reliance" is, not what constitutes a good or bad customer.

MR. JOOSTEN: A -- just to give you some examples, one of their concerns was -- was that you would have a safety function critical upon a -- and you had no staff that was cognizant of how to perform that safety function.

For example, they had some graphite experts, who the company had lost, and now were relying upon contractors for this expertise. But the -- the problem is that the company lost control -- the licensee lost control over the availability of that contractor, because that contractor could say, "A, you're not paying me enough money," or "B, I'm committed to somebody else this week."

And so that -- that's a situation where the expertise was outside of the licensee's direct control when he needed it.

Another case is -- is, for example, even with their own staff, if -- if they downsize and now you've got one fellow trying to -- to work the job for two units, he might no longer be available when he was needed on one particular unit. So it -- it -- those are two --

MR. POWERS: That's an availability issue, isn't it?

MR. JOOSTEN: Yes. But -- but, you know they're -- they're still -- I would say they've gone through four or five different drafts of what constitutes an intelligent customer and even within NII, one department may say something different than another department at this point. They -- they're still trying to define it. But --

MR. POWERS: That doesn't occur in the NRC.

[Laughter.]

MR. APOSTOLAKIS: Well, this is really interesting, though, because --

MR. JOOSTEN: It's real interesting, yes.

MR. APOSTOLAKIS: Do you mean the NII is going to check to see what the licensee knows?

MR. JOOSTEN: What they --

MR. APOSTOLAKIS: I can't see us doing that here.

[Laughter.]

MR. JOOSTEN: Let me just -- let me just -- yes, let me just say that it's actually pretty similar to what we do, but the NRC takes what I would call pretty much a hardware focus.

If you look at our FSAR, for example, it's voluminous; 99 percent of it is hardware. There is just a few pages dealing with the management organization.

But in the -- in the U.K., they realize that the safety management was just as critical as the hardware. And so they've now gone back and required them to define what constitutes the -- the safety basis, the -- the human side of the equation. So -- so, you know, how many engineers do you need, and what functions are -- are safety-critical functions?

So they -- they -- like we do with -- with safety injection pumps, they've asked them to do the same sort of an analysis in terms of the human input into safety.

And now they've checked the deltas against that. If the licensee proposes a change to downgrade the staff or to reorganize the safety functions, they now check the before and the after, and try to -- and -- and require the licensee, like we would in a 5059, to -- to look at the impact of this change in -- in -- in human -- in human safety and in the organization before they make the change and not afterwards.

We sort of operate here sort of retrospectively waiting for millstones to happen and then go in and try to clean it up.

So that is really revolutionary, I think, what -- what NII has -- has done here in terms of putting a whole new focus on the human factor as opposed to just hardware.

PARTICIPANT: You're making him hard to live with. He's going to quote that back to us.

[Laughter.]

MR. APOSTOLAKIS: I want a copy of the transcript as soon as it's available.

[Laughter.]

MS. BIER: There -- in both the rail and the U.K. nuclear power industry, safety regulators have also raised concerns about increased use of overtime after deregulation and, in some cases, also under-reporting of overtime, which leaves the regulated party in a situation where it may not know how much work is really required in order to perform certain tasks if it's not reported accurately.

With respect to the experiences of safety regulators, there is some evidence that deregulation does result in increased workload for regulators.

In the airline industry, the FAA underwent significant staff and budget cuts right around the time of deregulation -- very reminiscent of what we're seeing now at the NRC -- and later found out, somewhat unexpectedly, that its workload had increased quite dramatically, and that it really no longer had the staff to cope with the increased workload.

A number of observers of deregulation, some of whom were very strong proponents of deregulation made comments around that time, 1988-1990 time frame, that if the industry had experienced overall increases in accident rates, Congress would have borne a significant share of the responsibility for not allocating sufficient staffing and resources to the FAA to ensure a safe transition to deregulation. In the --

MR. APOSTOLAKIS: But since these accident rates --

MS. BIER: Yes.

MR. APOSTOLAKIS: -- have not gone up, does Congress and the Department of Transportation -- do they deserve praise for doing -- maintaining safety, and at the same time reducing expenses? Why don't they say that?

PARTICIPANT: Good question.

MR. APOSTOLAKIS: In fact, that's an observation. It's a statement of fact.

MS. BIER: Well, they did reduce cost, but it did come at a cost in lives, in fact. There are specific examples that you can find, primarily in the new entrant airlines, of accidents that happened because of inadequate oversight or where inadequate FAA oversight may have been a contributing factor.

And I think that it is in -- in the aviation industry, they were able to withstand that impact because the new entrant airlines never carried a significant fraction -- a large fraction of the passenger miles, and the improvements in other parts of the industry sort of balanced out the overall safety record.

I'm not sure that we in the nuclear power industry can afford to have a segment of the industry that is operating in an unsafe manner.

But, yes, their -- they managed -- one example of the kinds of management techniques the FAA had to rely on in order to manage its workload, they need to give check rides to pilots in order to qualify them for new aircraft and when they change airlines.

And there was such great turnover in the industry that the demand for check rides grew beyond what the FAA could do. They licensed pilots within the individual airlines to deliver check rides for their own airlines.

And as you might expect, there were occasional instances of abuse, of pilots signing off on check rides that had never been given. So, you know, they managed their workload, but it did come at some price in terms of safety.

In the U.K., the situation was a little different. There, I think the nuclear installations inspector recognized in advance that they would require additional resources to deal with the transition to privatization.

They staffed up rather modestly, but they recognized that they had to free up some senior people from routine inspection duties in order to think about more strategic issues.

In addition, as I mentioned earlier, because of the importance of organizational factors and safety culture types of issues in deregulation, safety regulators in both the rail and the U.K. nuclear power industries have begun requiring prior regulatory approval of major changes. In the rail industry, that has focused on prior approval of major mergers of which a number are currently being discussed.

In the U.K., the effort has focused mainly on downsizing, outsourcing and staffing changes, but I think would be considered to apply to things like mergers and consolidation of safety functions and so forth.

In both industries, the approach being take is not prescriptive. The agencies are not prescribing how regulated parties shall achieve management of safety, but are basically requiring regulated parties to demonstrate that they have an adequate plan for managing safety after -- through the transition to these organizational changes.

As is true in any case study, the case studies that we looked at, deregulation is not a perfect, natural experiment. In each case, it was confounded with other factors, some of which were favorable to safety, which might have compensated for adverse effects of deregulation.

MR. POWERS: I guess I don't understand that. Like the first one, it says "decades-long trend of improving safety."

MS. BIER: Yes. Yes.

MR. POWERS: -- "may have masked adverse safety consequences of deregulation." What may not have, too? I mean --

MS. BIER: Right. We don't know --

MR. POWERS: -- what is the --

MS. BIER: Well, the -- we don't -- it's -- it's a hypothetical question whether safety would have improved faster or slower in the airline industry in the absence of deregulation. But they were riding -- this -- this slide, I think, is actually not in your packet. (Indicating) This is from Boeing.

But they were riding a very significant trend of improving safety at around the time of deregulation, around 1980. And it's quite possible that that trend would have been, you know, even more rapid in the absence of deregulation.

MR. APOSTOLAKIS: So put that back up there again.

MS. BIER: Sure.

MR. APOSTOLAKIS: The rest of the -- where does -- where does the curve go?

[Laughter.]

MS. BIER: Well, they're -- they're trying to drive it as close to zero as they can.

MR. APOSTOLAKIS: No, I know. But on the left, in the 61, 59 to 61 -- my goodness, look at that.

[Laughter.]

MS. BIER: That -- the heavy line is U.S. and Canadian. And, in fact, there are some specific examples of the kinds of technology changes that came in around the time of deregulation in the airline industry.

That's when you saw the advent of crew resource management techniques and training. It's when you saw more widespread use of high-fidelity flight simulators in training, improved engine reliability, also improved preventive maintenance practices, and knowledge base for preventive maintenance.

So there were a number of major technological changes, some of which may have been accelerated by deregulation, but some of which may have been just technological inevitabilities that helped mask adverse effects of deregulation.

MR. POWERS: Well, I mean, even if they did mask it --

MS. BIER: Yes.

MR. POWERS: -- the effects -- the effects could not have been very big.

MS. BIER: Right. That is certainly true.

MR. APOSTOLAKIS: I guess it's just a caution.

MS. BIER: Yes. It's a caution.

MR. APOSTOLAKIS: It's a caution.

MS. BIER: In the rail industry, deregulation led to significantly improved profitability of the rail industry. That's due to the specific nature of the economic regime that the -- that the railroads were operated under prior to deregulation, which prevented them, for example, from abandoning unprofitable routes.

And so a lot of the improvement in safety is attributed to improved financial profitability that made it possible for them to increase their maintenance expenditures.

In the U.S. nuclear power industry, some plants may be financially better off after deregulation than before, but some are probably going to find deregulation financially very stressful.

Rail safety -- rail deregulation also took place at a time when the Federal Railroad Administration was for other reasons becoming much more activist with respect to safety regulation.

In the U.K., there are a couple of factors. One, which I mentioned earlier, is the fact that the nuclear installations inspectorate was very actively involved in planning for and overseeing the transition to privatization, which presumably would have had some beneficial effects.

In addition to that, the years immediately following nuclear power privatization in the U.K. were accompanied by extensive financial subsidies for nuclear power, and so the cost-cutting pressures might well have been much more dramatic in the absence of those subsidies.

So, yes, I think George phrased it appropriately, that these are some cautions in interpreting the results.

And as a result of these kinds of factors, we cannot necessarily conclude that safety improvements similar to those observed in the aviation and rail industry will necessarily be observed in the nuclear power industry after deregulation.

MR. POWERS: When Tony Pratangellia (phonetic) comes and talks to me --

MS. BIER: Yes.

MR. POWERS: -- he puts up slides that say, "Everything is much greater. It's -- it's terrific." They look a lot like your airline slide.

MS. BIER: Yes.

MR. POWERS: They come screaming down and they're down in the noise, and I mean, it's hard --

MS. BIER: Yes.

MR. POWERS: You don't believe they can change those numbers very much.

MS. BIER: Yes.

MR. POWERS: So why do you -- why are -- why do you say that the safety improvements couldn't occur? I mean, it sounds like they are occurring. Certainly, we see people doing outages now in much better fashion than they did before, driven by the economic cost of doing an outage.

MS. BIER: Yes.

MR. APOSTOLAKIS: It might not be safer.

MS. BIER: It might not be safer. Some of the case studies that were just discussed earlier --

MR. POWERS: I think they'll make an argument that they are. And I think you -- they claim that they can show me plots that will prove to me that it's safer. I haven't seen the plots, but I -- they claim that it can be; and assuredly they seem to be going out of their way to avoid hazardous situations.

MS. BIER: Yes. I think that there is an incentive for the utilities to -- to avoid risk and regulatory shutdowns in the aftermath of deregulation. And that incentive is probably greater than it was previously.

There are also some pressures to cut costs and possibly some learning curves along the way to learning how to do that appropriately.

And I certainly cannot stand here and argue that the industry will not maintain the trend that we've observed over the past ten or twenty years of improving safety in particular areas. But I wouldn't want to give a guarantee that they will, either.

MR. POWERS: Well, I see the industry -- industry leaders on -- on a relatively regular basis announcing that a safe plant is a profitable plant --

MS. BIER: Yes.

MR. POWERS: -- that an economially run plant is a well-run plant, things like that. I mean, they seem to say it regularly.

MS. BIER: Yes.

MR. POWERS: There seems to be a -- a -- a lot of attention to this.

MS. BIER: Jim, do you want to comment?

MR. JOOSTEN: Yes. Can I just make a quick comment?

MS. BIER: Sure.

MR. JOOSTEN: When I -- when I looked at the U.K. study, I -- I had -- approached it with the same sort of skepticism, thinking that I would find a lot of hardware, you know, cost-cutting, turning back maintenance intervals, you know, skipping some frequencies, trying to -- just plain -- you know.

What I actually found was just the opposite. And, in fact, the -- the financial risks associated with shutting down a reactor in the U.K. under the new competitive market were much more intensified than they have been in the past, because of the power contracts that they get into, which -- which put extreme penalties on a reactor that comes offline unexpectedly. So their whole philosophy had shifted pretty much toward reliability, with an emphasis on reliability.

So now in the U.K., the plant manager at Sizewell (phonetic), for example, instructed his staff that they were to take their time getting the plant back online -- this is totally contrary to the way I was brought up at Zion --

MR. POWERS: At where?

MR. JOOSTEN: At Zion.

[Laughter.]

MR. JOOSTEN: You take your time to get the plant back online to make sure the maintenance is done right, because what's more important is once we enter into a contract, that we are reliable on that contract. So that -- that was one emphasis. But coming back to Vicki's point --

MS. BIER: Yes.

MR. JOOSTEN: -- the -- the reason why it could be more dramatic here in the United States is not because of the hardware issue.

The utilities, I expect here, will also put the money into reliability. You'll also see a reduction in SCRAM rights. You'll see some improvement in -- in hardware, which could bring the plant offline or -- or compliance issues.

Where you see the problem, as we saw in the U.K., is on the -- the human factors, the organizational aspects of -- of safety. Now, there, you know, there was just a general disorganization that took place on a -- on a massive scale.

And what would happen here in the United States in, you know, my rough estimation is is that you -- the situation could be dramatically more complex, because there is 3,200 electricity suppliers here. There was just the CEGB over -- over there initially. You've got just a -- a few power stations there. We've got, you know, 100 nuclear stations here.

So the -- the size of our system and the -- the pace of change, which would happen here, would be far more dramatic than what happened in the U.K. And I would expect -- and the coordination amongst the regulators is -- is also less. I think the attention to human factors issues is less.

So we're not proactively involved yet like the British regulators were. So I -- I think that the chances for a -- a -- an accident here, or not -- not necessarily an accident, but -- for a safety impact here would be much greater than, say, in the U.K.

MR. BONACA: Yes. One thing that -- if I may?

MS. BIER: Yes. Sure.

MR. BONACA: However, these parallels are being made -- but there is a fundamental difference in nuclear, it seems to me, with the dealing with standard costs.

I mean, if you were working for a power plant until recently, the people really carry the burden in the nuclear program of -- of invested costs, literally. They felt a guilt of it, if nothing else. So I mean -- and therefore, you had a squeeze coming in in trying to compete with something that was given to you, that you had no control of.

Now, with the dealing with standard cost, truly the focus is operation and maintenance and -- and power plants are more capable of -- of dealing with those specific issues, you know.

I mean, so there are some things that I'm not sure that parallels in Britain. I don't know if there are. If there are parallels in the airline industry, I don't think so.

I think that, in general, however -- I think that deregulation is bringing a more favorable economic environment for the operators. I'm talking about the utilities themselves alone --

MS. BIER: Yes.

MR. BONACA: -- just the operators at the nuclear units.

MS. BIER: Yes. I think I will jump ahead to my conclusions and maybe come back to hit some other points, if we have time. But I think if I were to say what I see as the single biggest safety challenge associated with deregulation, it is the change and the transition.

If you look at the number of management changes, mergers, acquisitions, new management philosophies, even at a plant that is not necessarily being sold, all of those things create change and turbulence in the short term.

They may turn out to be good for safety in the long run, if the plant gets bought by a company that has greater nuclear expertise, or if economies of scale enable them to have higher levels of safety expertise within the company, for example.

But that in the short term, it creates a high level of confusion where people at the plant may not for a period of time know what process they need to go through to get support from engineering, or what process they need to go through to bring safety issues to senior management's attention and get resources devoted to resolving them, if they're suddenly dealing with a brand-new management team that they haven't worked with before.

That management team is likely to be distracted and focusing on coming up to speed with, you know, overall plant operations and an unfamiliar plant.

And I think those kinds of transitional issues are what I would consider to be probably the most serious safety problems, not necessarily that deregulation will be bad for safety in the long term.

MR. APOSTOLAKIS: Vicki?

MS. BIER: Yes.

MR. APOSTOLAKIS: This -- the -- the way you have stated the lessons learned --

MS. BIER: Yes.

MR. APOSTOLAKIS: -- these are sort of general, a general kind of way.

MS. BIER: Yes.

MR. APOSTOLAKIS: Now, do you plan to also give some recommendations or suggestions as to what the NRC, in fact, can do to contribute? It does -- you know, to say it takes total commitment --

MS. BIER: Yes. Yes.

MR. APOSTOLAKIS: -- you know, this can be -- I don't know what to do if you tell me that.

MS. BIER: Yes.

MR. APOSTOLAKIS: But what can a regulatory agency, in fact, this regulatory agency, do to make sure that the problems that you --

MR. POWERS: Or even more --

MR. APOSTOLAKIS: What?

MR. POWERS: Even -- even very specifically, can we understand the problems that may exist within the workforce, within the safety culture by looking at performance indicators based on the hardware?

MS. BIER: Well, first of all, I want to preface this by saying that I've been instructed that the NUREG that I'm producing shall not include recommendations; but, yes, I do plan to deliver some to the agency in any case. And so

I'm speaking for myself, not for the -- the official product of this work.

But, yes, we do have some recommendations. I think one of the most important ones, getting at your question, is to revisit the performance oversight process and ensure whether it is capturing organizational safety culture kinds of impacts.

Given how important those have turned out to be, that if we have a process that is predicated on assuming it's going to capture those, we have to at the very minimum demonstrate whether it is doing that or not.

And I think that there are other things that the agency may want to do in the area of organizational culture. One is just to collect greater baseline data on what kinds of staffing levels, expertise, organizational structures the licensees have now, so that it would be in a better position to assess the safety significance of any changes.

MR. BARTON: That's pretty hard to do when you take a -- a merger like Unicom (phonetic) and Peeco (phonetic).

MS. BIER: Oh, yes. Yes.

PARTICIPANT: Yes.

MS. BIER: Absolutely.

MR. APOSTOLAKIS: You're saying --

MS. BIER: Yes.

MR. APOSTOLAKIS: -- we should look at the organizational culture and so on. I remember there was a hearing in the Senate and the Commission was testifying.

MS. BIER: Yes.

MR. APOSTOLAKIS: And the chairman of the Senate subcommittee thought that it was unheard of that a regulatory agency would tell the licensees how to monitor their facilities. And he asked, "Does the FAA tell Boeing what to do?"

MS. BIER: Well, I think the answer to that is the case that I'm the most familiar with at the Federal Railroad Administration, no, they are not telling the regulated parties how to manage. They are requiring that the regulated parties demonstrate that they have a plan for how they will manage safety.

And so it is not prescriptive, but it's proactive in the sense of attempting to demonstrate safety before changes are made instead of afterwards.

MR. APOSTOLAKIS: Comments?

MR. LEWIS: May I make a brief comment?

MR. APOSTOLAKIS: Yes.

MS. BIER: Yes.

MR. LEWIS: The reason why --

MR. APOSTOLAKIS: Your name?

MR. LEWIS: -- Vicki is not making recommendations is because --

MR. APOSTOLAKIS: Paul, your name, Paul?

MR. LEWIS: Paul Lewis.

[Laughter.]

MR. LEWIS: This -- the contract is a grant. And according to the contract rules, people with grants cannot make recommendations. If we want a recommendation, then we have a contract.

[Laughter.]

MR. LEWIS: If I can -- another comment. Maybe --

MR. APOSTOLAKIS: I -- it should be the other way around.

[Laughter.]

MR. APOSTOLAKIS: With grants, you're not supposed to --

MS. BIER: Speaking as a grantee -- yes.

MR. APOSTOLAKIS: -- to ask for anything specific, right? You give them the -- the money, and they do the work.

MS. BIER: Yes.

[Laughter.]

MR. LEWIS: Would these two slides answer his question about specific --

MR. APOSTOLAKIS: Is Vicki also not allowed to go to conferences and present papers with recommendations?

[Laughter.]

MS. BIER: Oh, I am --

MR. LEWIS: With recommendations, I don't know.

[Laughter.]

MR. LEWIS: Is she -- I suppose if she states they are her --

MS. BIER: Yes. I've -- yes, I've been told that I can provide recommendations to the agency as long as they are not in the NUREG --

PARTICIPANT: Personal -- if they're personal recommendations.

MS. BIER: -- as long as they -- right. I can write a personal letter to the agency with my recommendations, but -- yes.

Another area that I think is very important to look at as a recommendation is further study on the effects of financial pressures; that, yes, deregulation is likely to be financially beneficial for some plants, but it may not be financially beneficially for all plants.

And if financial pressure is a leading indicator of safety problems, which we've seen at least some indication that it is or might be, that would seem like an important thing to know and something that maybe the NRC could devote more research budget to studying.

MR. APOSTOLAKIS: It seems to me the message is clear that we really have to do something about this safety culture business, and --

MS. BIER: Thank you.

[Laughter.]

MR. POWERS: My goodness, that's a shocking conclusion for you to come to, George. I would never have expected that of you.

[Laughter.]

MR. APOSTOLAKIS: I try to surprise you, Dana.

[Laughter.]

MR. POWERS: Gosh. It was just the power of this -- these presentations that drove you to that decision reluctantly, as it may have been.

[Laughter.]

MR. APOSTOLAKIS: I -- I was -- I was very skeptical, when I came at 12:00 o'clock. I must say now, you guys convinced me.

MS. BIER: Well, that's very flattering.

[Laughter.]

MR. APOSTOLAKIS: Anything else, Vicki?

MS. BIER: I think those are the major issues. There are some other points, but --

MR. APOSTOLAKIS: Well, thank you very much for an interesting presentation.

MS. BIER: Thank you.

MR. APOSTOLAKIS: And the next person is Isabelle and J.

MR. PERSENSKY: I'm actually just here for the charts.

MR. APOSTOLAKIS: What are --

MR. PERSENSKY: I'm here to put up the charts.

MR. APOSTOLAKIS: Do you feel now better, J.?

MR. PERSENSKY: Pardon?

MR. APOSTOLAKIS: Do you feel better that the 27 inches were put to rest?

MR. PERSENSKY: I would like to -- yes, I do feel better.

MR. APOSTOLAKIS: Good.

[Laughter.]

MS. SCHOENFELD: I'm Isabelle Schoenfeld. I work in the Regulatory Effectiveness and Human Factors Branch.

I have worked at NRC in human factors for 15 years. The first four years I was in the NRR in -- in human factors, doing reviews in human factors and participating in inspections on training procedures, management organization, safety culture issues.

And for the last eight years, I've been in research, working in areas of training, human performance evaluation, protocol, risk communication. I also serve on the OECD Committee, CSNI Committee, extended task force on human factors.

MR. APOSTOLAKIS: And your training is in what area? Did you say that?

MS. SCHOENFELD: I have a -- my masters is in public administration with a specialty in management organization.

MR. APOSTOLAKIS: Thank you.

MS. SCHOENFELD: I'm not going into -- talk about the characteristics of safety culture. I see that Jack Sorenson (phonetic) did a very good job of that in the November presentation.

But I will remind people that the definition that's generally used for safety culture comes from INSAG-4, which is: Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear power plant safety issues receive the attention warranted by their significance.

And in talking about activities in the international arena, safety culture activities, I'm going to briefly describe activities for the NEA, the Nuclear Energy Agency's Committees on Safety of Nuclear Installations, Committee on Nuclear Regulatory Activities, the NRA, the International Atomic Energy Agency, IAEA, and some examples from individual countries.

Regarding CNRA activities, the NEA established a task force to advance discussion of how a regulatory organization recognizes and addresses safety performance problems that may stem from safety culture weaknesses.

And this resulted in a report entitled, "The Role of the Nuclear Regulator in Promoting and Evaluating Safety Culture," which was prepared by Dr. Tom Murley in June of 1999.

The report is meant to be the first in a series of reports, which focuses on early signs of declining safety performance and the role of the regulator in promoting and evaluating safety culture.

It addresses the importance of safety culture to nuclear safety, the role and attitude of the regulator in promoting safety culture, the role of the regulator in evaluating safety culture and regulatory response strategies. A follow-up paper is currently in preparation.

Regarding the CSNI activities, there is a document titled, "Research Strategies for Human Performance." And in the area of organization safety culture, this document called for a workshop on organizational performance, and also calls for work that would be directed towards the development of positive indicators for safe organizations.

If -- if and when that work is done, it should be coordinated with the IAEA, since they have priority in the safety culture area.

The workshop was held in Switzerland in June of 1998 -- here it says May, but it was June -- sponsored by the Expanded Task Force on Human Factors. There were 28 participants from 12 countries, and they were from regulatory bodies, utilities and research institutes.

They produced a state-of-the-art report titled, "Identification, Assessment of Organizational Factors," in February 1999.

One of the factors they addressed was organizational culture, and it was defined as "the shared assumptions, norms, values attitudes and perceptions of the members of an organization."

Further, it states that "safety culture is an aspect of the organizational culture where safety is a critical factor in the norms, values, attitudes of every employee throughout the organization."

In addition, CSNI has just recently undergone a reorganization and the ETF on human factors has now become a special expert group on human and organizational factors. And it will report directly to the CSNI, instead of reporting to a working group.

It will collaborate and respond to requests from CNRA, the working groups on operating experience, and working group on risk assessment in particular, and other working groups of the CSNI. And it will be guided by the Research, Strategies for Human Performance Document and the CSNI's strategic plan.

The first meeting of this group will be held in September 2000.

PARTICIPANT: And Isabelle will be our representative.

MS. SCHOENFELD: The IAEA activities -- IAEA, of course, does the bulk of the international work in this area. They have an office devoted to safety culture. They provide a variety of safety culture services to member states.

These services are either being given on continued support during a long-term enhancement process, or they come in for parts of the enhancement process as -- as needed.

They develop safety culture guidelines. There are about half-a-dozen-plus reports just addressing -- just addressing safety culture.

They provide peer review of an organization's safety culture by an external group. They hold meetings on safety culture self-assessment. And there is a draft document based on a meeting that was held in June 1998. There will be another meeting in 2000, and then a final document.

They've held workshops in the Eastern European countries on the management of safety and safety culture. And they've convened an IAEA working group, which was comprised of senior representatives of utilities and -- and -- and senior representatives from -- regulators from Canada, the United States, Sweden, and IAEA agency staff. They produced a paper on shortcomings in safety management symptoms, causes and recovery in 1998.

The senior representatives of the utilities and regulators from Canada, the United States, Sweden and the IAEA discussed common factors from recent cases involving safety management problems, and subsequent recovery processes, with a view to determining the need for further work to help prevent such difficulties in the future.

An item of commonality that they've identified in their report was a need to carefully monitor the change in safety culture as changes were taking place.

This was deemed necessary in order to ensure the safety management changes were driving the culture in the right direction; that is, towards a learning organization and away from a command/control type.

The working group had six action items for IAEA. The first was to develop guidelines describing the processes that could be used by senior corporate management of nuclear facilities, for early recognition of shortcomings and degradation of -- in safety management.

Two, develop qualitative and quantitative performance indicators for senior utility management to enable them to discern and react to shortcomings and early deterioration in the performance of safety management; three, develop guidance for regulatory bodies on how to detect shortcomings and early signs of degradation; augment the existing operational safety services, or develop a new service, which will assess the effectiveness of management processes used by senior management; prepare documentations on lessons learned through case studies and the early recognition of and recovery from degraded performance; and organize workshops for senior utility management and senior regulators on that.

Several IAEA activities related to these six actions are listed on this next couple of slides. I wanted to go through it. I hope to bring the schedule back on time.

MR. APOSTOLAKIS: So these -- these are tools that are available now or --

MS. SCHOENFELD: Some of them are. Some of them are in -- being developed.

MR. APOSTOLAKIS: OSCART and SCART?

MS. SCHOENFELD: Regarding other countries' safety culture programs --

MR. APOSTOLAKIS: Excuse me. Who -- who -- I understand that you are our representative on the CSNI force.

MS. SCHOENFELD: Yes.

MR. APOSTOLAKIS: The IAEA, do we have anybody, or they do --

MS. SCHOENFELD: Well, they bring in experts as needed.

MR. APOSTOLAKIS: As needed.

MS. SCHOENFELD: They're not a continuant. And the working group of senior regulators, Bill Travers served on that working group.

MR. APOSTOLAKIS: Okay. Now, then, I assume that INSAG has the overall responsibility, or is it out of their hands now?

MS. SCHOENFELD: I'm sorry. Who?

MR. APOSTOLAKIS: The International Nuclear Safety Advisory Group that came up with the idea of safety culture --

MS. SCHOENFELD: Yes.

MR. APOSTOLAKIS: -- are they still in charge, or --

MS. SCHOENFELD: Yes. They are -- those are the people who have these -- the responsibility to develop these actions --

MR. APOSTOLAKIS: Do you remember who they are now?

MS. SCHOENFELD: Shurston Dahlgren (phonetic) heads the group in safety culture.

MR. APOSTOLAKIS: Oh, okay. Well, she's not a member of INSAG.

PARTICIPANT: She's not a member of INSAG.

MS. SCHOENFELD: She -- no. The IAEA safety culture group. I don't know the member of the INSAG.

MR. APOSTOLAKIS: Okay.

MS. SCHOENFELD: Regarding other countries' safety culture activities, they fall into several areas, including regularly scheduled safety culture audits; developing models of organizational performance, which will include safety culture; developing and investigating safety culture aspects of deteriorating performance and events; safety culture self-assessment guidelines.

The next four slides provide some examples of these activities. This information was primarily derived from an informal survey that I conducted with my colleagues on the expanded task force. So --

MR. APOSTOLAKIS: I see on page nine, you stop at the U.K. There is no page ten with the U.S.A.

MS. SCHOENFELD: No.

[Laughter.]

PARTICIPANT: No. I don't think it's important.

[Laughter.]

MS. SCHOENFELD: And that concludes my presentation. If there are any questions --

MR. APOSTOLAKIS: Very good. Thank you very much.

We still have presentations, don't we?

PARTICIPANT: Right. Dave -- Dave Trimble, representing NRI.

MR. APOSTOLAKIS: Yes.

PARTICIPANT: He has promised to be first. And then J. has just two slides. And then you wanted time to --

MR. APOSTOLAKIS: Yes. I would like to go around the table here and get views and -- you will be around?

PARTICIPANT: I can stay as long as you'd like, but tell me when you can let some of our guests run to the airport.

MR. APOSTOLAKIS: Oh, I -- I think for our deliberations here, we really need you, but your contractors can leave, unless they -- they're anxious to find out what the members think.

PARTICIPANT: I'll be here.

MR. APOSTOLAKIS: I -- I suggest that we finish everything, with all the presentations by 5:00. So we'll start going around the table -- okay.

So those who have to catch planes, you are free to go.

MR. TRIMBLE: Yes. I'm -- I'm Dave Trimble, the chief of the operator licensing and human performance section over in NRR. And I have no trouble keeping this presentation very short.

We -- my background is more of an operational background, Navy nuclear training supervisor in utility, NRC resident -- senior resident inspector, and commissioner's assistant in -- in -- here in this job.

I just wanted to make a couple introductory comments. We talked about the fatigue issue. I just want to give a -- a characterization of that, that we -- we are -- we have two things before us. One, we have a proposed rulemaking that was submitted by Mr. Quigley that we're evaluating between now and the December time frame.

And we're also looking at a -- a task that the Commission gave us which was to reevaluate the -- the fatigue which, as you well know, went to overtime hours.

MR. BARTON: This rule-making is different than the one that exists out there now with respect to limiting the hours that you can work?

MR. TRIMBLE: The proposed rule-making that you are talking about?

MR. BARTON: Yes.

MR. TRIMBLE: The control -- I guess I would characterize that, and Dr. DeSaulniers is here today to give more detail, but, Mr. Quigley's proposal, in large measure, it does take the current policy guideline values and puts it into rule format. It makes it mandatory for --

MR. BARTON: It takes the guidelines and makes them mandatory.

MR. TRIMBLE: Yes. It goes beyond it in a couple of areas, too, like additional training for people, but that is principally where it is from. The second area I wanted to touch upon is -- Jack, I think, characterized the user need that NRR anticipates sending over, and has been delayed.

But my understanding of that is it is up to the last step in there of the office rector, and that should be taking place here shortly. Our goal here is to talk about the asterisked items here.

The other items on the slide are pretty much items that you are familiar with that are ongoing activities. We thought you would be more interested in the four asterisked items. And I would like to have Dick Eckenrode, senior human factors engineer, present those to you.

Dick.

MR. ECKENRODE: Hi. I am Dick Eckenrode from the Operative Licensing Human Factors and Plant Support Branch. That is even bigger than yours. It has been named many things over the years.

My background is: Actually, I am an aeronautical engineer. How I got here is a long story, but I have been 40 years in the Human Factors Applications business. I primarily try and stay out of research, but I've applied Human Factors principles for over 40 years now. The first one we want to talk about -- first of all, these activities here, the one, Fatigue Policy, we will give you a few more things on that, but the other three are really connected.

So, we are going to do it in a slightly different order. We will put the fatigue one up first. In February of 1999, we received a letter from Congressmen Markey, Dingell, and Klink requesting information on staffing and the use of overtime. That is the first item on there.

The second one, of course, is the request for proposed rule-making that you just heard about. And that has been -- they basically asked for a clear and enforceable policy on working hours.

MR. BARTON: If I take that new regulation which is going to basically take the guideline and make it a regulation, and Inspector finds a utility violates that in that one of the licensed operators worked more than he was supposed to by the regulation, and he applies the significant determination process to that, and it is a "No, never mind," it is a 10 to the minus 12, CDF, what the hell have we done?

MR. ECKENRODE: Nothing.

MR. BARTON: That is progress.

MR. ECKENRODE: That is if it was to become a regulation. We know that the Commission's policy has weaknesses. First of all, it is designed for an eight-hour working period. And many of the plants are now in 12 hours. So it is really not being considered here.

It is not responsive to risk insights. And a lot of the key terms in it are undefined, such as routine, heavy use of overtime, unusual circumstances. There is a lot of -- several other ones in there. Temporary basis, I think is used. So, that is the other area. There are weaknesses we know there.

You heard that we had a stakeholders meeting a couple of weeks ago to get issues out. Basically, that was all of the support to air the issues, get them out in the open. It was -- I think you heard, NEI and NPO, PROS, UCS, and the rule-making petitioner were all there.

Based on that, we have about four options. Other than doing nothing, that is, we have four options. One is to revise the policy. Second one is to provide guidance to Part 26, which is the fitness for duty rule. Third one is to develop an industry standard, and the fourth one is the rule-making.

We have not, at this point in time, decided on any of these. It is basically much too early in the process to do any of this.

MR. BARTON: What would you do in the fitness for duty rule? It now, I believe, requires, you know, observation.

You know, people work in a continuous observation program and you look for alcohol, fatigue, drugs, and all these kinds of things, attention to duty. So that is already in the rule, is it not?

MR. ECKENRODE: That is correct.

MR. BARTON: Well, what would be different in Part 26?

MR. ECKENRODE: Well, that is the Part 26 rule.

MR. BARTON: Yes, I know. Well, the option is to provide more guidance in Part 26.

MR. ECKENRODE: Probably primarily a regulation guide. Words in Part 26 I have here, as a matter of fact, it says, "Must provide reasonable assurance that nuclear power plant personnel are not under the influence of any substance, legal or illegal, or mentally, or physically impaired for any cause."

And the second part of it is, "Licensee policy should also address other factors that could affect fitness for duty such as mental stress, fatigue, and illness."

Those are the words that are in Part 26 now.

MR. BARTON: Right. Sounds like it is all there.

MR. ECKENRODE: Dale, would you like to discuss that further?

MR. TRIMBLE: We are going to have Dr. DeSaulniers come up and --

MR. DESAULNIERS: I am David DeSaulniers, also a member of the Operator Licensing Human Performance and Plant Support Branch and technically on the fatigue policy, and contact for the petition for the rule-making.

I believe your question was, "What will we do in the area of providing additional guidance with respect to Part 26?" Again, as Dick Eckenrode indicated, we are very early on in the process. So, there is no actual proposal in place for us.

Specifically, what we could consider doing is providing a guidance document that would describe guidelines for a fatigue management program. We could conceive that program having basic elements of activities that would prevent fatigue which may be in line with working out guidelines, activities that would detect fatigue accordingly, so that we would have a behavioral observation program.

Whether or not that is adequate to address fatigue, would have to be addressed. And activities that licensee could engage in to address mitigation of the effects of an impaired -- fatigue-impaired personnel on plant safety by perhaps adding independent review of work that is being performed by individuals that would be suspected of being at high risk.

If you have individuals working a significant amount of overtime, you could perhaps put in other factors to ensure that either they do not work on safety related equipment, or that they have additional management controls to ensure that the work is done properly.

Again, that is just initial thoughts. Nothing has been -- there is no developed proposal on a particular regulation guide at this point.

MR. BARTON: Thank you.

MR. ECKENRODE: The other three areas on the former slide are -- are kind of connected together here in a group.

Human performance in reactor oversight process: First of all, there is an assumption that was alluded to by Jack here that effects of human performance on plant safety will largely be reflected in the performance indicator and the inspection findings.

As you are aware, there is concern that that assumption may or may not be true, that we want to look at the possibility of other things. So we decided to take a two-pronged effort here.

One is to provide research for the user need that would look into operating experience, and past human performance analyses, and risk analyses that have all been done. They ask for work that has been done and see if they cannot come up with an answer to the question.

The second part is that we would like to use our HFIS, our Human Factors Information System, go in and look at, first of all, look for about 18 months or so a new program, the new inspection program. You understand, of course -- I think you are familiar with HFIS.

It looks at inspection reports, and LERs, and gets the human performance data out of them. We hope to use this in the new process with the new inspection procedures, and do it again.

If there is enough data still left in the inspection findings, we hope to compare it then to the last four or five years of historical data to see if we cannot determine whether these inspection findings and performance indicators do reflect the human performance problems.

We have -- first of all, the inspection process now has a series of -- there are baseline procedures. There are supplemental procedures. And when I say supplemental, basically, the supplemental ones are based on one or two white inputs, if you know what the colors are.

The second one is based on one degraded cornerstone, two white inputs, or a yellow input. And that is where this human performance inspection procedure would fit as a supplemental to that.

If they find that the area -- if they find human performance problems in one of these supplemental procedures, inspections, they might want to go into this detail of human performance one that we have been developing.

I cannot really tell you too much about it right now because it is out for comment at the moment in the regions. I will give you -- the next slide gives you a little bit of indication of what is included in it, and it is just about everything you can think about in human performance.

It does ask questions in all these areas which is the standard human factors type areas to look at. Basically, it looks at the corrective action programs. It goes in and says, "Where is the problem? What is the problem? And, how did the utility go about correcting it?" It is looking at their process for correcting all these actions.

MR. BARTON: Correcting human performance identified deficiencies.

MR. ECKENRODE: Yes. The last part of the thing, we have been asked to attempt to put together a significance determination process for human performance. This is in case the research and so forth does try to tell us that the performance indicators do not do the job, or the current SDP does not do the job.

And, frankly, the current SDP does not look at human performance areas. So we have looked at the -- for a -- try to develop now a significance determination process in these six functional areas which cover just about everything that we think we need to do.

It also looks at it in all the usual human factors areas, right there. It is based on several premises. The one that we are trying to develop now, the first premise -- and I will read it to you because I think it is important -- is every human action requires information to initiate the action and control capability to accomplish the action.

We believe that this will cover all the human performance activities that are going to come up in the inspection findings.

The second premise is that no information or control capability is better than incorrect information or control capability. This is beginning to give us a little bit of information on significance.

And the third premise, anything less than a complete failure to perform an action may not be as risk-significant as a complete failure. And this is going to require a little work that we have not gotten into yet.

And finally, we are trying to use the accepted risk guidance that is out there. We are using the approach of -- in Regulatory Guide 1.174, using probabilistic risk-informed decisions based on plant-specific changes in the licensing basis.

And finally, we are going to be using the information from the Brookhaven preliminary report right now on the guidance for review of changes in risk-important human actions. And of that, what we are really doing is using the generic tasks they have defined, or that they have identified.

They have them identified in two categories. One is what is considered high risk area, and the other is potential risk area. I think you are familiar with those two. I believe you have the reports there. We are using that information to help define a level of significance.

And it is going to depend an awful lot on plant-specific IPEs, I think, and PRAs to give us any further definition beyond that. And that is the things that we are doing in the NRR right now that are new.

Are there any questions?

MR. APOSTOLAKIS: Thank you. Oh, I am sorry.

MR. SIEBER: Your third premise, is there analysis that backs up that statement?

MR. ECKENRODE: Well, no. It basically says it may be less risk significant. All we are doing is identifying the fact that there may be a different kind of problem.

Time considerations, for instance. You know, the task may be done, completed, but it may be untimely. And that may or may not be risk significant. We do not know yet. But all we are trying to do is indicate the fact that there could be that condition.

MR. APOSTOLAKIS: Anything else?

Thank you very much. I understand there is one more short presentation.

MR. PERSENSKY: I am going to use one slide. If you go back to your original package of slides, page 16, Jack's slide. Really, when you look at the program as it is described -- by the way, I am J. Persensky. I work at the office of Research.

MR. APOSTOLAKIS: We know you. You have done this before.

MR. PERSENSKY: I have done this several times before.

If you look at the table that is in the back of the program, at the very end of the program document, the SECY, you will note that except for those things that are called "Continuing," everything ends in 2001.

If you look at the resources section of the SECY, you will also see that the budget is pretty thin after this year. Part of the reason for that is because we do not have the user need yet. Once we have the user need, things may open up in that area.

But, what is going on right now is one of the things we said in the future activity is that we are going to meet with you and continue to interface with the ACRS. The other is the budget prioritization process.

There is not a prioritization process in this program because each of the offices has their own prioritization process for the budget, and that determines the way things are going to work. That is an ongoing process right now.

In fact, while we were sitting here, one of the people came in and ask questions of Jack on some priority issues within this. The other is we are going to finish up the work at INEEL for the ASP work.

But probably the biggest thing that I would like to talk about is the fact that we have a lot of information. You have been dumped -- a lot of it has been dumped on you today. We have more, in fact, risk information, what is going on in other places, what is going on internationally, user needs, changes in the process.

We are proposing that we have a peer review workshop where we bring together people from the human factors community, from the reliability community, from the industry, from various other agencies that are working on problems such as this, and say, "Okay. Let us go through this," and as really a working group of trying to assimilate data and the information that we have.

From that, take issues such as the question of Lake Nair (phonetic). Okay. We have identified Lake Nair, but we have not identified what to do about it. What can we do? Is it a research issue? Is it a regulatory issue? Is it really an issue from a PRA perspective?

So, those are the kinds of things we want to address and we want to bring together. For instance, we bring Jim Reason in on that part to discuss the Lake Nair issues. So, that is the next big step.

We do have funding for that in this fiscal year. And out of that, we would expect to come a further version of this that has more detail for future work.

In addition to that, of course, the continued work in international cooperation as Isabelle talked about, the CSNI, our continued work with IAEA. Halden is -- we have renewed the contract with them for the next three years which really means a lot of interaction with 21 other countries. It is not just the Halden project itself.

And a number of us are involved with standard groups like IEEE, ANS, ASME, and so we bring together -- bring in information from these groups, as well. And we hope that eventually we can hold together a longer term program based on these interactions.

The only other slide was just the slide from the table that had the schedule information on it.

So, with that, the presentation is done. We are, in fact, seeking a letter of support for the program.

MR. ROSENTHAL: Yes, while the transcript is going, I have to make it very clear. We do -- there was a lot of discussion on safety culture, in one manner or shape or form.

The staff does work for the Commission, and we are not doing research in safety culture. And, in fact, in the paper, the attachment page four, we very clearly say that there was Commission direction --

MR. ECKENRODE: Yes.

MR. ROSENTHAL: -- in 1998, that we not do research, And we are following the Commission.

MR. BARTON: So you are doing work on safety culture without research.

MR. ROSENTHAL: We are not spending money doing research. We're following what's going on overseas. And if we believe that we have to pursue it, we will not -- we're not going to go around it. We would go back to the Commission.

MR. BARTON: Sure.

MR. ROSENTHAL: I just needed that on the transcript.

MR. APOSTOLAKIS: I guess the questions in front of us are three questions which I will pose to the members.

First question is: What is your overall assessment of what we heard today? The second is: What should we present to the full Committee at the April meeting, or have the staff present, because clearly we cannot have all the four hours of presentation?

And the last one is whether we should write the letter.

So, who wants to go first? Dana, are you ready?

MR. POWERS: Yes, I guess I will comment a little bit. His first question addresses what should be presented, and the only thing that I am not sure about is: What are we going to write a letter on? I have a feeling that the only thing that is useful to present to the full committee is the material that Jack and, at the end, J. Persensky --

MR. BARTON: Initial package of slides?

MR. POWERS: Yes, the initial package of slides. Most of the other material, I think, was educational for the subcommittee, but I am not sure that I want to belabor the entire committee with that.

MR. BONACA: How much time do we have, by the way?

PARTICIPANT: One hour.

MR. BONACA: One hour, okay.

PARTICIPANT: That might not be enough for all of these slides.

MR. POWERS: Yes, they may need some pruning and what not, but I think we are going to have to understand -- the Committee as a whole is going to have to understand what to write a letter about.

The disappointments that I have in what was presented here is it boils down to what I didn't see. I see the Commission launching a new effort for planned assessment and inspection in which they have stated, "Yes, there are these cross-cutting issues, some of which involve human performance."

And they have assumed that the set of PIs and baseline inspections that they have will reveal any degradation of human performance fast enough that corrections can be made before that degradation becomes catastrophic. And that is fine. I mean, you have to make assumptions on something here.

But when you make an assumption that profound, I think that there should be launched an immediate effort to go out and see if you validate that assumption. And I just did not see anything in here that was directed into that effort.

MR. APOSTOLAKIS: Except the last presentation of this.

MR. BARTON: David Tremble's presentation.

MR. APOSTOLAKIS: One or the other.

MR. POWERS: Look, this is a profound assumption that they are making. They have got kind of a pilot program going on that goes on way too short of a time to validate that assumption. I think you have got to get on that. And if that is wrong, it has some real ramifications on the new inspection process.

The other thing that I think you have asked for a lot, is we did not see someone standing up here and saying, "What this agency needs is the capability to do PRAs with this accuracy. And to do that, we have to be able to do the human reliability and human error analysis to this accuracy."

What I think I learned today was that that was too simplistic of a question for us to pose. It is more complicated than that. And I appreciate that information, but I think that core need is not only what the Committee is missing, but what the Commission is missing.

Somebody is saying, "I have got to be able to do my human error analysis this accurately, or this well, or cover these kinds of topics. And I cannot do that now. And I can do that if I do this kind of research."

And I just do not see that kind of clear indication of what it is that the Commission should be supporting to carry out its mission as it is stated in its strategic plan, and intimated in a lot of its actions. I guess those are my two comments.

MR. APOSTOLAKIS: Are you in favor of writing a letter?

MR. POWERS: I am not wild about writing a letter that is negative. And if I can re-examine the material and come back supportive, then yes, I want to write a letter. But, if I have to write a letter that says, "Gee, I think there is something that is really missing here," I do not want to write that.

MR. APOSTOLAKIS: Okay.

MR. BONACA: I am in favor of writing a letter mostly because there is a program. I share your perspective, but I think that the program has the right elements and the right applications. I think we have to say that.

One thing that strikes me, however, is we have a report from INEEL, and I hope that some of the information is provided in the early presentation that tells us -- what we really probably knew from reading LERs and things like this -- how dominant is human performance on vulnerability and initiators, too.

And yet, we are still focusing entirely on equipment in our program now. Let me go just a step further. Let me give you an example of what I mean by that.

When we look at the oversight process, we are going to count the number of initiating events, or initiators. We are going to look at the mitigating system failures. Now the licensees go a step beyond that. They have root causes, and they identify where there is human failure that is causing, in fact, the mitigating system failure.

Why could we not ask the licensees to provide this information and to be the beginning of a human reliability assessment? Again, if you do not count necessarily, and you do not assign a number in the PI, there is information out there that could be derived even through the assessment process right now, rather than stopping simply at a headcount, you know, three trips, X number of mitigating system failure?

This information is right there. The licensees evaluate them through the system. And we could have immediately some feedback to the human reliability. And let us not call it, you know, culture because culture is something a little more vast and vague, and so let us --

MR. APOSTOLAKIS: Well, what is it the licensees should provide, the --

MR. BARTON: HPES Data, I think that is what they called it.

PARTICIPANT: HPES, Human Performance Evaluation System.

MR. BONACA: For the number of failures that they provide. I mean, just as an example, George, that I would like to maybe give in the letter, is there is information here that is at our fingertips.

We can get it, and better ways exist, but it still is not reflected in the regulation, in the processes. And I think that, you know, there are ways in which it can become available and used even in the short term.

On the significant examination process, I need to ask a question of whether or not that is going to be risk informed. And if it is, still the issue we will have to address is: Are we going to look only the individual events, or are we going to look at processes and how they are affected by repeats of the same? Again, it is an indication of human performance.

Again, going back, I would recommend that -- I would lean towards having a letter and trying to bring in some thoughts about how to use the information that is at our fingertips and has not been sufficiently utilized.

I will add just one more thing. We have now a presentation also, coming to us on a different subject which has to do with the risk based analysis on reactor performance. It is another area where we made the same comments in December that it is a wealth of information. Okay? Data, actual data, that has not been sufficiently utilized, advertised, and distributed.

MR. APOSTOLAKIS: I thought the last letter, also, on the oversight process made a good point.

MR. BONACA: I wonder if we should -- we could maybe --

MR. BARTON: Tie it together?

MR. BONACA: Tie them together.

MR. APOSTOLAKIS: Okay. You agree, I assume, with Dana's suggestion that you guys, Jack and J., presented here, with some pruning, should be okay.

MR. DUDLEY: I thought I also heard a recommendation that there be at least the results of the INEEL.

MR. BARTON: Yes, but I thought there were.

MR. APOSTOLAKIS: To what, present them?

MR. DUDLEY: Yes.

MR. APOSTOLAKIS: INEEL has not finished -- has not finished. It's not finished. Maybe we could insert a couple of --

PARTICIPANT: Have two summary slides and just --

PARTICIPANT: A summary --

MR. APOSTOLAKIS: And I do not know whether you want these guys here. It is up to you. We do not interfere in management decisions.

[Laughter.]

MR. DUDLEY: Well stated, George.

MR. APOSTOLAKIS: Mr. Sieber.

MR. SIEBER: Right off the bat, I agree with Dr. Powers and Dr. Bonaca that we ought to have a presentation. It ought to concentrate on Jack's information.

The thought that comes to mind is that none of this is new. This Human Performance Evaluation System was around at least 15 years or maybe more, and it came about because people when they looked at LERs, saw the trend away from design deficiencies, and equipment failures causing events at plants to the point where at least half of them were caused by human performance failures.

And that is why the number 50 percent feels comfortable to me because I have seen that number different places. Now to me, that is risk significant, and to do very little in the way of evaluating the risk of human performance problems for doing something to regulate human performance and behavior, I think ignores some responsibility that the NRC has toward protecting the public health and safety.

And perhaps there is a way to weave that kind of a thought into the introduction to a letter. But to me, I think that is an impressive number, and I think something needs to be done, but you cannot do anything until you quantify it. You cannot quantify it until you have the analysis technique, and the PRA to do it. And you have to build that on some kind of a base.

And Dr. Bonaca's idea, I think, is a pretty good one, provided the licensees will give it to you. And if you cannot get it, it will be very difficult for the staff to get that on their own. And so, when I would write a letter, I would write it to bring that thought forward, that there is a significant risk.

And the Human Performance Research and tool development ought to continue because it is probably almost as significant as the other causes of events in the power plants.

MR. BONACA: Also, the 50 percent which is human performance regulation, are most insidious because they come from true random events that may happen out there.

I mean, the others which are equipment related, you really have an understanding coming from experience and sort of -- those kind of career performance are totally insidious because you do not know what happened. Did somebody do something absolutely unexpected? And here you have a failure.

MR. SIEBER: Okay. So my letter really would be positive and supportive of continuing efforts. In fact, expanding those in light of the risk contribution that this makes.

MR. APOSTOLAKIS: Mr. Barton.

MR. BARTON: Yes, Dr. Apostolakis.

MR. APOSTOLAKIS: I am ready to take notes.

MR. BARTON: Well, I think we got -- we've dumped a lot of data today. I thought that the overall presentations were very well done, and well thought out, and a lot of data, having to sort all of that out just to -- you know, what I think we would like to hear.

Dana's made it clear of what we want to hear in the April meeting. I would add one thing to it. I think some of the criticism we have had on the oversight process and the SDP, I think what I would like to hear in addition to Jack and J.'s slides is some more on the planned activities, the NRR's activities in human performance and getting the inspection procedure out, and tested, and when all that might happen. I think that is key to getting that up and working in the new oversight process.

What I would like to see in the letter: I have not made up my mind whether it is a negative or a positive.

So I am kind of neutral on the letter, but I think we need -- I would say write a letter based on -- you have got input from three people on what might be included.

And I would add to that the need to stress the work that is going on in safety culture, even though nobody likes to hear it, and does not want to spend research on it, I think we have to keep prodding that and saying we think it is important, and why it is important.

MR. POWER: I wonder if we would be wasting our powder on that rather than waiting until our senior fellow comes back with his report on safety and culture.

MR. APOSTOLAKIS: I wanted to raise that issue. I will raise it in the morning.

Anything else, John?

MR. BARTON: Yes, I guess the other uneasiness I have is I heard so much, but I do not know what kind of product I get when --

MR. APOSTOLAKIS: Closure.

MR. BARTON: Closure, yes.

MR. SIEBER: I think there is something new happening in this area all the time. It is almost like saying --

MR. POWERS: Yes, but you can still use that --

MR. SIEBER: The regulations are refined enough.

We do not need to --

PARTICIPANT: But human performance --

PARTICIPANT: That's right.

PARTICIPANT: It's --

MR. POWERS: When is something going to come out that the licensees can use or agency can use?

MR. SIEBER: Well, we ought to define what closure is.

MR. POWERS: I think what I really learned today is, and why it was useful to sit in here, I conceived of having a nice crisp package that says, okay, "Here is a tool you can use. It is up to date."

And I guess I have learned that it's really a lot more complicated than that. And it requires more thought on that.

But on the other hand, I did not see that thought coming through that said, "Okay. Here is the package. We are going to give them to you," that takes into account all of this --

MR. APOSTOLAKIS: Maybe Jack can address that when --

MR. POWERS: Now maybe the situation is what J. said at the last, is they have got this tidal wave coming in at them, and maybe they have not sorted it out. And if that is the case, then I am reluctant to write a letter until they have had a chance to sort it out.

MR. APOSTOLAKIS: Okay. John.

MR. BARTON: That is it.

MR. APOSTOLAKIS: Well, I wanted to raise the issue of sorts of work that Dana started talking about. It seems to me that what we have here is two issues that perhaps we should keep separate.

I think we need to really send a strong message to the Commission that neglecting this safety culture issue, with all that it entails, is really a major oversight, a little bit like -- I think Jack Sieber used that word.

And I am not sure that this is the right forum -- the right opportunity for us to do this because this will overwhelm the program that the staff has entered today.

Now I understand that, Jack, you are scheduled to make a presentation to the Committee sometime in the next two or three months.

MR. SORENSEN: I am not aware of the schedule.

MR. APOSTOLAKIS: Well, maybe we as a subcommittee can recommend that we move up --

MR. POWERS: You as the person in charge of activities, the fellow, can make all the recommendations you want.

[Laughter.]

MR. APOSTOLAKIS: A recommendation will be forthcoming.

[Laughter.]

MR. APOSTOLAKIS: But I would really keep the two separate. I would propose that we write the letter now, that touches a little bit on the safety culture issue that says we will address it in the next two months or something, in a more detailed fashion, and focus on the program that the staff presented today.

And given our previous letters, I would be positive with some recommendations for improvements, because I am positive. I do think that the staff now is on top of things.

You can always ask, "When am I going to get the product?" Well, fine. That is a suggestion to them to work on and improve the thing. This is a monumental effort here. Surely, we did not expect them to come with a perfect product today, but I do want to be positive and encouraging. I think they need it.

And I leave the ground attack on safety culture and so on for a separate letter so that this will not be overwhelmed.

Now, in a series of suggestions I say would be very reasonable to make and you already gave me several, and I am sure that others will come up as we discuss the letter.

But I think the overall approach -- let us not lose sight of the fact that I think today I did not see anyone getting upset in four hours. I did not see anyone dismissing what was being presented, unlike other times.

So it seems to me that the staff finally has gotten a plan that -- with some improvements, will lead somewhere. And I agree with Jack, I mean, we should stop doing this every six months. I mean, they can use the resources doing something else.

MR. BONACA: The other thing I would like to point out: We can say something about human reliability without saying something about safety culture.

Safety culture is pretty more undefined right now, and complex issue that invokes -- involves all kinds of other things, and that is why probably the Commission is reluctant to tackle it, because it really has not been defined. It involves all kinds of management considerations, cost consideration.

Human reliability, per se, is purely one of the root causes of failures out there. And so we can address it in the context, recognizing it brings a lot of other information coming, it is very valuable. It is a great effort, and should be continued, and it may lead to improvements in the oversight system.

MR. APOSTOLAKIS: I would not be completely silent on the safety culture because it seems to me you --

MR. BONACA: No, I am not saying to be silent. All I am saying is that you do not have to make such a leap from what we heard today about --

MR. POWERS: What I think we will be able to do that the Commission probably has never seen is when a fellow comes back and reports, we are going to be able to see a couple of things, I think.

I do not want to prejudge his report, though I have read the draft version of it. It looks like we are going to be able to see that it is possible to quantify the effects of safety culture, and that the data exists out there. And I think that is something that I do not think that the Commission really has been apprized of well, that it is not in a more feel-good type of field in its entirety.

There is a strong element of that, but there are some guys that have actually tried to quantify things and see correlations.

The other thing is I think we are going to be able to tell them there is an optimum in the regulation of safety culture, that there is clear-cut evidence that if you over-regulate, safety cultures decay. As you drop back in the regulation, safety cultures improve. I think that is a concept that was certainly new to me.

And I guess I share with Jack, that it is a suggestion right now, maybe not definitively provable, but it looks very plausible. And it would be one that would be interesting to pursue.

MR. APOSTOLAKIS: But you are not suggesting that they do that.

MR. POWERS: No, no. I think we have to wait. That is why I do not want to cue our shot. I would like to go in there full force on this thing because I share with you this uneasiness when I see the whole world looking at safety culture, and this stands at the poll for reasons that I think are largely nomenclature.

MR. APOSTOLAKIS: And misunderstanding of what we are talking about.

PARTICIPANT: Yes.

MR. APOSTOLAKIS: I think that one of the speakers -- and I do not remember who it was -- the issue of safety management is not attractive in our business in this country, the attention it deserves as it has in another countries. We are still too much hardware oriented.

And I see it again with DOE announcements, with NERI, the Nuclear Energy Research Initiative, and so on, where there were some hints by some workers that maybe we should look at management of safety and so on. No; the answer was a resounding no.

Develop new designs, that is how you are going to convince the public that nuclear power is safe. So there is an intrinsic mind-set there which I think we should start attacking because I think it is not right.

So we can wait on that one until our senior fellow stands up there in defense of this.

I think I got all the information I need and the input from you. We will have a presentation by Jack and whoever else he wants, and J., with some maybe cutting out a few of the views you have now, but adding others as you see fit, especially from INEEL, and then maybe summarize our discussions today to the full Committee. And I will then draft a letter and come with a draft in April. Okay.

Yes, J.

MR. PERSENSKY: George, I asked you to put off your specific comments on the Commission paper earlier today.

MR. APOSTOLAKIS: On the Commission paper.

MR. PERSENSKY: Yes, you said that you --

MR. APOSTOLAKIS: Yes, I am so tired now.

MR. PERSENSKY: Okay. Well, it worked --

[Laughter.]

MR. APOSTOLAKIS: I am really -- I will tell you, on page two -- on -- which page two is this, because there are two page twos? Page two of the Human Performance Program. If I had to prioritize my concerns, the second full paragraph that says, "Sensitivity studies also found" --

MR. PERSENSKY: Yes.

MR. APOSTOLAKIS: I do not like the sensitivity studies. I mean to say that, you know, small changes in the human error probability, factors of three to ten times, that small? And on what basis?

I mean, we are trying to get away from these other various sensitivity studies. And then it says, "Changes in AGPs, 29 times up or down." Now why would anyone change the AGP 29 times up or down to see what the input is on the CDF?

And I want to know how many in the room think that there would not be a significant impact on the CDF if you change the human error probability 29 times? I think this product does not do justice to the rest of the program. It is arbitrary.

And maybe you can rephrase it a little bit to say the sensitivity studies -- but my goodness, 29 times without any explanation?

And then another one I had was on page four, just the short paragraph above the new heading, "Based on permission and direction, there is currently no research being done." If evidence is starting to suggest that the agency should more specifically address safety culture, the staff should bring the issue to the Commission for action. When I read that, I stopped. I mean the previous two pages supplied evidence.

So I do not know. I mean, this "if evidence is found," it seems to me that you have just found it. Now -- and you may want to state it that way for your own reasons. Other than that --

PARTICIPANT: Notwithstanding the evidence found.

[Laughter.]

MR. APOSTOLAKIS: Okay. Thank you all for coming, presenters; members, of course. We are adjourned.

[Whereupon, at 5:40 o'clock, p.m., the subcommittee meeting was concluded.]

REPORTER'S CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

NAME OF PROCEEDING: MEETING: HUMAN FACTORS

CASE NUMBER:

PLACE OF PROCEEDING: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Jeannie Rivers

Official Reporter

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