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NUCLEAR REGULATORY COMMISSION

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SYSTEMS INTERACTION
PUBLIC MEETING

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BRIEFING ON

SYSTEMS INTERACTIONS

PUBLIC MEETING

Nuclear Regulatory Commission
Room 1030
1717 H Street, N.W.
Washington, D.C.

Monday, April 18, 1983

The Commission convened, pursuant to notice, at 2:05 p.m.

COMMISSIONERS PRESENT:

NUNZIO PALLADINO, Chairman of the Commission
VICTOR GILINSKY, Commissioner
JOHN AHEARNE, Commissioner
THOMAS ROBERTS, Commissioner
JAMES ASSELSTINE, Commissioner

STAFF AND PRESENTERS SEATED AT COMMISSION TABLE:

S. CHILK
T. FITZGERALD
A. THADANI
F. COFFMAN
T. SPEIS
H. DENTON
A. KENNEKE

AUDIENCE SPEAKERS:

J. HELTEMES

* * *

DISCLAIMER

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P R O C E E D I N G S

(2:05 p.m.)

CHAIRMAN PALLADINO: Well, why don't we start.

Good afternoon, ladies and gentlemen. The Commission is meeting with the staff today to discuss systems interaction. The subject was identified in 1978 as an unresolved safety issue, commonly known as a USI, with the Task Action Plan Number A-17.

Systems interaction was also identified as an issue requiring resolution in the TMI Action Plan NUREG-0660. Because we have had little dialogue with the staff on this matter recently, we have asked that the staff provide us with a status report.

It is my understanding that the staff is also prepared to discuss USI A-17 as it relates to other ongoing programs.

I would like to point out that the intent of today's meeting is to discuss the generic subject of systems interaction and that we should avoid discussing any specific cases. However, the general counsel advises that he will review the transcript following the meeting. If anything in our conversation impinges upon our Ex Parte rule, then the transcript can be served on the parties to a specific proceeding with an opportunity to comment.

Before we begin, do any of my fellow

Commissioners have any additional remarks?

(No response.)

CHAIRMAN PALLADINO: If not, then I will turn the meeting over to Mr. Denton.

MR. DENTON: Thank you, Mr. Chairman.

The presentation today will be made by Themi Speis, Frank Coffman, and Ashok Thadani, who worked on this issue for a number of years.

Before I begin, I did want to point out that this subject is also the subject of a differing professional opinion. This DOP is being handled in accordance with the Commission's practices; namely, Chapter 41.25. And the Commission will eventually have an opportunity to review the disposition of that.

I didn't intend to go into the details of that today unless the Commission so desired.

Also, as you mentioned, the issue is subject to adjudication in at least one proceeding. We intended to stay away from any specific plant application today and just discuss the generic nature of the proceeding.

So with that introduction, let me turn it over to Themi Speis.

MR. SPEIS: Thank you.

Mr. Chairman, Mr. Commissioners, the presentation today will consist of two parts. One of them I

have named "Introduction and Background," and the other one will get into the essence of the program itself. Frank Coffman will present the second part.

In addition to Ashok Thadani, we have with us Frank Rowsome, the assistant director for technology, who will participate if there is a need. He is sitting back here.

May I have viewgraph number 2, please?

(Slide)

In the introduction and background I would like to go through a definition of what we mean by systems interaction, give some examples of the type of interactions we are talking about, and say something about our focus on this issue and why we think there is a need for systems interaction analysis, and also provide a summary of how we are treating systems interaction in the review process at present; that is, in this kind of review process, to the extent that it has been treated.

May I have viewgraph number 3, please?

(Slide)

It would be appropriate to start the presentation by trying to give a definition of what we mean by systems interaction.

I have seen a large number of reports and documents, and not all of them have provided the same

definition. So I will try to treat one of them.

Usually, the phrase "systems interaction" denotes the types of events that could occur or have been experienced where an intersystems dependency could negate or seriously degrade the designed action of a safety-related system.

To amplify on this definition, I have provided a number of examples. You see the first one, a failed power supply which can cause a spurious signal tothe control system which, in turn, can open relief valves, leading to a loss-of-coolant, a small LOCA.

Such a thing has happened, for example, in the Crystal River 3 reactor a few years ago where the power supply was lost to the integrated control system, and the system thought it was under high pressure and then the valves opened up and they couldn't close, and finally you had a small loss-of-coolant accident.

Another example that I provided was similarly a failed power supply which could result in failure of control instrumentation leading to a transient and resulting in reactor scram. I think a similar type of event has taken place in Oconee a few years back.

I can add to those two by assuming the initiating event to be the same; for example, you can lose power supply, which could lead to loss of normal feedwater.

Or you can disable the control valve, the feedwater control valve, by something happening to the air, for example, control air.

Another thing I have listed under example 3 was the things that happened at the Browns Ferry 3, the partial failure to scram event, where both the vent and the drain system were connected to a common discharge and that failure led to the partial failure to scram in Browns Ferry.

Another classic example could be the failure of a turbine, which could generate a missile, which, in turn, could damage some safety-related system.

(Whereupon, Commissioner Gilinsky arrived at the meeting.)

COMMISSIONER AHEARNE: Could I ask a sort of a lead-in general question?

MR. SPEIS: Yes.

COMMISSIONER AHEARNE: In trying to keep track of the various bins into which we put tend to put equipment -- safety-related, important to safety, and then all others -- in the system interaction program that you have, is there any necessary including of more than one of those categories?

Another way of asking the question is: Does the system interaction phenomenon necessarily involve both

systems that are safety related and beyond that; for example, systems important to safety but not safety related?

MR. SPEIS: Yes, let me address, that. The program at present is focusing on the systems which are safety related, and the systems which are safety related are defined in Appendix A to Part 100. And we're talking about making sure that the primary boundaries are --

COMMISSIONER AHEARNE: Yes, I am familiar with Harold's definition.

MR. SPEIS: Okay. So it is focused on that. But the program itself, of course, tries to assess what if a non-safety-related system fails and what type of effect it would have on a safety-related system. Did I address your question?

COMMISSIONER AHEARNE: Well, in the middle there I thought you were saying that the program itself concentrates on safety-related systems --

MR. SPEIS: To make sure that --

COMMISSIONER AHEARNE: -- and many of the examples you've given are ones in which the significant to safety system was the tree-ring event.

MR. SPEIS: The important thing is to make sure that these other things that I have talked about don't affect the functioning of the safety-related systems. That

is the focus of the program.

COMMISSIONER AHEARNE: That is the final concern, obviously. But whatever screening technique that you develop, will you be, by requirement, looking at more than safety-related systems?

MR. SPEIS: Can you --

MR. THADANI: Yes, let me address that, Commissioner Ahearne. The program looks at sources and targets where the faults could initiate and propagate through. And the intent of the program is indeed to look at the so-called systems which are not called safety related but nevertheless they are indeed important to safety because of consequential effects that might result.

So the program doesn't -- --

COMMISSIONER AHEARNE: The sources then would include the systems that have safety significance but are not necessarily safety related.

MR. THADANI: That is correct, yes.

COMMISSIONER GILINSKY: Could I ask you, is this a new name for something we've been doing for a long time or does this involve a qualitatively different look at the subject, a deeper look or more sophisticated look?

MR. SPEIS: I would say that we are trying to make a more sophisticated look. The question is -- originally, I guess, the ACRS brought it up a long time ago

-- was how good was our review process, the SRP where systems and components are being looked at separately by people who are either civil engineers or electrical engineers or mechanical engineers; is there any way that we can in a more structured and methodical way come to the problem are there any interdependencies or any interactions that take place between these systems that are being looked at by different disciplines to make sure that no common cause or other other interdependencies affect the functioning of these systems?

So we are trying to come up with some more structured method in addition to what we already do in the Standard Review Plan.

COMMISSIONER AHEARNE: And what does that greater degree of structure consist of?

MR. DENTON: Well, we will get there.

MR. SPEIS: We will discuss the methodology. We will discuss the methodology in great detail.

MR. DENTON: There are several techniques that are under evaluation in that whole process that Themi will describe.

MR. SPEIS: We will describe those.

CHAIRMAN PALLADINO: So you are looking at a program that can identify some of the things similar to those that you used as examples, because some of the

examples have been addressed; for example, turbine missiles.

MR. SPEIS: Yes, but --

MR. DENTON: But once we find either from experience or some other mechanism a potential interaction, like fires or equipment qualification or flooding of a compartment, then they are usually dealt with in the Standard Review Plan today. So what this program is is to find those interdependencies that we don't yet know about and see if they need to be dealt with in a similar fashion.

MR. SPEIS: I will show you a list later on of the sections in the Standard Review Plan that addresses what we have learned, what we think we know we can cope with. But as Harold said, you know, we are searching for something beyond what we already know.

The next viewgraph, please, number 4.

(Slide)

Specifically, there are three types of systems interactions of interest to us: There are: functionally coupled, spatially coupled, and humanly coupled systems interactions. This viewgraph tries to define what we mean by those three things.

The functionally coupled systems interactions resulting either from the sharing of components between systems or through physical connections between systems,

including electrical, hydraulic, pneumatic, and mechanical.

The spatially coupled systems interactions result from the proximity of systems to one another within the plant. We're talking here about dependencies coupled by shared environment, environmental conditions. A classic example, for example, is the Browns Ferry fire, which resulted in closure of main steam isolation valves and hindred the supply of the makeup cooling water system for decay heat removal.

The induced-humanly coupled systems interactions were plant malfunction or an error in written procedures induces an operator action. Earlier I talked about the Crystal River 3 event, where it was, one would say, a functionally coupled interaction, but there humanly coupled aspects to it. If you recall, the operator was trying, attempting to balance the high-pressure injection system. He was following procedures correctly, but he was not aware that --

COMMISSIONER AHEARNE: Instruments were --

MR. SPEIS: -- the influence -- midway, that's right, yes.

COMMISSIONER GILINSKY: Where was this?

COMMISSIONER AHEARNE: Crystal River.

MR. SPEIS: Crystal River 3.

COMMISSIONER AHEARNE: Remember, the instrumentation went out and instruments failed at midpoint.

MR. SPEIS: So there was the possibility that because of that false indication, he could have taken incorrect action, but at the same time, as I say, he was following procedures.

Next viewgraph, please.

(Slide)

This is kind of a -- it's upside down.

(Laughter)

With this viewgraph, I have --

COMMISSIONER AHEARNE: Human error there.

MR. SPEIS: Yes.

(Laughter)

I have attempted to focus the area where the systems interactions program is concentrating. We are talking about how to get to the dependent faults in a more structured way. And the dependent faults have been further declassified into the functionally, humanly, and spatially ones.

If you use this diagram here, and by having the dependent faults and the independent faults, and if you add human errors and if you add the quantitative system unavailability, then you are talking about a PRA, assuming

that the PRA is able to handle all these things in a correct manner. But the --

COMMISSIONER GILINSKY: Are you talking about something more than common-mode failures or any other complicated kind?

MR. SPEIS: Well, I think many people have called systems interaction common-cause failures. I think I am talking about the same thing. Am I?

MR. THADANI: Pretty much. It is essentially dependency analyses with some additional aspects of the humanly induced failures, which are sort of not traditionally considered dependency analyses, but it's pretty much --

COMMISSIONER GILINSKY: What about errors induced by common and incorrect maintenance, is that something that would fall within this scope?

MR. SPEIS: Well, I guess that will come into the human, into the human element.

COMMISSIONER GILINSKY: But would you include that within your analysis?

MR. SPEIS: I guess at present the people who come up forward with numbers -- let me go back. When you do a PRA, you try the best way you can to assign or to understand the behavior of human beings. Okay. And again, to the best of our knowledge, based on experience and so

forth, they try to provide a number that supposedly has taken into account these type of things.

I don't think this program per se will be able to come up with such detailed structure that you can put all these things into a program; for example, what happened at Salem, you know, you're going to -- I don't think we're going to be able to come up with a myriad of trees where we're going to say, you know, have the breakers been lubricated or have they been properly maintained.

But in general, you know, things of that sort will enter the --

COMMISSIONER GILINSKY: Well, let me, since you bring up Salem, you've got two breakers that are physically very close to each other, they're maintained in common, there is some electrical connection. Is that something that is a potential subject for further study or not?

MR. SPEIS: Well, I would --

COMMISSIONER GILINSKY: Or are you looking at more complicated systems?

MR. SPEIS: I think it goes beyond. If there is proximity, then you would postulate certain hazards and determine if those hazards could indeed affect more than one component; in this case, perhaps two breakers. But the program would not, I don't believe, get into the maintenance-related activities.

CHAIRMAN PALLADINO: Aren't those humanly coupled type? If somebody does the wrong maintenance, that's a human intrusion into the system.

MR. THADANI: Yes, yes, you're absolutely correct. But the program scope is somewhat limited, in that it would only look at those humanly induced failures which result from failures in control or other systems which result in loss of some instrumentation in the control room; that is, the operator has less information available to him now, and on the basis of the information available to him, he follows through on certain procedures which may or may not be the correct way to go.

MR. DENTON: It is not focused towards solving those kinds of problems. It's more, at least I see it, assuming that the equipment works properly is maybe another way to say it. Except for interactions that people didn't know about, maybe losing instrument air might cause several effects that had not been properly examined. So it's an attempt to make sure that propagating functional dependencies are fully carried out, and maybe spatial issues are carried out.

We have seen a few cases where ladders or space heaters may fall and impinge on cable trays or other safety-related equipment. And then we're thinking about the human-coupled one, but I don't know that we will be able to

develop any algorithms or any way to zero in on the most likely cause of any particular plant.

COMMISSIONER AHEARNE: Is the human-coupled one restricted to operators?

MR. THADANI: Yes, it is.

MR. SPEIS: The next viewgraph --

(Slide)

-- kind of reiterates what has already been said. The need for the program, again, the operating reactor experience has revealed the unpredicted dependencies that we have provided tne examples already. I have talked about those three examples.

I already said about the compartmentalized approach that has been followed in the review, and we want to make sure that some more systematic way is found to make sure that no gross or interdependencies have been overlooked.

I guess the ACRS has been a strong proponent of this program from -- they started talking about it back in '74. I have asked Frank and Ashok why was the program formalized in '78. I am not so sure I have gotten a good answer. Maybe he will help --

COMMISSIONER AHEARNE: Well, I think --

MR. SPEIS: -- with what happened between '74 and '78.

COMMISSIONER AHEARNE: -- you might, when you say it has been a strong proponent of systems interactions studies since '74, you might go on to say and they also have been a very strong critic of the NRC's programs, or lack of programs, in this area over these years, too.

MR. SPEIS: Yes. I would also like to say that when the program was initiated back in 1978, Sandia was hired to help put together an interim approach on how to get to the problem, and we used Watts Bar as a test case. When the results came forth back in 1980, the ACRS wasn't too happy with the results and the conclusions. And that --

COMMISSIONER AHEARNE: Nor was the staff either, was it?

MR. SPEIS: Well, neither the staff, both the ACRS and the staff, and maybe Ashok can provide more insight. But I know that because of that then, a more rigorous effort was undertaken to look into a number of matters in addition to the one that Sandia had used at that time.

MR. DENTON: And let me point out, the ACRS was not able to advocate a specific methodology. It's like the staff should improve its knowledge of the earthquake predictions. You know, a very difficult task.

And we set out to find people who might lead us in this way. We thought we had a solution back in the Watts

Bar time, and that didn't pan out, so we're continuing the search for these methods.

And I think we in the ACRS both have been dissatisfied with progress, but you can't force the science to jump out with a methodology just by pushing. But we have continued to push on it. And I guess we have a few candidates now that we're exploring.

MR. SPEIS: We will talk about that.

The next viewgraph, 7 --

(Slide)

-- shows how we treat systems interactions within the present system, NUREG-0800. We believe that the potential occurrence of any significant systems interaction is minimized because of the current licensing requirements and procedures which are utilized in the review process.

COMMISSIONER AHEARNE: Could you speak to, for example, how does the SRP handle systems interaction under environmental qualification?

MR. THADANI: Do you want to discuss that?

MR. DENTON: Well, I think the short answer would be the EQ rules have tended to minimize systems interaction, just like the fire rule would minimize fire or sabotage, by prescribing certain actions to be taken that are intended to get at that cause of dependency.

COMMISSIONER AHEARNE: Well, but I thought the

primary focus of the EQ rule was to look at a range of systems broader than safety related but still in the range of systems, and to demonstrate by a variety of mechanisms that they could withstand the environmental effects.

And I don't recall much on if they in that process have some degradation but still within the acceptable range for the individual system performing, I don't recall any focus on what is now the effect of that degradation on other systems.

MR. DENTON: Well, I guess I was answering in a sense in looking at EQ we look at temperatures and pressures and radiation levels in a given compartment --

COMMISSIONER AHEARNE: Right.

MR. DENTON: -- and make sure that the equipment that's in there is qualified for that condition. So in a sense, if there is a pipe break that causes those environmental conditions, that's a possible system interaction, the equipment should be qualified for that type of pipe break.

MR. THADANI: Yes. I think in fact, Harold, I think that's a good example. In various reviews in the Standard Review Plan, high-energy line break or moderate-energy line break and so on, one postulates certain breaks and then goes about making assessments in terms of what else could fail as a result of that

postulate.

The process one goes through is to collect a team of people with certain disciplines and perform walkthrougns in tnose areas where one would postulate such breaks. That is indeed an ingredient of a systems interaction.

COMMISSIONER AHEARNE: Yes.

CHAIRMAN PALLADINO: Looking at some of these items on the list, they seem to be examples of common modes of failure, earthquake, fire, flooding, high-energy line breaks. This is your current approach then, I gather, to systems interaction?

MR. SPEIS: It is presently viewed --

MR. THADANI: To add to that, that is indeed the case for spatial interactions, and then one would also be concerned with functional interactions, control system failures which could --

CHAIRMAN PALLADINO: Well, when you get down to reactor protection systems and safety shutdown systems, those might have functional interactions.

MR. THADANI: Yes.

COMMISSIONER AHEARNE: But there you also, though I thought a lot of the systems interaction piece of that is under the A-47 unresolved safety issue.

MR. THADANI: That's from dynamic effects, yes.

MR. SPEIS: We will say something more about this later on, why we think A-47 is kind of a subset in some ways of A-17.

I think it would be more fruitful to go through the program itself.

COMMISSIONER AHEARNE: Well, wait a minute. Let's talk about your last comment there, though. When you say that current requirements, present results of the current requirements appear adequate pending completeion of the program, what results are you speaking about?

MR. SPEIS: Frank, can you respond to that?

MR. COFFMAN: Historically, I guess we could begin with Phase I results, which was --

COMMISSIONER AHEARNE: Phase I of?

MR. SPEIS: Systems interactions.

MR. COFFMAN: Of the systems interaction program, which was completed about April of 1980.

COMMISSIONER AHEARNE: Is that the Sandia study?

MR. COFFMAN: That's the Sandia study of Watts Bar using fault tree analysis.

COMMISSIONER AHEARNE: But I thought Themi just said that the ACRS had expressed great dissatisfaction with that, and I thought that the staff also was dissatisfied with that study. So are you saying that -- it sounds like that they proposed an approach with which the staff was

dissatisfied, and I am not sure whether that is a result -- which then chose the present approach as adequate.

MR. DENTON: I think you have to look at it the other way. That was an attempt to get at it. It didn't show that all the people weren't satisfied with it; neither did it show a lot of contributions to risk from the neglect of these areas. I think that's all Frank is saying about it is that, well, that was one effort to get at it and it didn't show --

COMMISSIONER AHEARNE: Well, just to make sure, if I could, so that I don't misunderstand. I thought the conclusion out of that Phase I effort was that that approach wasn't very useful. Is that incorrect?

MR. COFFMAN: There were two conclusions at the end of Phase I: one made by Sandia and apparently supported by the staff, or the evidence in the documents that we have, supported by the staff, is that Watts Bar was "well protected against interactions." So there was no adverse safety at Watts Bar because of systems interaction.

The other conclusion was the dissatisfaction with the methodology. It used fault trees, and it became evident that it was deficient in three areas: one, it was inscrutable, it was -- not inscrutable -- it would be difficult to read a broadly scoped fault tree analysis of a plant. So if you'd extend the scope, you'd have that

problem.

It at the time pushed the limit of present computer capabilities to in fact manipulate, using Boulean algebra, manipulate the fault tree.

And thirdly, there was a more vague dissatisfaction in that it did not identify some events, selected events of interest to the ACRS.

COMMISSIONER AHEARNE: Such as?

MR. COFFMAN: I am not sure I can recall them. The staff did address them separately in a letter in September, I think it was, September of '81. But I cannot recall them.

MR. DENTON: I have no doubt it failed to predict the next LER, you know, that kind of --

COMMISSIONER AHEARNE: It predicted it, the lat one.

(Laughter)

CHAIRMAN PALLADINO: Which one did it fail?

MR. DENTON: I wasn't trying to be humorous. I don't know which one it failed now.

MR. SPEIS: Whichever.

MR. THADANI: May I just respond to part of your comment? The judgment is that the current requirements are adequate. That judgment derives partially from the early work that was done in the systems interaction, but largely derives from the upgrading that has been made in the Standard Review Plans in the last several years, I would think in the last 4 or 5 years.

Frank, in this slide, listed a number of sections which require a fair amount of what I would call systems interactions studies being done. Beyond that, there have been a number of bulletins that have gone out as a result of some of the events that we have experienced. And the fact that this USI is exploratory in nature, sort of these factors combined to lead us to a judgment that these requirements are adequate.

It may be that after we get done applying these comprehensive techniques we will find out that something else or more needs to be done.

MR. DENTON: I think there is another answer too, and that is, most of the LERs that we see in contributors to risk, if you look at the precursor study even, are not system interaction studies unless you define everything as "system interaction," like maintenance of that other breaker. There are a lot of human failings to carry out

things that you would think would happen.

Usually, the hardware is adequate. A large part of this program has been hardware. I remember the ACRS asked me one time, what would happen if every wire in a cable tray was connected to any other wire in the cable tray? You can run through those kinds of analyses, but you end up with more circuits in that kind of thing.

The PRAs that have been done that look for single failure certainly look at the first two or three levels of support systems. So I kind of doubt if the work we're doing will show new functional system interactions. They're already taken to a fairly detailed level.

Spatial interactions may show up in this study, where what's put in what rooms that may fail that may interact with something else. And I think as we will tell you, the Indian Point study already has 20 volumes of information just trying to catalog what's in rooms that might interact with each other. So it's a very voluminous thing.

The human side is going to be very tough to get at. You know, the basis for one's confidence depends on the PRAs that have been done, the fact where we think the risks are, what the LERs are showing the risk. And I think the best indicator is experience. Many of the ones on this list we had to learn through experience. Things like flooding

and fires have come in through experience.

And I guess, finally, it's not that anyone doesn't want to do a system interaction, it's trying to find a way to know the unknowable. It's like searching for a cancer cure, and if we could find a way to really get in there and that would identify these or the two or three missing interactions, we'd do something with those.

And it's been the frustrating search for a methodology that we can improve the state of knowledge.

CHAIRMAN PALLADINO: There's one difference, though. Here you don't know the extent to which interactions exist. It's different from searching for a cure for a particular disease, because you're searching to see if there exists such a disease, in a sense, or the extent to which such a disease exists.

MR. DENTON: And we do find them in LERs, but usually they're at a level of detail that you would not expect to turn up without, as Frank said, exhausting some computer's memory in trying to catalog the possible interactions.

MR. SPEIS: Also, what I would add the following, that the present USIs, all of them are trying in one way or the other to address that issue of systems interactions. For example, pressurized thermal shock, you know, one of the concerns there is that you could have an

undercooling/overcooling transient. Well, why would you have an overcooling transient? Because something would happen to your control system.

But that has been identified, and we are focusing on that specific issue.

MR. DENTON: It would be useful to go maybe right into Frank's description of the efforts that have been made to develop the methodology and to have the focus on --

CHAIRMAN PALLADINO: Are you also going to go into the specifics of what you're doing now in and in the future?

MR. SPEIS: Yes. And the schedule for the program and where we think it will go.

CHAIRMAN PALLADINO: Could you also indicate somewhere along the line why in 1981 in our annual report we anticipated it was all going to be done by November of that year, what happened on that?

MR. DENTON: That must have been the Watts Bar effort.

MR. SPEIS: Well, that's all right, somewhere along the line. We will talk about that.

Maybe you can say a few things about this.

MR. COFFMAN: The next viewgraph you have there, 8, I will just let you read it. I will make a couple of comments.

To focus a minute on the word "analyze," "develop independent methods ot analyze plants," it puts us into a search process. The methods are in essence a search process which I think Chairman Palladino just summarized.

We have to have confidence in that process before we go out and endeavor to apply it. And we're trying to apply it in a way where the process is orthogonal or independent, provides a different perspective to the present review process, which Dr. Speis described in the Standard Review Plan.

One of the areas that it is distinctly different is that the Standard Review Plan does identify distinctions between important-to-safety equipment and safety-related equipment. The methods, the orthogonal methods, that we are trying to apply do not make a distinction between safety related and important to safety, and they would freely transcend that boundary and would not be constrained by that distinction.

COMMISSIONER GILINSKY: What is the basis for your analysis? Is it the FSAR or what, or are you looking at specific plants?

MR. COFFMAN: The basis as far as the source of information about the plant?

COMMISSIONER GILINSKY: Yes.

MR. COFFMAN: The FSAR is in there, is among the documents. There is an extensive list of documents, but not the primary document. It's primarily, piping and instrumentation drawings. And certainly, the FSAR is part of that. Plant arrangement drawings, electrical line

diagrams.

COMMISSIONER GILINSKY: Which you get from the company or --

MR. COFFMAN: Yes, sir.

COMMISSIONER GILINSKY: There was some controversy about whether or not you were getting the right information or adequate level of detail.

MR. COFFMAN: That was on a different --

COMMISSIONER GILINSKY: Is that -- am I clear on this?

MR. DENTON: To get very far into it on the trials that we've done, you need a lot more information than is typically provided on an application.

COMMISSIONER AHEARNE: Well, it's my understanding from all the stuff that you've sent up that we haven't yet actually gone through one in detail. Is that correct?

MR. DENTON: There are a couple that are under development.

COMMISSIONER AHEARNE: Right.

COMMISSIONER GILINSKY: I think these are all plant-specific studies.

MR. DENTON: Special studies trying to develop a methodology.

MR. SPEIS: And apply it.

MR. DENTON: It's not as -- we don't have a methodology yet.

COMMISSIONER GILINSKY: A methodology that would apply to all plants?

MR. COFFMAN: Well, let me go to the next viewgraph, number 9 --

(Slide)

-- and say that the whole program includes the review of some plant-specific studies, systems interaction studies. And those three are listed there under the first major heading.

So the program includes review of utility programs. It also includes our development of independent methods. And it's easy to bounce back and forth and get confused on them.

But as far as review of the utility methods, PG&E has performed their study on Diablo Canyon, and the staff had reviewed that back between June and November of 1980. That was their program, their criteria for what constituted an interaction, and the whole process of how they were going to go through making their search.

COMMISSIONER ROBERTS: How did that work come about?

MR. COFFMAN: The ACRS encouraged that under one

of the design criteria which calls out for special studies of plants that have site-specific hazards, and this was a seismic hazard.

MR. DENTON: And this was limited to spatial interaction due to earthquakes.

COMMISSIONER ROBERTS: All right. That's Diablo Canyon. What about the Indian Point 3 and Midland 2?

MR. DENTON: Similar answer but different --

COMMISSIONER AHEARNE: Also spatial interactions?

MR. DENTON: No. No. ACRS.

MR. COFFMAN: As far as the scope, the Indian Point effort is much broader. It is, in essence, a full scoped systems interaction effort.

COMMISSIONER GILINSKY: ACRS magnitude 7 request.

(Laughter)

MR. SPEIS: There is no formal requirement at present to perform a systems interaction study, you know, per se, explicitly.

MR. DENTON: We funded the first one, which was Watts Bar effort, and that one didn't go anywhere, as we have discussed. And then the ACRS asked for these. If you take the Indian Point one, I guess it was about a year ago that the staff went back to the ACRS with its views on the proposal that Indian Point had come up with, that we thought it was a reasonable way to go foward.

The ACRS reviewed it and concurred in that opinion. And the company has been carrying it out ever since. It's about a $2 million study, separate from the PRA study which they already have in hand of multi volumes.

So they are attemtping to see if they are spatial, functional, or human interactions that are outside the design envelope and that were covered in their PRA.

COMMISSIONER AHEARNE: And what method are they using?

MR. COFFMAN: Their method is essentially one of tables identifying, beginning with the safety functions, and identifying the systems required to support those functions; then going another step in detail looking for the support systems behind the primary systems and then continuing on until they have essentially identified what they feel is all the equipment which is depended upon to perform the basic safety functions.

Their next step then is to selectively fail some of that equipment and look for the adverse effects it would have on the safety functions to in fact determine whether it would penetrate a regulatory requirement or some more rigorous criterion.

COMMISSIONER AHEARNE: And they are doing this for every safety system?

MR. COFFMAN: They are doing it for every safety

function, so, yes, they begin even more generally than safety systems.

MR. DENTON: I think one of the issues in this kind of thing is how far do you go? In other words, when they did the PRA on Indian Point, they had to pick some level to stop and try to draw fault trees and event trees. This is a little different approach, I guess, which would test whether they drew the line in the right place.

They have agreed to inform us if they find any interactions that are outside the design envelope.

COMMISSIONER AHEARNE: They are not then merely taking the fault tree/event tree system descriptions that they developed and just recalculating on this, is what you're saying?

COMMISSIONER GILINSKY: Why is this different?

MR. COFFMAN: This is -- it's hard to explain.

COMMISSIONER GILINSKY: Maybe that's what you said before, but I didn't understand it.

MR. COFFMAN: The difference is in the methodology, the fact that this method was developed by Power Authority of State of New York and their contractor, EBASCO. They developed this method. They felt like it was the best approach to search the plant for interactions. It is not a fault tree method.

COMMISSIONER GILINSKY: But ultimately, shouldn't

those interactions express themselves in a fault tree hierarchy?

MR. SPEIS: Ultimately, yes, they should, depending on how far you carry your fault tree --

COMMISSIONER GILINSKY: Or event tree, I would say.

MR. SPEIS: -- how many systems you include in terms of developing fault trees for it, because even in a PRA you are limited by how much you can do. So a number of systems are indeed left out.

COMMISSIONER AHEARNE: I mean the fault trees give you the model that you will ultimately end up with or carrying around at any particular time. Here, as I understand it, you're combing the systems for interactions to see whether the model is right, whether you need to adjust it in some way. Is that right or not?

MR. COFFMAN: No, that's -- well, I guess -- the purpose for the systems interaction program was not initially to check the fidelity of the fault trees. However, there is -- the input can be made from the result of the systems interaction program into the fault trees. But the purpose was initially to search the plant to identify any hidden dependencies. It's a more rigorous single failure analysis.

CHAIRMAN PALLADINO: The fault tree will not

quite do what you're looking for here, because if you take a system and then say, suppose this component operates and then doesn't and then what if it doesn't, then you go down the various chains. Here you're looking for what if something like a fire were to impact or some other common cause were to impact on this component, would it affect the operation of the others.

I think you're putting a different overview on the fault tree.

MR. COFFMAN: Well, I think that was a short answer, that conceptually it can be done.

CHAIRMAN PALLADINO: If it's a three-dimensional.

MR. COFFMAN: You can identify -- in fact, in the Sandia study they identified location, and if that location is susceptible to a fire, then that could be part of the fault tree analysis. Conceptually, it can be done.

COMMISSIONER GILINSKY: Well, are you saying that some of these things just don't lend themselves to fault tree descriptions?

MR. COFFMAN: No, I guess I am saying that the fault tree may not be the most effective method of searching the plant, and it may -- the limiations on--

COMMISSIONER GILINSKY: Well, I wouldn't think it searches the plant. It basically contains -- it is a model of the interactions as you understand them. And until --

MR. COFFMAN: Maybe I should --

MR. DENTON: But to some extent, I think that it's the same deck being shuffled in many of these different approaches to it. But my sense is that in normal PRA practice, they make decisions about where to stop carrying out what level of -- they're the primary safety systems, the support systems, and then there are systems that support the support systems.

Somewhere they decide where you're going to stop drawing these trees, because their view is the risk contribution gets too small to try to keep book on it.

I think what Frank is trying to describe is a system where it would be an elaborate accounting system before any judgments are made about the risk significance of that system, and we'll start with that.

COMMISSIONER AHEARNE: But you have to stop at some point.

COMMISSIONER GILINSKY: That's okay. That's okay. But suppose he finds something and it turns out to be very important, even if it's way down somewhere.

MR. DENTON: Then you'd have to go to a PRA source to find out how important it is.

COMMISSIONER GILINSKY: Then you would realize that you really do have to factor this interaction in and hook that up to something in your fault tree.

MR. SPEIS: Exactly. You would have to. Once you identify --

COMMISSIONER GILINSKY: Unless you make a change, yes.

MR. SPEIS: Somehow you have to develop judgment on how important it is, and if you want some quantitative assessment, you would certainly fold it into a PRA, if you have a PRA available for that plant, to see what the significance is.

MR. DENTON: I think these tables you are constructing don't go at all to the probability of a failure.

MR. SPEIS: That's right.

MR. DENTON: That's just on what systems does this system depend? So they don't put any numerical probabilities of failure, but just to see what is the connection. Then if they find connections that eventually you've got to go back through a PRA-type analysis to evaluate that interdependency.

COMMISSIONER GILINSKY: Well --

MR. DENTON: But Frank is just identifying dependencies, I guess.

MR. SPEIS: Yes. An example, when you go through fault trees and event trees in a PRA, some PRAs at least, you might postulate an initiating event is a small LOCA,

and you can draw functional trees or event trees to what systems are needed to mitigate consequences of that initiating event. And for each system you would draw a fault tree.

Now, in many cases, the fault tree level doesn't go far enough to depict that perhaps a common failure somewhere down, semi-hidden, not only causes you to fail one train of the mitigating system but also could result in the small LOCA initiator.

COMMISSIONER GILINSKY: But you are saying there that the typical fault tree doesn't go into as much detail in the system as this particular approach does?

MR. SPEIS: This approach goes in much greater detail --

COMMISSIONER AHEARNE: So if you cut off --

MR. SPEIS: -- for more systems.

COMMISSIONER AHEARNE: -- if you cut off this approach, it's the same level of detail as the typical fault tree analysis?

MR. SPEIS: Oh, yes, absolutely. Oh, yes.

MR. DENTON: We're not necessarily wedded to this one. That's one of the ones.

COMMISSIONER AHEARNE: Yes.

MR. DENTON: And there are two othe ways that we are also testing. This is a way, though, that Indian Point

is doing it to the satisfaction of the ACRS. Now, the results of doing it this way, we don't know yet.

COMMISSIONER AHEARNE: Before you leave this one, though, it sounds to me that on this development of tables you don't necessarily get to the point the chairman asked about; that is, a fire causing a common-cause failure to a whole host of those systems.

MR. DENTON: Yes, that's right.

COMMISSIONER AHEARNE: Now, the tabs are --

MR. DENTON: Yes, they kept the fires another way, I think, and the simple way I understand it is they are going into every room and photographing or recording everything that's in each space, and through some bookkeeping system then intend to evaluate, if there were a fire, flood or moisture problem or whatever in that room, what equipment is in what proximity to each other.

So I understand that there are about 20 volumes now of catalogued data giving spatial interactions that are under evaluation.

COMMISSIONER AHEARNE: I see.

MR. THADANI: That's right.

MR. DENTON: So that would answer, in other words --

COMMISSIONER AHEARNE: Yes.

MR. DENTON: -- out of that they would hope to be

able to answer that question if you get a fire in any space what would it affect throughout the plant?

MR. SPEIS: These volumes have not been submitted to us. And as has been said --

(Laughter)

-- one of the ways to assess the importance of these interactions is either to go through a quantitative approach or develop some other criteria, you know, using some deterministic, common-sense way of saying it's important or not important or whatever.

CHAIRMAN PALLADINO: I hope you don't carry all those volumes. There's a space where you could drop them and have an interaction.

(Laughter)

COMMISSIONER AHEARNE: Are they attempting to keep track of all of these tables manually, or are they attempting to program them?

MR. DENTON: Jim, do you know whether --

VOICE: I think it's all manual.

MR. DENTON: Is it manual?

VOICE: The Benson tables.

COMMISSIONER GILINSKY: It's not computerized? It's not computerized? You've got to be kidding.

(Laughter)

COMMISSIONER GILINSKY: In 1983.

CHAIRMAN PALLADINO: Can I go back to the first one where you were talking about 1980 PG&E did some work and you have dates here, 1/84 to 4/84. What does that mean?

MR. COFFMAN: The results of the PG&E work have not yet been submitted to the staff. And we anticipate that we will receive them so that we could review them during that time frame.

COMMISSIONER AHEARNE: I thought, Frank, you earlier said the staff reviewed it in 1980.

CHAIRMAN PALLADINO: That's what I thought, yes.

MR. COFFMAN: The staff reviewed the PG&E search process and their criteria againstwhich they were searching, and in fact audited, sampled some of the search process.

CHAIRMAN PALLADINO: Well, what is going to be reviewed in '84?

MR. COFFMAN: The evaluation. It's easy to discover spatially coupled systems interactions. There are like, you know, so far I have been told there are over 1,500 that they have discovered at Diablo Canyon. The question is how important are they to safety?

COMMISSIONER GILINSKY: When you say --

CHAIRMAN PALLADINO: Spatially, they're all interrelated.

COMMISSIONER GILINSKY: Yes, spatially related

interactions.

Are you talking about just things being close to each other or interactions that affect safety?

MR. COFFMAN: Now, given a seismic event, which was a constraint on the Diablo Canyon program, is there enough lateral displacement, tilting, failure of supports, that you could have specific piece of equipment adversely affect safety-related equipment? And they went through with a very fine-tooth comb and --

MR. DENTON: That one, they were able to focus just on seismic interactions and, as I understand it, took a team of mechanical engineers and maybe structural engineers, six or eight, ten people, and walked through the plant and stopped at every room and the looked to see stairwells, whatever might be supportive, safety-related equipment or non-safety-related, to see what might fall on anything else or what might hit. And then eventually, if they concluded that it involved safety-related potential, they decided to fix the stairwell from falling rather than trying to analyze it.

As I understand, that's been their choice throughout is to when they find interactions, to prevent them from occurring through design rather than try to analyze what would happen if a non-safety-related stairwell fell on safety-related piping.

COMMISSIONER GILINSKY: That sounds like a good idea.

CHAIRMAN PALLADINO: But there must be assumptions made at every point about what's happened, what happens to whatever you're considering failing, how it'd fall. In Diablo, one could start with, I don't know what the probability is, but a big crack in the earth and the whole plant goes.

(Laughter)

COMMISSIONER AHEARNE: Well, they're spatially related. I don't know what assumptions you're making.

(Laughter)

VOICE: (Inaudible) SSE, Jim.

CHAIRMAN PALLADINO: No, I am getting to both. I am just trying to illustrate that you make a lot of different assumptions about every stage is spatially related. But I guess you're trying to make reasonable ones.

MR. COFFMAN: That was part of what was reviewed in 1980, was the ground acceleration; and in fact a lot more detailed criteria to tanks, could they deflect elastically sufficiently to impact. And all that criteria was reviewed in detail back in 1980.

COMMISSIONER AHEARNE: And so they expect their results sometime the end of this year?

MR. COFFMAN: Yes, sir.

COMMISSIONER GILINSKY: From these utility studies, though?

MR. COFFMAN: Yes, from PG&E we expect --

COMMISSIONER GILINSKY: Well, what are we doing?

COMMISSIONER AHEARNE: Wait. Could he finish --

COMMISSIONER GILINSKY: All right.

COMMISSIONER AHEARNE: -- finish on what they're doing?

COMMISSIONER GILINSKY: Sure.

COMMISSIONER AHEARNE: On the PASNY study you've got here, running over a period of about 4 years.

MR. COFFMAN: Yes. Let me break that down a little. The methods development was begun in July of 1980,and it was a methods development by the utility themselves.

Then they received, as Mr. Denton mentioned, they received the ACRS endorsement of their method earlier in '82, and from March of '82 through November they actually conducted their search of Indian Point 3. And they are now in the process of evaluating what they found to determine its safety significance.

And we are told that somewhere around September of this year we can expect their results. I can't speak with authority as to when they will have it in, because it is voluntary, it is something that they --

COMMISSIONER AHEARNE: Sure.

MR. COFFMAN: -- have volunteered to do.

MR. COFFMAN: And then they have allowed for a time period to make any fixes of the plant. So that's why you see the extended date there. But the staff expects that we would be able to perhaps draw conclusions from the results of their effort somewhere around the middle of the spring in '84, April '84, somewhere.

MR. DENTON: I don't want to put all of this on the ACRS. The staff supported it and urged them and no doubt jawboned them along also. So it's done with our support and endorsement. And there has been a lot of cooperation between the two parties in doing the study.

COMMISSIONER AHEARNE: And what is the -- Midland, is that just -- is that a third method or --

MR. COFFMAN: Their method we don't know as much about as the others, because it's a newer method. I am not even sure I could call it a separate method.

Their program really represents an aggregation of all the activities which they feel could be characterized as systems interactions. They are following along the work that was done by PG&E on Diablo Canyon as far as the methodology of doing these walkthroughs.

It's alittle bit of a misnomer to just call it a walkthrough, because there is a lot of work that goes into

knowing where to walk, what to look for, how to keep track of it, that type of work. But their program, in essence, is more an aggregation of what they're doing under present requirements to demonstrate its adequacy.

COMMISSIONER AHEARNE: Well, if the PG&E and the PASNY ones, it sounded like the staff had early-stage involvement discussing the program and the approach. I gather from your last comment that staff has not had that level of interaction on the Consumers Power program?

MR. COFFMAN: Not to that degree, but we have been involved iwth them since June of '82.

COMMISSIONER AHEARNE: Are they doing a tabulation approach similar to PASNY?

MR. COFFMAN: Their approach is more similar to PG&E'S.

COMMISSIONER AHEARNE: Is it focused on seismic concerns?

MR. COFFMAN: Yes, it's focused primarily on the spatially coupled.

MR. DENTON: I think the Indian Point --

COMMISSIONER AHEARNE: Draft settlement?

MR. DENTON: Yes, on Midland, you recall, which is a B&W plant, and I think they undertook both a PRA and a systems interaction study to prepare themselves for a licensing decision someday.

(Laughter)

MR. DENTON: I think we ought to next go to Commissioner Gilinsky's question of what are we doing in this area. There are a number of other techniques which the staff has been talking to laboratories about and trying to develop.

And let me ask Frank to maybe distinguish those from what the utilities are doing.

COMMISSIONER GILINSKY: Well, let me ask you this. What is our goal here? Is it to be performing such analyses on individual plants ourselves? Is it to do a few sample cases? Is it to teach people how to do it themselves?

COMMISSIONER AHEARNE: Or to find out whether it's worthwhile doing this at all.

MR. DENTON: I think it, as Commissioner Ahearne has correctly characterized it, is to see if we could develop a methodology that would have a payoff. And we haven't come to that decision yet. If we could find --

COMMISSIONER GILINSKY: Well, let's see, is the way to decide whether there's a payoff for developing a methodology or to look at one or two cases and see whether you end up finding interactions that are missed by the more conventional approaches?

MR. DENTON: Well, what we hope to have coming in

at the same time would be the Indian Point systems interaction study, which has been -- at least the scope of the program has been concurred in by ACRS and the staff, this DIGRAPH matrix analysis method --

CHAIRMAN PALLADINO: Are you going to explain what it is?

(Laughter)

MR. DENTON: I was afraid you would ask.

There is still a third way of trying to identify these. And we would then have three different methodological approaches to the same plant and see if out of that any item turned up significant contributors to risk that had been missed in the normal safety review.

COMMISSIONER GILINSKY: It sounds like a very careful and reasonable way to aproach things. But I must say I get a little worried when I hear the word "methodology" used too many times.

CHAIRMAN PALLADINO: Well, in a sense we have some methodologies. For example, when you look at flooding and --

MR. DENTON: When we find an interaction we usually --

CHAIRMAN PALLADINO: -- when you would look at earthquakes.

MR. DENTON: Yes.

CHAIRMAN PALLADINO: I don't know if you look at everything.

MR. DENTON: We are searching for unknown interactions that are not presently reviewed.

COMMISSIONER GILINSKY: But it sounds like -- and I don't mean to make fun of this -- you are really searching for new methodologies rather than new interactions. That means I might develop, oh, three methodologies and --

COMMISSIONER AHEARNE: They're trying to figure out how to do the search.

MR. COFFMAN: Yes.

MR. DENTON: A method to identify an interaction.

PG&E was kind of expert opinion, just having people walk through and do it by eyeball.

COMMISSIONER GILINSKY: Well, but isn't the real test whether they come up with interesting things?

COMMISSIONER AHEARNE: Yes, that's the --

MR. DENTON: Yes.

COMMISSIONER AHEARNE: -- staff seems to be struggling with trying to find a way to do that search and then as the test to see whether it does come up with the interesting things. That's at least as I read it.

MR. SPEIS: And how important those things are to safety and to take the next step to revise the Standard Review Plan to provide some more rigorous way of looking at these intersystem dependencies and making sure that those systems do perform their functions.

COMMISSIONER GILINSKY: Well, you have been concerned about this an awful lot more than I have. But I think the way I would have approached it is to take a bunch of smart people and have them think about some specific plants beyond the conventional thinking that goes on in conventional review, and see whether that, you know, any of the various intuitive notions about what might be important in fact turn out to be important on closer examination.

CHAIRMAN PALLADINO: Maybe this is what they are doing.

COMMISSIONER AHEARNE: Maybe it is. Let's keep going.

MR. COFFMAN: Well, let me ask for supporting viewgraph number 18.

CHAIRMAN PALLADINO: You're not going to skip DIGRAPH?

MR. COFFMAN: No, sir. I am going to give you that. But in answer, while that's being located --

(Slide)

CHAIRMAN PALLADINO: There it is.

MR. COFFMAN: -- let me say that the plants are big enough, complex enough, and the answers, the dependencies are so well hidden in the details of the plant equipment that it would take some awfully smart people -- certainly smarter than I am -- to -- I would enjoy being part of that team.

But it would take some awfully smart people some really tough thinking because you've got to consider lots of combinations of operating modes and equipment and state of equipment.

So a systematic method to guide the process is what we have been looking for. So when we refer to "a method," it is really to guide intelligent people. And a fault tree, for example, is one way to guide intelligent people to search plants. Tables like PASNY has, is another

way. And then this is the third way that we consider potentially the most efficient method of systematically searching the plant for systems interactions.

We begin with a system description, or the plant description. And I have put it up here in a very elementary way for illustration of the process.

In essence, you're taking the plant instrumentation and drawing, piping and instrumentation drawings, but supported by other information, and you are translating that into a directed graph, which in essence is a graphical technique where, you know, you have notes, you have connections, and you have the tendencies indicated simply by the circles, arrows, and the lines.

This is a long, meticulous process to translate the plant into this model.

COMMISSIONER AHEARNE: What is the difference -- what are the differences there between your systems description, directed graph, and PASNY's table?

MR. COFFMAN: Well, there are many differences. An advantage is that -- and I am not trying to get around your question; it's just such a broad scoped question.

COMMISSIONER AHEARNE: It's just that your description sounded like you're trying to track from A, system A, and track for systems it interacts with.

MR. COFFMAN: Yes. In essence, both methods are a

systematic way of searching the plant. It's a procedure that you use to guide the analyst to go through and search the plant. So in essence, they're the same in process and objective.

COMMISSIONER AHEARNE: What are the characteristics of B and D, for example; what type of characteristics would enable you to go in, if you start with A, what are the characteristics of the other systems that would lead you to draw B and D?

MR. THADANI: B and D? Fault tree event? What do you think --

MR. COFFMAN: B and D, you mean the equipment here that's --

COMMISSIONER AHEARNE: Your description of PASNY sounded like they take an function and on that function they're going to get a set of systems, and they take those systems and work up a table of all of these systems that interact with that system. Now, that particular table is a system interaction. I was wondering what it is that is different about your B and D which --

MR. COFFMAN: Well, this method allows what we think is a more systematic search and in the sense that it does not require any more than just pairwise modeling of dependencies. The problem with the other methods is that the analyst may have to consider combinations of faults

more than just a pairwise consideration of equipment. I think That may not be coming across very clearly.

Here the analyst goes through and looks at each piece of equipment and asks, what does that equipment require to operate successfully, in contrast with the PASNY method or a fault tree method where he would have to consider also degraded or defaulted condition of that equipment, that piece of equipment, or supporting equipment.

Here the analyst only looks at the successful operation of the one piece of equipment.

COMMISSIONER GILINSKY: How do you go about deciding whether this is a useful thing to be looking at or not?

MR. DENTON: Well, the way I approach it is that I have heard advocates of at least three different methods. One is the make-a-table; you list everything you can find on the table. The DIGRAPH method, and one table before that one, which is -- what is the name of that one?

MR. SPEIS: Event tree/fault tree, failure-modes-and-effects analysis.

MR. DENTON: It's a more complicated system than fault trees or event trees. And they all -- so there are three methods which practitioners in this field advocate. I can find nothing in the literature, scientific literature,

that says, this method has been tried and it beats this method.

So it's not as though we're looking into a --

COMMISSIONER GILINSKY: Well, ultimately, you're going to have to apply some test to it.

MR. DENTON: And so the way I had thought the way we intend to approach it is to do all three on Indian Point. In other words, Indian Point is doing one of its own choice there; we will have a laboratory do the DIGRAPH method, and another laboratory do the other one. So we will have three different approaches at a nominal sum of money, all in the same plant, and that would be the test, to see then on the same plant three different ways and see if any three turn up significant interactions, and then make a choice after that.

COMMISSIONER GILINSKY: So I have a couple of questions: One is, it sounds like this is going to take quite a while; and secondly, they are aware of what the other methods turned up. You know, it's not as if you're sending them off in separate rooms and we see what they turn up.

MR. COFFMAN: Well, if you look at the scheduling the --

MR. THADANI: The intent certainly is to keep the two teams apart.

COMMISSIONER GILINSKY: Yes, but --

MR. THADANI: The two laboratories. But there is a --

COMMISSIONER GILINSKY: -- they will at least see the --

MR. THADANI: Yes.

COMMISSIONER GILINSKY: -- utility report.

MR. DENTON: Well, I didn't want to do different plants. I figured that would -- we'd never get a comparison there either. So I thought it was best to do a plant. And the advantage of Indian Point is that not only is it high population, we've got a complete PRA for that plant to turn back to to judge the significance to the extent we would like.

COMMISSIONER GILINSKY: Well, let's see, how long does a thing like this take?

COMMISSIONER AHEARNE: No, don't leave the slide.

CHAIRMAN PALLADINO: I don't understand what "reachability" is, and if I see that A and C are not adjacent to each other but they're --

COMMISSIONER GILINSKY: Well, that's fine, but is it reachable at all?

CHAIRMAN PALLADINO: -- reachable twice, or whatever those numbers mean.

MR. DENTON: Well, I found, Mr. Chairman, after

about 4 hours I began to understand this matter.

(Laughter)

MR. COFFMAN: Maybe we should schedule --

(Laughter)

CHAIRMAN PALLADINO: I don't want the details, just -- not adjacent but to be reachable, I don't know what you mean by that.

MR. THADANI: We will come back to the schedule.

(Laughter)

COMMISSIONER GILINSKY: Well, can you just tell me how long these things take?

MR. SPEIS: We have a schedule here that shows --

COMMISSIONER GILINSKY: Briefly.

MR. SPEIS: -- that we hope to --

COMMISSIONER GILINSKY: No details, please.

MR. SPEIS: -- to have completed the evaluation and the application of those three methods by the end of '84, roughly.

CHAIRMAN PALLADINO: Which three methods? The one that --

MR. SPEIS: The PASNY, the DIGRAPH matrix,and the fault tree/event tree.

MR. DENTON: There is a third one we haven't shown you yet. But maybe we can answer the chairman's question, Frank, on this one.

MR. COFFMAN: Okay. The concept of reachability is simply it's a characteristic of a component. If a component can reach to the safety function and adversely affect the safety function. So it's a path --

CHAIRMAN PALLADINO: Because it's connected by a pipe?

MR. COFFMAN: By a pipe. But you know, there are a whole series of couplings, so it could be connected through a pipe, through cooling, then through power. So there are a whole series of couplings. And if you follow the path of couplings from the component to the safety function, then reachability can give you a feel for how important that safety -- how much that safety function depends upon that particular component, how reachable it is.

CHAIRMAN PALLADINO: So the adjacency matrix might not be related? It doesn't do -- the reachability matrix does not derive necessarily from the adjacency matrix?

MR. COFFMAN: Yes, it does derive. The process --

CHAIRMAN PALLADINO: Necessarily? Then I don't follow.

MR. COFFMAN: -- the process here is to go stepwise from left to right at each level. So you begin with the system description, go to the DIGRAPH, then you

translate the DIGRAPH into an adjacency matrix. Just where the first column is the components and -- well, the first row is the components also, but you're reading it that component A can reach directly to component B would be the way to read that.

CHAIRMAN PALLADINO: Is that what the adjacency matrix tells you?

MR. COFFMAN: Yes. And you only do it pairwise. You don't worry about how many other components it can reach to, and you only worry about it in success space. You only worry about what's required for successful operation.

CHAIRMAN PALLADINO: Are you sure that means there you read that in the adjacency matrix or the reachability matrix?

MR. COFFMAN: You read that in the adjacency matrix. You then manipulate the matrix by matrix factoring, which is, you know, just given there in the reachability calculations.

And N -- A being the adjacency matrix and N being the number of steps removed from the safety function that a component might be. And this is where the scope of the systems interaction problem can become excessive, is that in the Crystal River example, the nonnuclear instrumentation power supply was eight levels removed from the PORV. So you've got to go into the details of the

system quite a bit.

COMMISSIONER AHEARNE: All of these methods that you have talked about are I guess I would describe as brute-force approaches.

MR. COFFMAN: I would call them systematic, but I am not here to argue.

COMMISSIONER AHEARNE: Well -- and I am not saying that that isn't the only -- obviously, you guys have been struggling with this for a long time, but they all seem to have the characteristics of a very large amount of data and computation. Is that --

MR. COFFMAN: That's correct. And in fact, that's been a paramount consideration for the program is the fact that it is very resource-intensive, and before you would go out and do something like this on a plant, you would want ot have some confidence that it's going to give you some results that are relevant to safety.

CHAIRMAN PALLADINO: What are the three? The fault tree, the DIGRAPH matrix, and what is the other?

MR. DENTON: I think the other one is a bit easier. Let's go back one.

COMMISSIONER AHEARNE: The PASNY approach.

MR. DENTON: Go back one, Frank.

MR. COFFMAN: Okay. If we could have support viewgraph 17.

(Slide)

COMMISSIONER AHEARNE: An important (inaudible).

MR. DENTON: This is the third approach then. In other words, we talked about the tables, which is the PASNY one; the DIGRAPH. And this is the third one, which while looking like fault trees and event trees, it does give you additional information. And I will let Frank explain that one.

MR. COFFMAN: Yes. It's intended to be the most compatible with the PRAs. And present PRAs do not do a fault tree analysis of the initiating event, which is the first oargate you see there on the left. And they truncate how much detail they go into in developing the fault trees on failed systems, sometimes simply because of hte probability of the components failing.

So there is nonuniformity in the degree to which they go into details. And this method developed by Brookhaven, or I guess it's more -- it's a refinement of PRA methods by Brookhaven, in essence, adds the ingredient of doing the fault trees on the initiating events and taking advantage of some better computer technology to go more into the details to extend the PRAs more into the details.

It was -- we were primarily motivated to use this technique to have maximum compatibility with present

PRAs.

MR. DENTON: Well, one way I see this one, a normal fault tree, you'd go down the success-or-failure trees, but you can see in this one if system A is involved in the initiating event and then it's also involved by the circle on the right in a subsequent important action. So it's involved at least twice.

So by coupling the traditional fault trees with these other failure modes under it, you are able to see maybe a single system failure might crop up in the same fault tree two or three times. So I take it what would be done in this case, which is the third method we'd try on the same Indian Point data, it'd be something like this.

So it is true the three methods, I am sure our analysts would know what's being found in each group, but it might show up strengths or weaknesses among these three types and might enable us to choose which one, if any, had potential application.

COMMISSIONER AHEARNE: Is that what you mean by "methods application" that you mentioned?

MR. COFFMAN: Yes, that's the second item under number 2 in that viewgraph 9.

COMMISSIONER AHEARNE: Has this been -- has either the DIGRAPH matrix or this expanded approach been tried on any selected set of plant systems?

MR. COFFMAN: We have tried to -- we are in the process of trying to complete the demonstration of the DIGRAPH matrix analysis on Watts Bar on two operating modes of their high-pressure injection system, and we anticipate having that completed and documented by September of this year. And that's the first item under number 2 on viewgraph 9.

The work on PRAs, enhancing PRAs, is, you know, continuing, and we do not at this point have a separate demonstation of that methodology of the fault tree interactive failure-modes-and-effects analysis in addition to what we had planned for Indian Point 3, because that methodology as far as the nuclear industry was concerned was more mature than the matrix DIGRAPH methodology.

CHAIRMAN PALLADINO: Have any of these methods covered things, situations that would have led to failure other than those we have done by the more conventional methods?

I guess I am asking or have we found anything that makes it worthwhile or to the fact that we look at earthquakes and the more obvious interactions covering by far the largest fraction of possibilities?

MR. DENTON: I think for Indian Point -- I mean for Diablo Canyon they did find a large number of potential interactions, and they decided to fix those. I don't know

that we've come to a conclusion about how important they were in the overall picture. But whenever they find a potential, rather than analyze it, they fixed it, and that's my understanding.

COMMISSIONER AHEARNE: Well, other than that Diablo Canyon, have there been any that have been carried far enough to completion?

MR. DENTON: No. Then Indian Point has a commitment to us to notify us if they find anything in their study that is beyond the design basis analyses already presented. I think they did inform us of --

MR. THADANI: Yes.

MR. DENTON: -- a spatial finding in the auxiliary feedwater system.

MR. THADANI: That is correct, Harold. And there was an interaction they identified in the auxiliary feedwater system, and they have made some changes to that system as a result of their systems interaction study.

MR. DENTON: I think it's that one case from Indian Point.

CHAIRMAN PALLADINO: Well, all right. And let me just take that one more step. Suppose they hadn't found that. Were the consequences such that you should have made a correction or did it add significantly to the consequences of the event?

MR. THADANI: It's my understanding that it would not have added significantly to the consequences. It was important in terms of the reliability of that specific system, but that system was not a significant system in terms of risk.

MR. DENTON: In other words, for that plant and the analysis that had been done, this particular interaction was not that significant. Now, I think the Midland study is somewhat behind Indian Point.

MR. THADANI: Yes.

MR. DENTON: And they have not to my knowledge informed us of any such.

CHAIRMAN PALLADINO: I guess my question is, are we looking for a needle in a haystack, where if we found the needle, we didn't have any use for it?

MR. DENTON: Well, I think it's a difficult issue, the fact that we've not been able to make a lot of progress on it, and we've put in several man-years and hundreds of thousands of dollars a year trying to foster this area. It's clear the ACRS considers that we ought to do more and keeps pushing us to find a simplified non-brute-force method. So the jury really isn't in yet till we've got somewhat more results out of these.

COMMISSIONER AHEARNE: Harold, can you say a few words about at one stage there was a program which was

going to have four pilot plants. What happened to that?

MR. DENTON: Well, I thought if I could get --

COMMISSIONER AHEARNE: Yes, there was going to be something -- it wasn't clear what -- but it was going to be applied to four plants as sort of a pilot approach. Now it seems as if it has ended up being really an application to one plant. I am not criticizing that becuase I don't know -- I just don't --

MR. DENTON: Yes.Well, it had always been foreseen, I think, that some methodology would develop and be sanctioned by everyone and then we should begin to apply it, and we have thought about applying it to SEP plants in general or do four pilot plants.

But that kind of thinking was always ahead of the methodology. So I decided that I wasn't going to do any more pilot studies until I at least had a handle on whether DIGRAPH or enhancement --

COMMISSIONER AHEARNE: What approach to use.

MR. DENTON: -- or tables, some approach got pinned down a bit as to exactly how to do it and what to look for. So I have deferred doing it on a pilot basis, thinking that it was better to do it on a single plant that was more or less well understood to see what kind of payoff it had.

COMMISSIONER AHEARNE: Now, the ACRS at one stage

had one day agreed to -- I am not sure what verb you want to use -- but they endorsed the approach of PASNY. They also went on to say -- this is in their March 9th letter of last year -- that they recommend you consider simplified walk-through studies for all operating plants.

Have you given any thought to that? That's, I guess, closer to what Commissioner Gilinsky had suggested on the group of smart guys getting together.

MR. DENTON: Even limited walk-throughs are expensive. Diablo Canyon, PG&E indicated that they spent something like 50 man-years. Now, I can't vouch for their cost accounting, but that's what we were told.

On Consumers' effort on Midland, they have 1.5 man-years just on the walk-throughs on high-energy line breaks, which are part of the Standard Review Plan process. So even limited walk-throughs are expensive, and there's the chance that even limited walk-throughs will give you even more limiting results. So there has been that constraint or that consideration.

(Whereupon, at 3:15 p.m., Commissioner Gilinsky left the meeting.)

MR. DENTON: It has been tough to get our hands around it. A good architect-engineer would consider just these kinds of things and lay out designing a plant looking for interactions and try to devise a method to spot failures of application of good engineering without this brute-force method.

It has been difficult, and I have been unwilling to sponsor a requirement that somebody do it --

COMMISSIONER AHEARNE: Yes.

MR. DENTON: -- until I had a better feel for the advantages.

MR. COFFMAN: Could I supplement that by indicating that there are other walk-throughs that are required just already as part of the Standard Review Plan process. You know, fire reviews, 9.5.1, and there are other areas. So that walk-throughs are already being done as part of the review process, to some degree.

COMMISSIONER AHEARNE: But I think, as you earlier pointed out, you have to think ahead of time what it is that you might be looking for. And so a walk-through focused in that area would not necessarily pick up any -- it would be nice if it did, but you wouldn't have mentally got yourself set looking for these.

MR. THADANI: Yes. And in fact, that is one of the efficiencies, if you are going to perform walk-throughs, it is very important to go through the drawings, the background information, and indeed that is the same sort of information you need to do functional interaction analysis as well. So there is efficiency to trying to do it together.

COMMISSIONER AHEARNE: Yes.

MR. DENTON: My sense is that in -- and Themi might have a different sense -- that it appears that from the functional aspect, the efforts that are under way are not finding a lot of new functional interrelationships that were not already understood and accounted for. It just seems like somehow functionally it has been accounted for. Spatially, we turn up some unexpected or unusual spatial interactions, and then you have to go back, like in the auxiliary feedwater system and say how significant is a spatial interaction?

I think I saw a photograph once of a portable space heater sort of suspended over a cable tray. You know, that's one that a walk-through would -- did -- and would pick up.

(Laughter)

How important it was, we didn't ever evaluate; we just moved the space heater. The human factor --

COMMISSIONER AHEARNE: A candle turned out to be very important.

MR. DENTON: Human interactions are going to be a very tough area to do any real science with. I mean people know they are there, but how do you find them and identify them and improve them is going to be tough. So I think it's worth exploring to try to get a handle on, and that's why we have continued to push ahead on it. But we've not found any simple method to approach the problem.

COMMISSIONER AHEARNE: Now, as I read the material you sent down, you haven't yet reached the conclusion that you are going to go ahead with applying these other methods to the PASNY case.

MR. DENTON: No. We have reached it. I think it's just a question of dollars, and is this the right funding. We were going internally as a staff to fund these two alternatives.

COMMISSIONER AHEARNE: Oh, I thought that was Task 6 of A-17, which --

MR. DENTON: I don't think it's been signed off in my office yet, but that's due to --

COMMISSIONER AHEARNE: I read Task 6 as saying that to demonstrate the effectiveness of two candidate methods in contrast to that method employed by PASNY.

MR. DENTON: We do intend to approve that once

the contractual --

COMMISSIONER AHEARNE: Okay.

MR. DENTON: -- aspects are correct.

COMMISSIONER AHEARNE: See, because this had said Task 6 is not yet approved.

MR. DENTON: But not from -- but from the contracting side. In other words, once we and the lab reach agreement on --

COMMISSIONER AHEARNE: I see.

MR. DENTON: -- scope and funding --

COMMISSIONER AHEARNE: So you do intend to go?

MR. DENTON: Yes.

MR. COFFMAN: Yes.

COMMISSIONER AHEARNE: All right.

CHAIRMAN PALLADINO: Even though you say there's no good simple way, somehow I have it fixed in my mind -- and if it's incorrect I would like to have it out of my mind -- and that is that you are doing some systems interactions because you do look at such things as flooding or common-mode failures, and I presume that when you look at them, if you take flooding, you look at the consequences of the flooding.

MR. DENTON: Yes.

CHAIRMAN PALLADINO: So you have a first-order approach to it, even though it's not complete and it won't

show up all of the other items. But I guess I am also wondering why the walk-through is not an important supplement to that? I agree they've got to know what they're looking for.

MR. COFFMAN: I might --

CHAIRMAN PALLADINO: Why does it have to be something like 50 man-years, that's what I am wondering.

MR. DENTON: I guess it depends on the scope of the charge you give the people to walk through. But let me ask Ashok, who has thought about it.

CHAIRMAN PALLADINO: Well, I am sure I am not thinking broadly about it.

MR. THADANI: I might note that indeed you are quite correct that when you're looking for high-energy line break analysis and so on, you do perform walk-throughs, rather detailed walk-throughs. The estimates that we get in terms of what it costs to perform walk-throughs have varied -- 50 man-years that Frank mentioned for Diablo Canyon; I believe it was considerably lower for Indian Point Unit 3; I believe it was closer, the cost was closer to a million dollars or so. I may be off somewhat.

It's a matter of collecting a rather large team and pouring over a lot of very detailed information. And the way they perform these walk-throughs are, from what I understand, they take months. Several hours a day teams

will go through, and they can only cover --

COMMISSIONER AHEARNE: Crawl through.

MR. THADANI: That is correct. Crawl through. And it is a very resource-intensive exercise they're going through.

CHAIRMAN PALLADINO: They don't have a broad enough horizon, that's all.

Do you have more?

MR. DENTON: We have one more slide, and that would complete our presentation.

MR. COFFMAN: If we could go to viewgraph number 10.

(Slide)

I think we may have covered a lot of this already, the relationship to the other programs.

There has been some progress in already identifying these procedures, these methods which we've talked about, into a procedures guide, PRA procedures guide identified there.

COMMISSIONER AHEARNE: I guess I am a little puzzled by that, but we've just finished hearing how we do not yet know what approach to take and you're trying to develop an approved approach, but this says that the systems interactions analysis procedures have been incorporated into the procedures guide as at least I think

-- I inferred -- that we would have had to reach a conclusion as to what procedures we wanted to endorse.

MR. COFFMAN: They're included as options and identified --

COMMISSIONER AHEARNE: And which ones are included?

MR. COFFMAN: The PASNY methodology, fault tree interactive failure-modes-and-effects, and the DIGRAPH matrix.

COMMISSIONER AHEARNE: All three?

MR. COFFMAN: Yes sir. And they're included in a general way where it's more up to the analyst. But they're at least identified and the process of searching separately for interactions is called out.

The tie-in with PRAs is -- obviously provides a basis or a means for assessing the radiological risk significance of any discovered interactions in whatever units of incremental risk, increase or decrease you want to use or whatever is calculated by the PRA.

COMMISSIONER AHEARNE: Are you saying that as that once you have found something by systems interaction study, then PRA can determine how significant it is as opposed to saying that PRA is already giving you results on systems interactions?

MR. COFFMAN: Yes, it's the former.

If you do the systems interaction -- or once having done the systems interaction analysis at a plant, you can then assimilate the results into a PRA and you can do this, you either prune the trees when you establish that there are in fact deterministic dependencies that you have identified or you can add in the appropriate conditional probabilities to reflect stochastic dependencies that you are not certain that may or may not occur given an event.

And then there is by the combination of systems that are modeled in the PRA and in doing a Boulean absorption more on combinations of systems rather than just within one system, you then are able to pick up interactions that cross systems or possibly are part of an initiating event, could cause an initiating.

Another major or another close relationship exists between A-17 and A-47, safety implications of control systems. And there they are analyzing specific consequences in A-47 of only non-safety-grade control system malfunctions, and they are looking for specific consequences, like steam generator or reactor vessel overfill or reactor vessel overcooling, jeopardy to the reactor protection system or jeopardy to manual shutdown. So they're focused in on specific consequences there.

They do consider single failures, but it's primarily in the sense of they're selected single failures

and they're looking at the effects on a systems level, at the systems level. Once having identified these failures, then if it appears to have a significant systems level impact, they will then go to a simulator where they will do a more dynamic analysis looking for mutual influence among several parameters.

CHAIRMAN PALLADINO: Do they have the -- are they trying to search out or are they making assumptions about control system malfunctions? Do they have the same problem you have on systems interaction?

MR. COFFMAN: They have the same problem. They are searching out primarily by the use of a failure-modes-and-effects analysis. They selectively fail certain components. They may even fail combinations of components that are otherwise independent if past data has shown that there is a high failure rate on this other, on the second component.

So their search process is primarily one of experience, the analysts' inductive --

CHAIRMAN PALLADINO: Do they get away with that because they're looking at a smaller universe? Or if that's a good system for them, why isn't it a good system for systems interaction?

MR. COFFMAN: In fact, we've adopted it in the method where we referred to the fault tree interactive

failure-modes-and-effects analysis, but we've tried to begin more with the systems -- with the functions, moved down to the systems, down through the components, and then identify, try to identify the failed components that will -- in fact we know -- affect the safety functions.

They begin with selected failures. So there is that distinction.

MR. SPEIS: Let me say one thing about that. The focus there is to make sure that the failure is to identify non-safety control system whose failure could lead to some transients whose consequences would be exceeded by design-basis type of transients or accidents.

Also, we're looking at the frequency of the transient itself: Would the failure of an uncontrolled system lead to something more frequent than we thought before and therefore put it into the design-basis bin, you know; for example, overfilling of the steam generator or the vessel in a BWR.

MR. COFFMAN: The last comment would be that we're aware of this effort. We're aware of the large Office of Research program in this area and the fact that they will be using some sophisticated codes where they're trying to get the real-time effects of the plants, trying to get them interactive with the operators.

And we're going to enhance our interface with

them. We've been aware of this effort, that there is a need for us to enhance our interface.

I think we've covered the things I had on the viewgraphs.

MR. DENTON: I think we're at that point of awaiting for the results from the Indian Point study, and maybe some preliminary findings from these others. Perhaps later this year we'll have the first real hard results coming back in. It might be appropriate at that time to rebrief you on where it stands. We do have a case --

CHAIRMAN PALLADINO: When do you expect to get something?

MR. DENTON: I think the Indian Point study is intended to, at least the first results, come in this fall.

MR. THADANI: Yes. September, I believe.

CHAIRMAN PALLADINO: And this is on all the three types of failures, two or three types of coupling?

MR. DENTON: Yes. And that's probably the most extensive program, and it will be the first that would be completed.

CHAIRMAN PALLADINO: Now, they're supporting that themselves?

MR. DENTON: That is correct.

CHAIRMAN PALLADINO: But the other two are going to come in with the DIGRAPH matrix, and is this the fault

tree here?

MR. COFFMAN: Enhanced.

COMMISSIONER AHEARNE: Enhanced fault tree.

MR. DENTON: Enhanced fault tree.

CHAIRMAN PALLADINO: Are you going to support that?

MR. DENTON: We were going to support that. It's on the order of a million dollars, I think, the two combined, isn't it?

MR. THADANI: It's about a million dollars each.

MR. DENTON: It keeps going up.

(Laughter)

COMMISSIONER AHEARNE: The amount is listed in the back here, something like $2.6 million.

MR. THADANI: Yes.

COMMISSIONER AHEARNE: For '83 and '84.

MR. THADANI: Total program, yes.

MR. COFFMAN: It depends upon the scope, which is still being defined. But that would be the larger numbers.

MR. SPEIS: That's nopefully a bounded number.

MR. COFFMAN: Yes.

COMMISSIONER AHEARNE: Well, we are in the area right now where we should be spending these kinds of money -- that is, '83 moneys. Do you have this kind of money in '83?

MR. DENTON: I think we've got most of it planned for this purpose if we could define the job to everyone's satisfaction.

COMMISSIONER AHEARNE: I gather that Brookhaven is the group that is working on the enhanced fault; is that correct?

MR. COFFMAN: Yes, sir.

COMMISSIONER AHEARNE: What is the group that is working on the DIGRAPH matrix?

MR. COFFMAN: Lawrence Livermore.

COMMISSIONER AHEARNE: And the second question was, AEOD would seem to me to be an office that would have a lot of interest at least in working with you or at least commenting on what you are doing, since clearly the examination of the way systems fit together has to be one of the concerns as they look at, for example, to their LER analysis. What is their opinion of any of these issues, these programs? Do you know?

MR. DENTON: I think Mr. Heltemes is here representing that office.

MR. HELTEMES: Jack Heltemes, AEOD.

Dr. Ahearne, we have not looked specifically to view the program. We think it's a different and complementary approach. We look backwards, if you will, to operating experience, and I think they're looking forward

trying to anticipate problems.

So we would endorse the program as added assurance, if you will, of trying to uncover systems interactions. That's one of our principal goals and objectives, and we spend a lot of time doing that too, but we do it differently.

COMMISSIONER AHEARNE: I wondered whether you couldn't perhaps give them at least the benefit of perspective or advice on -- all of these have the potential of becoming very massive programs, and if perhaps -- as you say, you look backwards, so you have been looking at specific instances where things really have happened,and I didn't know whether perhaps by having someone on your staff at least looking at what they're doing, you might be able to narrow some of that scope.

My concern in this effort is that it has the potential of becoming so large that nothing ever gets done. It could easily -- as you pointed out in the Sandia effort it just got out of hand. It was just too large.

MR. HELTEMES: Well, we have, of course, shared all our thoughts in the sense of completed analyses with NRR, so they know where we have found the problems. Whether or not we could aid substantially in trying to reduce the scope, I am kind of reluctant I guess to go through that.

(Laughter)

COMMISSIONER AHEARNE: I just urge you to think about it because this has a lot of potential to get unbounded. And they recognize it, I am sure of that.

COMMISSIONER ASSELSTINE: I wonder if I could ask Jack a quick question before he leaves there. Would you agree basically that in your backward look, that you don't see evidence as well that systems interaction is a significant contributor to risk?

MR. HELTEMES: Well, I can say that in the studies that we have conducted, we certainly have seen evidence of systems interaction which has disturbed us, and we have done a number of studies, and that's one of the areas we really look at in reviewing operational information, primarily LER and foreign reports, primary sources there.

We certainly see a number of serious situations, we would say. Whether they're substantial contributors to overall risk, that's why we really identify them to NRR so that they can put them in perspective.

From an engineering standpoint -- and that's the way we go after it, through the engineering analysis -- they're troublesome to us.

COMMISSIONER ASSELSTINE: For the ones that you would view as significant, do they tend to fall in any one of the categories that was mentioned; that is, the spatial

relationships or the functional or the operator-related ones?

MR. HELTEMES: We have seen evidence of all three. And we have done studies of all three. For example, we have done a study very recently of the electrical equipment and how its failure modes could affect nearby equipment. But that particular study indicated that there were no serious problems within the plant. And so the results were very supportive to NRR's conclusions.

But we have seen human error and we have seen other coupling techniques that have resulted in system unavailability, safety system unavailabilities.

Does that answer your question?

COMMISSIONER ASSELSTINE: Yes.

MR. DENTON: Putting in more effort, we might find more. The question is is it -- should we put it in this way or put it in a bigger backwards look?

COMMISSIONER AHEARNE: Yes.

MR. DENTON: That's a question we've been grappling with, rather than just putting more into the front end.

There have been important system interactions that have been found, and that's how those did get into the Standard Review Plan. I think what we were discussing is how many more are out there to bite us that we might find

if we had the techniques to locate them.

COMMISSIONER AHEARNE: Yes.

CHAIRMAN PALLADINO: Any questions?

COMMISSIONER AHEARNE: No.

COMMISSIONER ROBERTS: No.

CHAIRMAN PALLADINO: There was one item I had mentioned earlier, although you have enlightened me so I could almost answer it myself. But what was said in the annual report has been thrust up to me a couple of times, the one in 1981, saying, during the coming year the staff will complete development of regulatory guidance for application and final analyses of systems interactions plan that some new plants nearing completion of construction. Staff also will be evaluating the conduct of the Indian Point analyses scheduled to begin in November 1981. We will be reading the results of that effort. I think that was more forward-looking.

At one time I wouldn't know how to have answered that. I don't know if you had any comments.

MR. DENTON: Other than I do not know specifically other than these reports are put together in anticipation of accomplishments, and it didn't come true.

CHAIRMAN PALLADINO: Okay, any other questions?

(No response)

CHAIRMAN PALLADINO: All right. Well, thank you

very much.

MR. DENTON: Thank you.

CHAIRMAN PALLADINO: This has been very revealing to me. I didn't appreciate what all systems interaction involved. I am not sure I still appreciate it, but I have a better feel for the extensiveness of it.

Unless there is anything more, we will stand adjourned.

MR. DENTON: Thank you.

(Whereupon, at 4:00 p.m., the Commission was adjourned.)

CERTIFICATE OF PROCEEDINGS

This is to certify that the attached proceedings before the NRC COMMISSION

In the matter of: Briefing on Systems Interactions

Date of Proceeding: April 18, 1983

Place of Proceeding: Washington, D.C.

were held as herein appears, and that this is the original transcript for the file of the Commission.

Mary C. Simons
Official Reporter - Typed

Mary C. Simons
Official Reporter - Signature

T. P. Speis, DST/NRR
x 27517

COMMISSION BRIEFING

ON

SYSTEMS INTERACTION PROGRAM

AND STATUS (USI A-17)

APRIL 18, 1983

SYSTEMS INTERACTION

BRIEFING OUTLINE

I. INTRODUCTION & BACKGROUND

- DEFINITION OF SYSTEMS INTERACTION
- TYPES OF SYSTEM INTERACTIONS
- STAFF FOCUS ON SYSTEMS INTERACTION
- NEED FOR SYSTEMS INTERACTION ANALYSES
- PRESENT STAFF REVIEWS OF POTENTIAL SYSTEMS INTERACTIONS

II. SYSTEMS INTERACTION PROGRAM (A-17)

- OBJECTIVES
- PROGRAM OUTLINE AND SCHEDULE
  - UTILITY PROGRAMS
  - INDEPENDENT METHODS DEVELOPMENT
  - PROGRAM EVALUATION & IMPLEMENTATION
- RELATIONSHIP TO OTHER PROGRAMS
  - PRA
  - A-47

SYSTEMS INTERACTION: AN INTERSYSTEMS DEPENDENCY THAT JEOPARDIZES THE DESIGNED ACTION WHICH A SAFETY-RELATED SYSTEM WAS TO PERFORM.

GENERAL EXAMPLES

1. A FAILED POWER SUPPLY CAUSING SPURIOUS SIGNALS TO THE CONTROL SYSTEM WHICH IN TURN CAN OPEN RELIEF VALVES CAUSING A LOSS OF COOLANT, A SMALL LOCA.

2. A FAILED POWER SUPPLY WHICH COULD RESULT IN FAILURE OF CONTROL INSTRUMENTATION LEADING TO A TRANSIENT RESULTING IN REACTOR SCRAM.

3. FAILURE OF BOTH VENT AND DRAIN SYSTEMS, DUE TO A COMMON DISCHARGE, COULD LEAD TO A PARTIAL FAILURE TO SCRAM IN BWRs.

4. FAILURE OF A TURBINE COULD GENERATE A MISSILE WHICH IN TURN COULD DAMAGE SAFETY RELATED EQUIPMENT.

5. A FIRE IN SOME COMPARTMENTS COULD RESULT IN SOME LOSS OF DECAY HEAT REMOVAL CAPABILITY.

TYPES OF SYSTEMS INTERACTIONS

FUNCTIONALLY COUPLED SYSTEMS INTERACTIONS-THAT RESULT EITHER FROM THE SHARING OF COMPONENTS BETWEEN SYSTEMS OR THROUGH PHYSICAL CONNECTIONS BETWEEN SYSTEMS INCLUDING ELECTRICAL, HYDRAULIC, PNEUMATIC AND MECHANICAL.

SPATIALLY COUPLED SYSTEMS INTERACTIONS THAT RESULT FROM THE PROXIMITY OF SYSTEMS TO ONE ANOTHER WITHIN THE PLANT.

INDUCED-HUMANLY COUPLED SYSTEMS INTERACTIONS WHERE A PLANT MALFUNCTION OR AN ERROR IN WRITTEN PROCEDURES INDUCES AN OPERATOR ACTION.

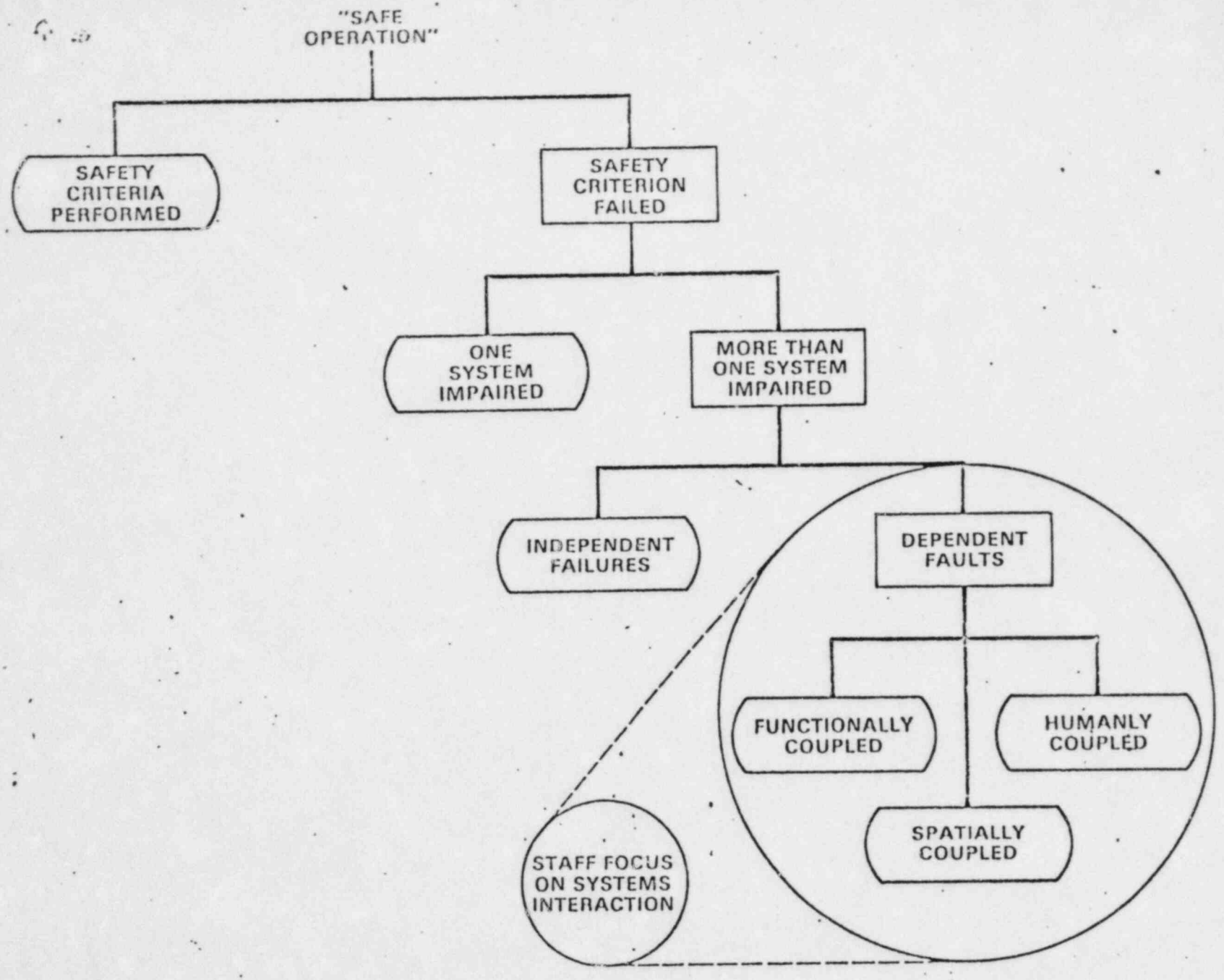

Illustration of Systems Interaction Focus

NEED FOR SYSTEMS INTERACTION ANALYSES

1. OPERATING REACTOR EXPERIENCE HAS REVEALED UNPREDICTED DEPENDENCIES (COMMON-CAUSE FAILURES)

   FOR EXAMPLE:

   BROWNS FERRY PARTIAL FAILURE TO SCRAM
   CRYSTAL RIVER - LOSS OF DC POWER
   BROWNS FERRY FIRE

2. THE ASSIGNMENT OF THE STAFF'S REVIEW SOMETIMES FOLLOWS THE ASSIGNMENT OF DESIGN TASKS TO TEAMS THAT ONLY SPECIALIZE IN PART OF THE PLANT.

3. ACRS HAS BEEN STRONG PROPONENT OF SYSTEMS INTERACTIONS STUDIES SINCE 1974

PRESENT STAFF REVIEWS OF POTENTIAL SYSTEMS INTERACTIONS

STANDARD REVIEW PLAN

HAZARD	SECTION
EARTHQUAKE	3.2 & 3.4
ENVIRONMENTAL QUALIFICATIONS	3.11
FIRE	9.5
FLOODING	3.4 & 3.6
HIGH ENERGY LINE BREAKS	3.6
HURRICANES/TORNADOS	3.3
MISSILES	3.5
REACTOR PROTECTION SYSTEMS	7.2
SAFE SHUTDOWN SYSTEMS	7.4

OIE BULLETINS

CONTROL SYSTEMS POWER SUPPLIES	(79-27)
MASONRY WALLS	(80-11)

THE PROGRAM ON USI A-17 IS A SYSTEMATIC RE-EXAMINATION OF PRESENT REQUIREMENT FOR ADEQUACY CONCERNING SYSTEMS INTERACTIONS

PRESENT RESULTS SHOW THAT CURRENT REQUIREMENTS APPEAR ADEQUATE PENDING COMPLETION OF THE PROGRAM

STAFF'S OBJECTIVES FOR SYSTEMS INTERACTIONS

1. TO DEVELOP INDEPENDENT METHODS TO ANALYZE PLANTS FOR INTERSYSTEMS DEPENDENCIES.

2. TO ASSESS THE ADEQUACY OF THE STANDARD REVIEW PLAN FOR COMPLETENESS CONCERNING SYSTEMS INTERACTIONS.

3. TO PROVIDE CORRECTIONS TO THE S.R.P. (AND POSSIBLY REGULATORY REQUIREMENTS) THAT WERE IDENTIFIED BY THE ASSESSMENT.

4. TO ASSESS THE RISK SIGNIFICANCE OF SYSTEMS INTERACTIONS.

SYSTEMS INTERACTION PROGRAM TASKS

		SCHEDULE
1.	**REVIEW OF UTILITY PROGRAMS**	
	PG&E RESULTS FROM DIABLO CANYON	1/84 - 4/84
	ASNY STUDY OF INDIAN POINT-3	11/80 - 9/84
	CPCo PROGRAM ON MIDLAND-2	6/82 - 3/85
2.	**INDEPENDENT METHODS DEVELOPMENT**	
	DIGRAPH-MATRIX ANALYSIS DEMONSTRATION	9/82 - 9/83
	METHODS APPLICATION (PROPOSED)	4/83 - 7/84
	EVALUATION OF APPLICATION	7/84 - 10/84
	METHODS APPLICATION IN SEP-III/NREP	UNSCHEDULED
3.	**EVALUATION AND DECISION ON USI A-17**	
	EVALUATION OF PROGRAM RESULTS	7/84 - 10/84
	DECISION ON SPECIFIC REQUIREMENTS	10/84
4.	**IMPLEMENTATION OF SPECIFIC REQUIREMENTS**	
	PROCESSING THE REGULATORY REQUIREMENTS	10/84 - 9/85
	ISSUE REG. GUIDE ON METHODS	10/84 - 9/85

RELATIONSHIP TO OTHER PROGRAMS

1. PRA

   - o SYSTEMS INTERACTIONS ANALYSIS PROCEDURES HAVE BEEN INCORPORATED INTO THE PRA PROCEDURES GUIDE (NUREG/CR-2815).

   - o PRAs PROVIDE A BASIS TO ASSESS THE RADIOLOGICAL RISK SIGNIFICANCE OF SPECIFIC SYSTEMS INTERACTIONS.

   - o LESSONS LEARNED FROM THE SYSTEMS INTERACTIONS PROGRAM WILL BE ASSIMILATED INTO SUBSEQUENT PRA EFFORTS.

2. TASK A-47 (SAFETY IMPLICATIONS OF CONTROL SYSTEMS

   - o A-47 IS ANALYSING SPECIFIC CONSEQUENCES OF ONLY CONTROL SYSTEMS MALFUNCTIONS.

   - o A-47 CONSIDERS SINGLE INDEPENDENT FAILURES ALSO.

12/82

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Meeting Title: Briefing on Systems Interaction

Meeting Date: 4/18/83 Open X Closed ____

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