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PUBLIC NOTICE
BY THE
UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

AUGUST 7, 1996

The contents of this transcript of the proceedings of the United States Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards on AUGUST 7, 1996, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

PROBABILISTIC RISK ASSESSMENT SUBCOMMITTEE

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WEDNESDAY

AUGUST 7, 1996

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, T2B3, 11545 Rockville Pike, at 8:34 a.m., George Apostolakis, Chairman, presiding.

COMMITTEE MEMBERS:

GEORGE E. APOSTOLAKIS, Chairman

IVAN CATTON, Member

MARIO H. FONTANA, Member

THOMAS S. KRESS, Member

DON W. MILLER, Member

DANA A. POWERS, Member

WILLIAM J. SHACK, Member

ROBERT L. SEALE, Member

JOHN J. BARTON, Member

ACRS STAFF PRESENT:

JOHN T. LARKINS, Executive Director
MICHAEL T. MARKLEY
PAUL BOEHNERT
AMARJIT SINGH
MEDHAT M. EL-ZEFLAWY
NOEL DUDLEY

ACRS FELLOW PRESENT:

DR. RICHARD SHERRY
DR. GUS CRONENBERG

ALSO PRESENT:

TONY PIETRANGELO
JACK HAUGH
DOUG TRUE
GARY HOLAHAN
ALLEN HACKEROTT
RAY SCHNEIDER
ED BUTCHER
MICHAEL C. CHEOK
BOB YOUNGBLOOD
MARK CUNNINGHAM
STEPHEN DINSMORE
ANN ROMEY-SMITH

<u>ALSO PRESENT</u>: (CONTINUED)

PAT BARANOWSKY

HUSSEIN HAMAZEHE

RICHARD H. WESSMAN

GOUTMAN BAGCHI

KEN BALKEY

JOE MURPHY

WAYNE HODGES

A-G-E-N-D-A

P-R-O-C-E-E-D-I-N-G-S

(8:34 a.m.)

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a meeting of the ACRS subcommittee on probabilistic risk assessment. I am George Apostolakis, Chairman of the subcommittee.

ACRS members in attendance are Tom Kress, Mario Fontana, Charlie Wiley, Robert Seale, William Shack and Dana Powers.

The purpose of this meeting is to discuss risk-based in-service testing and in-service inspection requirements, pilot applications for risk-informed and performance-based regulations and related matters.

The subcommittee will also continue its discussion of issues identified in the staff requirement memoranda dated May 15 and June 11, 1996 including the role of performance-based regulation in the PRA implementation plan, plant-specific application of safety goals and requirements for risk neutrality versus the allowance for acceptable increase in risk. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full committee.

Michael T. Markley is the cognizant ACRS staff engineer for this meeting. The rules for participation in today's meeting have been announced as part of the notice of this meeting, previously published in the Federal Register on July 24, 1996. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard. We have received no written comments or requests for time to make oral statements from members of the public. We will proceed with the meeting, and I call upon Mr. Rick Sherry, ACRS Senior Fellow who will talk about high level goal definition and risk allocation.

DR. SHERRY: Thank you.

What I'd like to present today are some insights and methods for construction of lower level risk and performance goals based on high level goals, either the safety goal quantitative health objectives, or from the subsidiary safety goals.

The safety goals which have been identified include the two quantitative health objectives which are defined in the safety goal policy statement. For accidents initiated at full power, the individual early fatality frequency QHO is generally always the controlling health objective.

Based on the most recent U.S. accident data the quantitative value for the individual early fatality frequency safety goal is about 3.5 times 10 to minus 7 per reactor year.

The other subsidiary goals or the subsidiary goals which have been identified include the general performance guideline for a large release of radioactive materials of 10 to the minus 6 per reactor year which was identified in the safety goal policy statement also. And several goals which have been identified in various NRC documents including SEC-89-102 including the core damage frequency subsidiary of 10 to the minus 4 per reactor year, and the conditional containment failure probability of 0.1 which was identified for evolutionary plants.

MEMBER KRESS: Rick, where did you say that showed up in?

DR. SHERRY: One of the places it shows up is in SECY-89-102.

MEMBER KRESS: NUREG-1150 has the early fatality 5 times 10 to the minus 7. Has the accident rate changed that much since then?

DR. SHERRY: Yes. It's gone from about 50 per 100,000 down to 35 per 100,000 largely due to a reduction in automobile accidents.

To put these various goals in perspective with regard to a Level 3 PRA, the CDF goal can be compared against the output or the results from the Level 1 PRA. The large release frequency goal can be compared against the output or results from a Level 2 PRA. And of course the safety goal of quantitative health objectives can be compared against the offside risk results from a Level 3 PRA.

The one goal or proposed subsidiary goal which does not appear to correlate well with any of the defined levels of a PRA is the conditional containment failure probability goal in the sense that it is measuring only the integrity of the containment from the standpoint of a leak-tight barrier. And even considering its most general definition which would include loss of isolation and containment and containment bypass, it does not consider all aspects of containment performance related to risk.

The main areas which it neglects to cover are the mitigative functions of the containment. It doesn't account for suppression pool scrubbing, removal of radionuclides by other engineered safety features, sprays, fan coolers, ice condensers, etcetera.

MEMBER KRESS: So you wouldn't call that CCFP a good surrogate for the real goals?

DR. SHERRY: That's correct. I don't believe

-- of all the goals that's been proposed, I think it is the least robust and the one that's the most flawed.

One top-down approach to the definition of lower level goals is to identify the safety goal QHOs as the top objective, and then to develop lower level goals based on the results from PRAs to map from the safety goal QHOs to core damage frequency, large early release frequency goals. This is what I call the single objective top-down approach.

One of the elements of the top-down approach is the necessity to allocate the upper level goals horizontally across the spectrum of sequence types. As I have shown on this slide I have broken down the various initiator types into seven groups.

There are possibly various ways to do this, but one of the central concepts for doing this is try to balance the allocation or risk so that no one particular sequence or group of sequences will be allowed to dominate risk.

Once the lower level goals, safety goals, have been defined, then lower level performance criteria can be developed at the function, system or component level for use in a performance-based regulatory activity.

CHAIRMAN APOSTOLAKIS: Rick, wouldn't it be a little more, a little better from the communication point of view to have two or three levels first to have, immediately after the goals, the modes of operation, then underneath the major subsidiary goals, and then seismic/ fire and so on? Because these really we are mixing now shutdown/transition with seismic/fire. One is where the plant is and the other one is really a contribution to risk?

DR. SHERRY: Yes, that's true. I could -- one could subdivide for example the shutdown transition group into accidents caused by seismic/fire --

CHAIRMAN APOSTOLAKIS: Yes.

DR. SHERRY: -- internal initiators.

CHAIRMAN APOSTOLAKIS: Rearrange, not divide, rearrange the figure.

DR. SHERRY: I guess it could be done that way. I didn't see the need to do that at least for this sort of demonstration I guess.

CHAIRMAN APOSTOLAKIS: Well, as you go down from the top to the next level, the first thing to worry about is risk from operations, power operations and shutdown, right? So this would seem to be the very first step. In that sense that kind of hierarchy would be helpful. And then you go one stop down, what is it that contributes the most to each one of these, then you have the subsidiary goals. In that sense it would be a little more instructive I think.

DR. SHERRY: Yes, it certainly could be done that way.

MEMBER SEALE: Put it another way, the way George is suggesting you could add everything in the first subsidiary level and you'd get, the sum would be risk at the next higher level. Whereas on this array across here, these don't add to be equal to the QHO.

DR. SHERRY: Well, the way I would define them they would add. For example within the shutdown transition route, that would include all sequences initiated from non-power operation, whatever the initiator type.

CHAIRMAN APOSTOLAKIS: How about seismic, would seismic be part of it?

DR. SHERRY: Yes, seismic events initiator--

MEMBER SEALE: They don't add.

CHAIRMAN APOSTOLAKIS: Because you have separated seismic out.

DR. SHERRY: Yes, but the seismic, all the other boxes except for shutdown transition refer only to actions initiated at full power, at least in my setup.

CHAIRMAN APOSTOLAKIS: I know. I mean it's not wrong, it's just that it would be more instructive if you --

DR. SHERRY: It would include --

CHAIRMAN APOSTOLAKIS: -- I know, yes, that's the point.

MEMBER SEALE: That's the point.

DR. SHERRY: In the next several tables I am going to go through an example of this top-down goal definition and allocation of risk.

This slide basically is a summary of the NUREG-1150 Surry PRA analysis, and also the shutdown risk study for the Surry plan. I am using Surry as an example because it represents the plant with the most complete set of PRA studies.

Before I go on, I'm going to use a definition of large early release. Large early release is a average release of the volatile radionuclides iodine, cesium and telvrium group of 10 percent in a time period prior to the initiation of emergency protective actions. That's my definition of what a large early release is.

CHAIRMAN APOSTOLAKIS: So average first what, your averaging over what, average risk fraction?

DR. SHERRY: Average?

CHAIRMAN APOSTOLAKIS: The first work average?

DR. SHERRY: Yes.

CHAIRMAN APOSTOLAKIS: Over what? It's the average over what?

DR. SHERRY: It's the average of iodine, cesium and telvrium --

CHAIRMAN APOSTOLAKIS: No, no, that's the average of, but it's averaged over what? I mean what is the variable that this is the average of?

CHAIRMAN APOSTOLAKIS: Well, it's release fractions, okay. For example you have a release fraction 12 percent of iodine, eight percent of telvrium group, and nine percent of cesium. It's a simple, the average of those three release fractions.

CHAIRMAN APOSTOLAKIS: Add them up and divide by three, is that what you're saying?

DR. SHERRY: That's correct.

CHAIRMAN APOSTOLAKIS: Oh!

MAN: Higher math.

DR. SHERRY: Nothing complicated.

This slide shows the results of NUREG-1150 and shutdown studies given in terms of conditional risk. What you see here is the large early release conditioned on core damage, the individual early fatality conditioned on large early release, and the individual early fatality conditioned on core damage for each of those groups of sequences that I defined earlier.

I will use these conditional probabilities then to map from higher level goals to lower level goals.

And again this makes this analysis specific to the Surry PRA analysis.

Finally, this slide is a summary of the single objective top-down approach. In this column I have allocated the safety goal QHO value of 3.5 times 10 to the minus 7. That frequency I've allocated it equally amongst seven sequence groups. I have also subdivided the bypass group into two subgroups based on quite different conditional consequences from the 1150 study.

Starting from these allocated IEFF goals, then I calculate a large early release frequency goal using the conditional probability shown on Table B to establish a LERF goal for each sequence group. Similarly in this column I determined a core damage frequency goal, again using the conditional probabilities and the IEFF goal in showing this slide.

The important result from this approach is that the derived subsidiary goals directly calculated from the safety goal quantitative health objects result in total values for the large early release frequency goal and core damage frequency goal which are significantly higher than the proposed subsidiary goals, okay. Indicating that the CDF goal and the LERF goal that have been proposed are more restrictive than the safety goal quantitative health objectives.

CHAIRMAN APOSTOLAKIS: Let's understand this a little better. The goals -- well, first of all here, when you say seismic you mean all modes of operation?

DR. SHERRY: Again, it's only seismic full power. The same --

CHAIRMAN APOSTOLAKIS: Oh, okay. So if we add the top, like is it six or so, we get the number for power operation, correct. One, two, three, four, five, six, seven, up to other external, would that be correct?

DR. SHERRY: That's correct.

CHAIRMAN APOSTOLAKIS: Add those and get the power number?

DR. SHERRY: From here to here, yes.

CHAIRMAN APOSTOLAKIS: Yes, to there, yes, okay.

DR. SHERRY: That's full power.

CHAIRMAN APOSTOLAKIS: That's full power. And the first column is the actual results of NUREG-1150?

DR. SHERRY: That's correct.

CHAIRMAN APOSTOLAKIS: Now, how did you determine the goals in the next three columns?

DR. SHERRY: Okay, let me put this back up. For this particular column, okay, I had calculated an overall individual early fatality frequency QHO of 3.5 E to the minus 7.

CHAIRMAN APOSTOLAKIS: This was calculated where?

DR. SHERRY: It's calculated based on the current accident rate in the United States 35 per 100,000, nd the direction in the safety goal policy statement that says that the risk should be no more than 1/10th of one percent.

CHAIRMAN APOSTOLAKIS: So is this number based on data and calculations?

DR. SHERRY: This number?

CHAIRMAN APOSTOLAKIS: Yes. Or is it a goal that somebody legislated? This number, yes, 3.5 --

DR. SHERRY: It's a combination of both. It's calculated based on the guidance and of safety goal policy statement. And data in a sense of it's a current accident death rates in the United States

CHAIRMAN APOSTOLAKIS: Okay. But it's not the NUREG-1150 result?

DR. SHERRY: NUREG-1150 used 5E to the minus 7 for this based on accident death rates in 1986 I believe. Using this number then I essentially divided equally amongst the seven groups with this being a subdivision, okay. So it was equal allocation of this goal amongst these sequence groups, okay. So that's how this column was established.

MEMBER KRESS: You didn't do anything with that other than just use it to compare with what --

DR. SHERRY: Well, no, I used this number then and the conditional probabilities shown on --

MEMBER KRESS: Okay, to go to the other one --

DR. SHERRY: -- this to calculate this --

MEMBER KRESS: -- yes.

DR. SHERRY: Similarly, I used the conditional probabilities shown on the previous slide, you know, relating the individual early fatality to the core damage frequency to calculate this value for the CDF goal base don this IEFF goal, okay. Do you understand?

CHAIRMAN APOSTOLAKIS: And what was the conclusion again, that the CDF goal is --

DR. SHERRY: Well, that the --

CHAIRMAN APOSTOLAKIS: -- that's not the goal anymore, that's a calculation, right?

DR. SHERRY: That's a calculated --

CHAIRMAN APOSTOLAKIS: Yes.

DR. SHERRY: -- CDF goal derived directly from the safety goal qualitative health objectives. And this is not surprising, other people have seen this, and this is I think the point that Duncan Brewer was making at the last meeting, that if you calculate a CDF goal based on the safety goal quantitative health objectives, it will be, you know, generally about 10 to the minus 3.

CHAIRMAN APOSTOLAKIS: But you have made the assumption though that the individual early fatalities goal can be allocated fully for all the sequences. And if you look at the actual frequencies there is a tremendous difference.

DR. SHERRY: Yes, I mean that's arbitrary.

CHAIRMAN APOSTOLAKIS: Yes, I know. But I mean how much does the conclusion depend on this arbitrary assumption?

DR. SHERRY: In fact if you allocated it on a different rationale, let's say that you choose to allocate lower goals to the sequences which you believe have higher consequences. What that will result in then is essentially a larger allocation of the goal to less, for sequences with lower risk, conditional risk. This will result in an even higher --

CHAIRMAN APOSTOLAKIS: Really.

DR. SHERRY: -- yes, what you're doing is if you lower the allocated goal for sequences with high risk, transfer that to sequences with low risk, this will allow you to go to effectively a higher -- right.

CHAIRMAN APOSTOLAKIS: What was the actual core damage frequency that the 1150 calculated? You had it earlier.

DR. SHERRY: Sure do. Excuse me.

CHAIRMAN APOSTOLAKIS: Core damage.

DR. SHERRY: Core damage. I believe it's 1.4 times 10 to the minus 4, if my calculated is a total.

CHAIRMAN APOSTOLAKIS: So is that consistent with what you just said? Obviously there is an allocation that leads to a lower CDF than you have there. Anyway, I have to understand that better.

DR. SHERRY: Okay.

MEMBER SHACK: You're just saying that, I mean, if you meet the 1 times 10 to the minus 4, you're way ahead?

DR. SHERRY: Yes, for sequences which basically are not all weighted towards these high consequence sequences like, you know, if you had a 10 to the minus 4 core damage frequency for bypass sequences, now, that's a different story.

DR. SHERRY: Okay.

CHAIRMAN APOSTOLAKIS: So basically what you're saying is that, if you work backwards from the top level goals and you use the actual conditional failure probability so that the payment and other things, then the result in core damage frequency is higher than the goal that most people accept right now.

DR. SHERRY: That's correct.

CHAIRMAN APOSTOLAKIS: So the goal is more restrictive.

DR. SHERRY: Based on that observation another approach to top-down definition is to essentially allow, instead of only the safety goal quantitative health objectives being identified as top level objectives, identify the large early release frequency and the core damage frequency as equally important objectives that you're trying to meet.

This has some, I think, some, how shall I say it, some desirable features in that now you have a high level objective that basically controls risk both at the prevention level at the core damage frequency, at the containment performance level with the large early release frequency, and at the offside risk level with the safety goal quantitative health objectives.

The idea behind this approach is that you would again allocate each of these goals to a lower level and then choose for each of the sequence group the goal which is controlling, okay, as then the lower level goal that you're trying to meet. And again I have an example of application of this approach.

What you see here are, these three columns are the CDF goals calculated based on the three different objectives. In this case the CDF goal is calculated from the safety goal quantitative health objectives. In this case it's calculated based on the LERF goal, and in this case it's directly based on the safety goal, excuse me, the core damage frequency goal of 10 to the minus 4.

MEMBER KRESS: Now, these numbers would be dependent on your site, right?

DR. SHERRY: Yes.

MEMBER KRESS: So this is strictly specific for Surry site?

DR. SHERRY: That's right, these are strictly for the Surry site, so in that sense they are plant specific. Okay, because all the conditional probability shown on my second table were for Surry, okay.

And then the idea is to select, to compare the various goals for each of the sequence groups to determine which is limiting, okay, and choose that as the goal that you intend to meet, okay.

CHAIRMAN APOSTOLAKIS: What is the third column? Oh, I see, I'm sorry.

DR. SHERRY: Well, column here?

CHAIRMAN APOSTOLAKIS: Yes, that's fine. Go ahead.

DR. SHERRY: That's just --

CHAIRMAN APOSTOLAKIS: I understand.

DR. SHERRY: Okay. This column here that is a collection of the minimum values from each of these three columns, okay, that I claim represent the goal, the CDF goal, that you're intending -- that you should meet. And then these are the results from the 1150 study just for comparison.

MEMBER KRESS: So what that tells you is that you might as well just use the core damage frequency except for seismic and bypass?

DR. SHERRY: Well, basically what this tells you is that the core damage frequency goal will control all sequence or sequence groups which have low conditional risk. However, either the LERF goal or the safety goal QHO, and generally it will be the LERF goal, will control all the sequences like bypass seismic with high conditional consequences.

MEMBER KRESS: And it also tells you that CDF of 1 times 10 to the minus 4 is not all that bad with respect to the quantitative health goal. Because you had 8 times 10 to the minus 5, that's almost 10 to the minus 4.

DR. SHERRY: Right. But what happens is this has been reduced from the previous slide I guess, I guess it was the previous slide, in that a number of the sequences are now controlled by the goal of limiting the core damage frequency below E to the minus 4.

MEMBER KRESS: I guess that would come out to the E to the minus 4 if it hadn't have been for the seismic and the --

DR. SHERRY: Well, that's right.

MEMBER KRESS: -- so it's surprising, yes, okay.

DR. SHERRY: This would come out exactly to the --

MEMBER KRESS: Yes --

DR. SHERRY: -- minus 4 --

MEMBER KRESS: -- I'm sorry --

DR. SHERRY: -- if it wasn't for some of these other --

MEMBER KRESS: -- yes, it depends on what you started with is what you get there, that's right, okay.

CHAIRMAN APOSTOLAKIS: So this approach then, the core damage frequency should not be called a subsidiary goal, right?

DR. SHERRY: That's correct.

CHAIRMAN APOSTOLAKIS: It's a fundamental objective.

MEMBER KRESS: Yes.

DR. SHERRY: I guess my recommendation --

CHAIRMAN APOSTOLAKIS: A misnomer --

MEMBER KRESS: That that be a different --

DR. SHERRY: -- in that --

CHAIRMAN APOSTOLAKIS: -- different --

MEMBER KRESS: -- yes --

DR. SHERRY: -- regard be that the core damage frequency some goal for containment performance such as LERF and the safety goal QHOs all be identified as equally important safety goal objectives that you intend to meet. And not indicate that the core damage frequency or the LERF is in some sense subsidiary because it's not subsidiary in the sense that you would derive it from the QHO.

CHAIRMAN APOSTOLAKIS: It's lower at the PTS hierarchy there. Do you think that anyone would object to that, to have the core damage frequency elevated to that level, and de facto, I think that's how people are treating it?

DR. SHERRY: Well, I think that's true. I think the core damage frequency goal is used most in comparison to risk results.

MEMBER KRESS: That's because it's easiest to determine.

DR. SHERRY: Right.

CHAIRMAN APOSTOLAKIS: There is a very interesting analogy with environmental concerns. There of course again you can start again with the health objectives, humans, animals, and so on. Now, on that way to that, you know, you develop pathways and everything. Contamination of water is a consideration there in the pathways. And the question is now is it just one of the events that contribute to the pathways to health effects or is contamination of water by itself a fundamental objective.

In California for example is the site of the fundamental objective, even if there is no one around for hundreds of miles, you still have to clean that water. So it's the same thing, they elevated it up to the level of the fundamental objectives, we want clean water, period, we don't care about the risk.

DR. SHERRY: And I think a similar argument could obviously be made with core damage, that the Commission does not want core damage accidents to occur, you know, whether or not the --

CHAIRMAN APOSTOLAKIS: It's the same reasoning.

DR. SHERRY: In summary, I believe the multi-objective top-down approach has some desirable features. I think it reflects the defense-in-depth philosophy approach to safety in that it has specific objectives for core damage prevention for containment performance and offside risk.

As I mentioned the core damage frequency goal will control the core damage frequency risk for all sequences other than those with high conditional consequences where generally the large early release frequency goal would control.

One note or one comment in that the large early release or the containment failure goals are difficult to formulate for existing plants. As I mentioned before the conditional containment failure probability does not really consider differences in fission product mitigation in different containment types. The large early release is difficult to generalize to other than full power sequences. For shutdown sequences because of radioactive decay any definition of large early release based on fraction core inventory volatiles doesn't make any sense anymore.

Secondly, for seismic sequences the offside emergency protection assumptions are generally much different than for non seismic sequences, and there is hence not a direct relationship or the same relationship for seismic sequences or for shutdown sequences as for non-seismic, non-shutdown sequences in terms of the conditional risk of an early fatality given a large early release.

And one, I guess, final comment regarding seismic sequences. For the NUREG-1150 plants, for Surry 82 percent of the risk, the individual early fatality risk was contributed by seismic sequences for Peach Bottom was over 99 percent. A top-down approach would focus on the sequences, but the question is, is this appropriate given the large epistemic uncertainty in the seismic hazard, and secondly --

CHAIRMAN APOSTOLAKIS: What is appropriate to focus on them or whether the number --

DR. SHERRY: The question is, is it appropriate to focus on seismic sequences given that the present large epistemic uncertainties it drives the mean value high and hence the ranking of these sequences relative to other sequences. For example if you would rank on other parameters medians of the distributi n, you would probably have a much different relative importance for the seismic sequences. And most of that is due to the lack of knowledge on certain use of the seismic hazard.

And then the next question with regard to seismic sequences are, you know, what parameters do you monitor or measure with regard to seismic risk if you're going toward a performance based regulation regarding seismic sequences.

MEMBER KRESS: There aren't very many, are then?

DR. SHERRY: I don't think so. It's mostly the seismic sequences involve failures directly related to the ground motion. It matters only generally on the small contribution due to human error or --

MEMBER KRESS: It's mostly design in site characteristics.

CHAIRMAN APOSTOLAKIS: I think one of the, or a couple of things here that would be useful would be to think a little bit about how to allocate each goal to a lower level. I mean you have just divided it by the number of events that you had, right, but maybe that's not the best way to do it. I mean for your purposes today it was fine. And see what other people are saying about this.

You know, two approaches that come to mind is, one is based on what's feasible, if you look at what the PRAs have produced and so on and say well, for such and such a function or such and such a sequence, these seem to be the number that most people --

MEMBER KRESS: I think there is a fundamental allocation that would give you minimum risk. That might be the standard you would want to use.

CHAIRMAN APOSTOLAKIS: Well, let's say that --

MEMBER KRESS: There is a fundamental allocation among those that would give you minimum risk --

CHAIRMAN APOSTOLAKIS: Yes, but risk must be feasible too --

MEMBER KRESS: -- and it might be awfully hard to come by --

CHAIRMAN APOSTOLAKIS: Yes, yes.

DR. SHERRY: -- yes.

CHAIRMAN APOSTOLAKIS: You have to look at the actual what's possible.

MEMBER KRESS: But that would be a rational choice.

CHAIRMAN APOSTOLAKIS: Yes, that's why I think it would be a good idea to put these thoughts down and see what we can learn from it, I mean as a next step.

And the other one is, if you look again at the -- I mean you did some of it already. If you look at any of your diagrams for example, let's go to the one where you show the PRA, the three levels. As you move from the right to left, what are the major epistemic uncertainties and what's left out, okay. We already discuss the seismic issue, but I think that would be a controlling factor in whatever we want to adopt here.

I think you touched on one of the problems with the seismic which is, you know, if you have very large uncertainty, epistemic uncertainty, is it reasonable to work with a mean value? That's a legitimate question.

On the other hand given those large uncertainties, what course of action should we take? We can't ignore them and say gee, the mean value doesn't mean much, let's go with the median, thank you very much. No, because --

MEMBER KRESS: That's not right either.

CHAIRMAN APOSTOLAKIS: No, that's not right either. There is a big problem there. What do you do when the uncertainties are so large?

Any other questions? Any questions?

Dana?

MEMBER POWERS: Can I ask a couple of questions. On your shutdown risks you were operating using the scoping study risk assessment?

DR. SHERRY: Right, basically one focuses on the operation.

MEMBER POWERS: And you didn't have a source term that you could use for that for your large early release?

DR. SHERRY: What occurred was that there were no source terms that met my criteria to be defined as a large early release. Mainly it was due, what is it, let me back off. I may have not have selected one because of the problem I had identified that my definition does not make sense for shutdown sequences. There's not the same relationship between a release of that magnitude and early fatalities --

MEMBER POWERS: Well, at least, I mean the difficulty is people have not studied shutdown release fractions very closely and we don't have the same problem with the fuel that we do for power operations. The people that have looked at the possible shutdown release fractions come away saying one cannot ignore the intrusion of air into these vessels. And suddenly when you have air coming into the reactor vessel suddenly new elements show up in the volatile category, molybdenum and ruthenium being the ones that come most prompt to mind. Did you try to factor that in?

DR. SHERRY: No. On thing that --

MEMBER POWERS: Would it not have a tremendous impact on your consequences?

DR. SHERRY: It's, I believe it's possible that the mix of fusion products, isotopes that are released during shutdown may result in the latent cancer fatality quantitative health objective being controlled rather than the early fatality.

MEMBER POWERS: Have you looked at the toxicity of ruthenium relative to iodine?

DR. SHERRY: Radiotoxicity?

MEMBER POWERS: Yes, the radiotoxicity?

DR. SHERRY: No, I haven't looked at it in years.

MEMBER POWERS: I think, if you look at it in comparison to iodine, that on a equal release fraction basis it's worse than iodine.

MEMBER KRESS: If he defined a iodine equivalent for his large early release, he could probably factor those kind of sequences in I would think. I don't know how you do that. It must be use the toxicity numbers and get an equivalence.

MEMBER POWERS: There's been some attempts to look at it. It's never obvious how to do things, but people have looked at suppose you release just this element, this fraction of it and normalize it to iodine and normalize to cesium and things like that.

MEMBER KRESS: That's how you end up with the iodine fraction in the first place. He started with fatality numbers and worked backwards. He could do that for any mix of isotopes if he had some idea of what those were.

MEMBER POWERS: But I think you have to do it is the problem, you can't --

MEMBER KRESS: Yes, I think you have to, I agree.

MEMBER POWERS: -- draw conclusions there.

DR. SHERRY: You probably have to also do it on an isotope by isotope basis because of the decay various times --

MEMBER POWERS: Nothing is simple with these sorts of things. Let me ask you another question, you show very little consequences of steam generator tube rupture for Surry. Is that a peculiarity of Surry?

DR. SHERRY: I think it's possibly the area of the 1150 analysis and the assumptions that were employees. I believe that the reason that the early fatality risks were low in comparison to interfacing system. LOCA bypass accidents had to do with, well two things. One was the warning time core evacuation. And the second I believe was related to -- I think -- was related to the deposition of the radionuclides.

MEMBER POWERS: Deposition to the radionuclides outside the plant?

DR. SHERRY: No, no, the mitigation during the transport of the core to atmosphere. But I believe the main reason had to do with the timing of release in the morning time.

MEMBER POWERS: Because the mitigation of that sequence is a primary uncertainty in NUREG-1150. They did an elicitation on it and there was a substantial breadth of opinion on that.

CHAIRMAN APOSTOLAKIS: Okay. Go ahead, I'm sorry.

MEMBER SEALE: Well, one of the things that's evident in all of this is the questions that are raised because of special conditions and special considerations, introduction of air into the vessel and so forth. It seems to me that one of the things we need to do is to try to develop as much in the way of basic understanding of some of the relationships that exist in the manipulation of the numbers. What I'm driving at is Rick has done some work having to do with uncertainty versus mean value. it might be worthwhile for him to make a brief comment on that at this point because it could help us considerably in handling some of our uncertainty concerns.

DR. SHERRY: Can I have a couple of minutes? This is sort of a setup I think.

MEMBER KRESS: Bob Seals, the straight man.

MEMBER SEALE: But I think appropriate to the point --

MEMBER KRESS: -- you have the -- with you.

DR. SHERRY: The question has been raised, if you're calculating mean values and the safety goal policy statement says you should compare mean values from your results with the safety goals, then the question comes up how do you treat the uncertainties? And in the safety goal policy statement there is some words saying, you know, with due consideration of the uncertainties, etcetera, etcetera. But, if you look at the results from PRA studies, I think it will provide some insights which indicate that if you know the mean value, then you have a pretty good idea of what the 95 percentile will be.

The reason being is that the central limit theorem indicates that the product of probability distribution should tend toward a log normal distribution. And there's a --

CHAIRMAN APOSTOLAKIS: A product of random variables is not distribution.

DR. SHERRY: -- I knew someone would bring that up. Right, the product of random variables. The products of these random variables arise from the air suction, the ANDING events. And for the log normal distribution there is an upper limit on the ratio of the 95 percentile to the mean. And this is a plot of the ratio, the 95 percentile, the log normal distribution, to the mean as a function of the error factor. The error factor is a measure of the spread of the distribution and the maximum value for this ratio is a little less than 4.

Now, that's fine, but you say well, are the results from PRAs really, they're positively skewed, but do they, are they, can they be characterized as being somewhat like a log normal?

Okay, what I've done here is for a number of the various results from NUREG-1150, I've calculated the ratio of the 95 to the mean, okay, and as you can see they pretty much follow the range from about 2 to 4 as you would expect from that property of log normal distribution.

MEMBER KRESS: These are all CDS?

DR. SHERRY: Not --

MEMBER KRESS: No, no. You've got --

DR. SHERRY: I have everything in here.

MEMBER KRESS: You have everything.

DR. SHERRY: For damage frequency, person rem, early fatality risk, individual early fatality risk.

But, the point being is that it's -- if you know the mean, you can be fairly confident that the 95th percentile is only going to be a factor --

CHAIRMAN APOSTOLAKIS: Yes, you know there are cases, though, were the mean is to the right of the 95th percentile?

DR. SHERRY: Oh, yes.

CHAIRMAN APOSTOLAKIS: And that's really an annoying occurrence.

DR. SHERRY: Well, again, that occurs.

CHAIRMAN APOSTOLAKIS: It's really annoying when that happens.

DR. SHERRY: That occurs for log normal when the air factor becomes large. Here's the ratio of one. In this case, down in here, the 95th is below the means.

CHAIRMAN APOSTOLAKIS: That's right.

DR. SHERRY: And, if you look at results from 1150, if you look at these two cases with large air factors, you'll see that the 95th is below the mean.

CHAIRMAN APOSTOLAKIS: Yes, but there's an additional problem here. This is just the mathematics of it. But, as you go down to that level where the mean is very close now to the 95th or even to the right, you know that the value of the mean is really controlled by that little tail out there. Where did that tail come from? Somebody --

MEMBER KRESS: Dana Powers.

CHAIRMAN APOSTOLAKIS: Oh, well, if it was from Dana, it was okay.

MEMBER POWERS: Thank you, George.

CHAIRMAN APOSTOLAKIS: So, that's really the major concern people have with those situations.

MEMBER CATTON: Is there a formal way to chop the tail off?

CHAIRMAN APOSTOLAKIS: No, because it's an expression of what you know about the phenomena and if you cannot eliminate it, you cannot eliminate it.

MEMBER KRESS: The formal way is to get a new expert.

CHAIRMAN APOSTOLAKIS: Eliminate expert number 5?

MEMBER KRESS: Yes, get rid of expert number 5.

MEMBER CATTON: I'm having a little problem.

CHAIRMAN APOSTOLAKIS: Thank you very much, Rick. And we'll hear from you again soon.

The next presentation is from NEI and EPRI, industry initiatives. And I understand Tony Pietrangelo and Jack Hough from EPRI are the lead people.

And Doug True from ERIN is here for moral support or other kind.

MR. PIETRANGELO: Good morning. Thanks very much for having us back again. At the last meeting, there were a number of issues raised that we feel very strongly about and have done a lot of work in the industry trying to address. And I know you're going to revisit those this afternoon. The safety goals on subsidiary objectives, on the risk criteria, and so forth.

So, today, even though we've already given the ACRS a full presentation on the PSA applications guide that was issued last year, what we'd like to do this morning is focus in on the development of the criteria, the bases for the criteria, the considerations that went into arriving at those criteria to give you a better understanding, and hopefully give you an industry perspective on where we come down on a lot of the issues that you discussed previously and plan to discuss this afternoon.

Just a little overview. I'll give you some brief history on the applications guide and how we intend to use it. Jack will discuss the considerations and defining the screening criteria and the figures of merit. Doug will cover the screening criteria themselves, the principles for maintaining in depth, and dealing with uncertainties.

We've got a awful lot of material to go through in an hour, so we're going to be moving pretty fast. If there are questions that could wait until the end --

CHAIRMAN APOSTOLAKIS: Why didn't you ask for more time, Tony?

MR. PIETRANGELO: Very briefly.

The applications guide was issued in mid-'95. It's really intended to support both regulatory applications of PSA and non-regulatory applications. The utilities use the PSAs to develop -- to support better decision making at their plants. It's a general overall frame work or reference document for applications. It's not intended to be an application specific methodology but really it's trying to address a lot of the major concerns associated with the PSA in one document and provide consistency for all the further applications that are coming down the road.

We believe it's a suitable starting point, again, for those individual applications, including the regulatory applications that the staff is developing reg guides on now.

I think the staff knows this but we weren't sure whether the ACRS was fully aware, that we would really like the criteria we have in the guide to serve both regulatory applications and individual utility application.

Again, this is just a little picture to show how we would expect the document to be used. An application would be identified at the utility. The licensee would go through the guides that is provided in the various section of the guide and develop an application strategy using the guide as a reference. And then specific guidance would stem from considerations in the applications guide.

I already have examples of this with NEI's draft IST and ISI guidelines and EPRI tech based guideline.

At this point I'll turn it over to Jack to get into the meat of the presentation here.

MR. HOUGH: Thank you, Tony. If I could as you while I'm doing this.

MR. PIETRANGELO: Sure

MR. HOUGH: At this point, I'll move forward in the discussion and offer some comments regarding the relationship to the safety goal and the subsidiary objectives, figures of merits, that we have utilized. Some thoughts on defining screening criteria and a couple of comments on current PSA results.

By way of a little background just to get us all on the same page. Of course, the safety goal quantitative health objectives were broadly stated relating to the early and the latent, or cancer, fatalities. Trying to keep things to, say, a tenth of a percent of the health effects experience from other causes.

Over the course of time, in trying to utilize this broad statement of a goal, the staff and others have proposed some more specific safety -- subsidiary safety goals. For instance, in core damage frequency and conditional containment failure probability, and then the large release frequency as shown in the viewgraph. With the emphasis on CDF for the preventive aspects, for the conditional contain failure probability to address mitigative aspects. And then the larger release frequency is really an integrated blend of the two.

But, it is important to keep in mind, though, that these subsidiary goals have not been directly derived from the safety goals. In fact, they are not to date commission policy.

CHAIRMAN APOSTOLAKIS: Is that true, Gary?

MR. HOLAHAN: Yes. I have to hear exactly how -- can you say exactly how you said it again. Because it is related to the policy.

MR. HOUGH: I think, Gary, what I said was that the --

CHAIRMAN APOSTOLAKIS: Well, our viewgraph --

MR. HOUGH: -- that the goals were not derived directly from the QHOs.

MR. HOLAHAN: Yes.

MR. HOUGH: And that to date they are not commission policy, meaning the subsidiary goals.

MR. HOLAHAN: Well, I think maybe I would say it in a little different way.

MR. HOUGH: Okay.

MR. HOLAHAN: Subsidiary goals are -- the subsidiary objectives are part of the policy but they are not in themselves safety goals.

The safety goals are the health objectives, as identified. And the subsidiary objectives are not commission goals. But they are part of the same policy. That make sense? There is a policy which have both specific goals and subsidiary objectives.

CHAIRMAN APOSTOLAKIS: So, for all intents and purposes, they are being used?

MR. HOLAHAN: Well, they are -- they are being used and other guidelines are being derived from them, for example, in the regulatory analysis guidelines. And, one of the issues that the staff, and the committee, and others, are discussing at the moment is where do we go from here. Should it be more formalized and how do you decide to treat that for plant specific issues?

MR. TRUE: Gary, the safety goal policy statement, though, itself, does not address those three subsidiary goals in any way, right? It's just the background documentation and the interim staff guidance for implementation of the safety goal that has implemented those, is that right?

MR. HOLAHAN: I think that's fair, yes.

MR. TRUE: And I think that was the point that Jack was trying to make, was the safety goal policy statement itself doesn't address the security goals at all. Interim staff guidance has done that.

CHAIRMAN APOSTOLAKIS: Of course, it all depends on what you guys are going to do with it. Because, up until now it's just words.

But if it makes a difference in the guide, then, of course, we'll have to revisit that. And also, I believe the commission has said that we have to have defense in depth in there somewhere. Isn't that part of this? It's that part of the goal?

MR. HOLAHAN: Well, it's part of the PRA policy.

CHAIRMAN APOSTOLAKIS: The PRA policy.

MR. HOLAHAN: PRA policy statement certainly addresses defense in depth.

CHAIRMAN APOSTOLAKIS: Defense in depth.

MR. HOLAHAN: But, the other thing that I think also needs to be clarified is the commission has reviewed, and in fact approved, the staff's use of the subsidiary objectives. It's not just the staff inventing something that the commission doesn't know about.

MR. HOUGH: That was not implied.

And continuing, as the prior speaker, Mr. Sherry, looking at the NUREG 11-50 studies to gain some sense of what the risk assessments show us, if you take a look at the margins between the mean values as computed and the safety goal QHOs, you see that there really, for the various plants listed, a lot of room, a large margin, between -- amongst the plants for the current designs relative to the individual early and latent fatalities.

Now, if you take a look at the same plants and the core damage frequencies listed, the conditional containment failure probabilities, and the large release frequencies, see that things are a little different here in the sense that whereas the large release frequency subsidiary goal of 10 to the minus 6 is met by each of the plants. The core damage frequencies is calculated, or in some instances larger than the subsidiary goal. And the conditional containment failure probabilities are larger than the subsidiary goal.

MEMBER KRESS: Now, how did you define the large release frequency here?

MR. HOUGH: This was taken basically as the frequency of releases that cause the health effects leading to at least one or more --

MEMBER KRESS: One fatality.

MR. HOUGH: -- fatalities, yes.

We would conclude, also, on that that the CCFP, again echoing Mr. Sherry's presentation, is something that doesn't quite lend itself very conveniently to this concept of pinning down specific numbers for specific things.

And when you look at the safety goal and trying to select criteria, as we noted in the PSA applications guide in Appendix C, certainly I think that there's agreement that looking at the prompts and the latent fatality risk is important. I guess we would suggest to you that any subsidiary goals that might be adopted should only be -- or, should be accommodated to the degree in the sense they support the QHOs.

And I would also add that in the sense that they make sense for a given application and that they're workable across the fleet of the plants. And this, to me, means that there's a variety of things that have to take place when you're using the PSA for various applications. First and foremost is certainly the understanding of the PSA itself. What's in it. What's not in it. How does it model the plant. Does it -- Are you looking at strictly the numbers alone in an absolute sense? Are you look at the relative changes among things? Are there other figures of merit that you can use for the specific applications, RAWs, RRWs, Fussel-Vesselys, all that sort of thing. Are there ways in which you can group collections of sequences and so on such that aspects of uncertainties and the details of things that may not be so significant except that we can get lost in the arithmetic. Can these things be smoothed out by grouping into categories? Can you test the results in accordance with the sensitivity calculations that would make sense?

So, in doing all of that, and again, a lot of that focuses on arithmetic. But there's more to the point. If you go, for example to the severe accident -- excuse me, the Generic Letter 88-20 that asked us to do the IPEs, a very fundamental premise of that that it's purpose was to enhance the understanding of the plant. And to bring this new technology to bear so that people really grasped the dependencies throughout and they understand that when you goose the plant here how it responds there. And that's really one of the beauties of the tool.

But that is not enough in and of itself. What we need is to consider all the defense in depth issues. We certainly echo everything that's been said here. You need to factor in all the operating experience. You need engineering judgment. You need the supporting deterministic analyses and understand how you've done those and how they relate to the question at hand here, whether it's addressing TH success criteria or anything else. And you need the expert advice or the expert panel judgment that tries to integrate all of this information.

CHAIRMAN APOSTOLAKIS: Well, I am really disturbed by all this.

MR. HOUGH: Yes.

CHAIRMAN APOSTOLAKIS: Because I really don't know what it means in practice.

MR. HOUGH: Well, I think --

CHAIRMAN APOSTOLAKIS: It means let's look at this, let's look at that. I mean, what it comes down to is that you, yourself, are using numbers. If you go to the --

MR. HOUGH: Yes.

CHAIRMAN APOSTOLAKIS: -- previous slide with the core damage frequencies, the question that comes really to mind is the following. Zion is reporting 3.4 ten to the minus 4. Sequoyah is reporting 5.7 ten to the minus 5.

If we look at the insides that you mention, we understand these plants now because we've done these PRAs. Don't you think that we will find that for Zion this 3.4 ten to the minus 4 shows that there is a sequence that perhaps we should do something about?

But, such a sequence perhaps does not exist in Sequoyah for some reason? I mean, aren't these really the insides that you're getting from that and then you say, gee, if these other four plants have managed not to have that, why not Zion? That's really what it comes down to. I mean, not to dismiss the number and say, well, 3.4 -- what do the numbers mean. Let's do nothing about it because the numbers are uncertain and the insides are important. What I'm saying is that there is almost a one to one correspondence between insides and numbers. Let's not forget that. I mean, we tend to downplay the numbers a lot but I can't believe that there are no real engineering differences between Zion, that reports 3.4 ten to the minus 4, and Surry that reports 4 ten to the minus 5. I mean, that's an order of magnitude.

MR. HOUGH: Well, I don't think I said anything to suggest other than that. Certainly there are differences. They're related, perhaps, to the design features themselves. That Perhaps some aspects of the numbers are due to methodological differences of that sort of thing.

CHAIRMAN APOSTOLAKIS: Yes. Let's say we take out --

MR. HOUGH: So we normalize all that sort of thing out. Yes, there are some difference.

I think the key here is that when you go back to the large release frequencies, you see that when you look at this on an integrated entity, then you see that you meet the health objectives. All right. And a plant is an integrated entity. It's not just the question of the core damage frequency. It's not just the question of LERF although one can put some figures of merit on these and try to accommodate these things.

But, as I said, there's a whole host of additional features or aspects to the question that needs to be brought to bear. It's not merely saying let's dismiss numbers and walk away from them. I'm saying that there is, if you will, an integrated analysis approach that has to be brought to bear and that we're doing in various of our pilot projects.

CHAIRMAN APOSTOLAKIS: Now, I think, then, what it comes down to is an issue of policy. If we relate it to what Rick Sherry was saying, and I don't think you can prove this technically. I mean, it's really a matter of policy.

Do you want to elevate core damage frequency to the level of what they call in decision analysis fundamental objectives, or, do you want to limit your fundamental objectives to the health objectives, and then everything else is subsidiary and treated as such? That's really what it comes down to.

And you are taking the position that you would not like to see the core damage frequency elevated to that level. I mean, it all comes down to that, I think.

MR. HOUGH: It really does come down to that. Albeit in the PSA applications guide, for example, we do have some various regions related to core damage frequency.

CHAIRMAN APOSTOLAKIS: Sure.

MR. HOUGH: Et cetera, et cetera. For considering changes to the baseline.

CHAIRMAN APOSTOLAKIS: You can still do that.

MR. HOUGH: You summarized my point well.

CHAIRMAN APOSTOLAKIS: Because if it's a fundamental objective, I think, then, it's treated a bit differently.

MR. HOUGH: Yes. Right.

In the applications guide, we did --

CHAIRMAN APOSTOLAKIS: No.

MR. HOUGH: Oh, I'm sorry. Go ahead.

CHAIRMAN APOSTOLAKIS: Maybe it's in the guide but -- So, one of the messages of what you're saying is that -- another of the messages, the way I read it, is we should not treat these subsidiary goals as criteria?

MR. HOUGH: Yes.

CHAIRMAN APOSTOLAKIS: That if it's 3 ten to the minus 4, I mean, let's look into it. Maybe there's a reason for that and we can live with it if we have other mitigated features and so on.

MR. HOUGH: That is correct.

CHAIRMAN APOSTOLAKIS: And the question that always comes to my mind when I hear that is, where would you draw the line? Is that somewhere in your PSA guide? I mean, would you say the same thing if it was 5 ten to the minus 2, the core damage frequency that the other features perhaps --

MR. PIETRANGELO: No, it's in the criteria.

CHAIRMAN APOSTOLAKIS: It's in the criteria.

MR. PIETRANGELO: The way it was being discussed at the last meeting was a cliff at ten to the E minus 4. That based on what you're going to see in a little bit, didn't make a whole lot of sense.

CHAIRMAN APOSTOLAKIS: We'll come to that.

MR. HOUGH: We'll come to that point in about four or five viewpoints.

CHAIRMAN APOSTOLAKIS: Fine.

MR. HOUGH: So, the guide does make use of core damage frequency and LERF, large early release frequency. With our definitions on large early release frequency in that we're looking at unscrubbed releases or unscrubbed with a time dependency relative to reactor vessel breach and the total volume change of the containment. So, we have two ways of looking at that.

The applications guide, in looking at CDF and

LERF, does focus, then, again, both on the preventive and the mitigative aspects. But it doesn't necessitate necessarily that you go off and trace every single sequence or consideration out of the level 2 analyses. There are some rather large and dominating things and we've talked -- or, Mr. Sherry's presentation pointed out some of the features of bypass and so, other things, failure to isolate and various other phenomenology issues.

Now, it is interesting that not only core damage frequency but CCFP is influenced certainly by the plant design and the mix of the core damage contributors. The individual plant damage states and the conditions that you're operating in. But the high CCFP is not necessarily co-equal with high risk. There is -- you can take a look at some studies that have been done, for example, with one plant where an individual standby system that was -- the question was, what is the effect of this modeling it in or putting it in the model or not having it in the model. And without getting too lost in the numbers, the core damage frequency without the plant was of the order 2E minus 5 with a LERF of 1E minus 6. With the system, the core damage frequency went down to 8E minus 6 and the LERF went down to 9.5 times 10 to the minus 7.

But the net effect of all of this was that when you went from the without to the with consideration, the CCFP went up from .05 to .1. So, that you have to be careful. If you try to pin down some things too hard in terms of saying like the CCFP must be this number and so on, you can get into some illogical situations where clearly the value of that standby system overall was positive. So, this is the sort of thing that we're suggesting that you need to be careful of when trying to pin down specific components in the risk picture.

And I think I've really covered that.

MEMBER KRESS: Before you take the slide out.

MR. HOUGH: Sure. Hang on.

MEMBER KRESS: Your --

MR. HOUGH: Loss of viewgraph.

MEMBER KRESS: Loss of viewgraph accident.

Your second bullet is high CCFP does not translate to high risk, I agree with. But the inverse of that is low CCFP does translate into low risk I think would be an equally good statement, wouldn't it not?

MR. TRUE: Depending upon what the core damage frequency is.

MEMBER KRESS: Of course. Of course. But I'm assuming the core damage frequency is somewhere around ten to the minus 4.

MR. HOUGH: Right. I think, yes, we could say that. We agree with you on that. But the point here, I think, was to show that you can get into these other difficulties. And I think, again, Mr. Sherry's presentation pointed all of that out as well.

Now, there are all different ways that one might go about trying to define some screening criteria. Putting limits on absolute values or relative changes, or place some ceilings out there, or take a graded approach as we did in the PSA applications guide. There's some difficulties with the first two, certainly. That when you set limits, say, a 1E minus 6 change, then depending on where the plant is at, is it at 10 to the minus 6 or 10 to the minus 4 kind of plant, then you're saying that a 1E minus 6 change might be, say, some 10, 20, 30, 40 percent sort of change at the low end of the spectrum but it's a 1 percent change up at the high end of the spectrum. And trying to hold everything to a 1 percent sort of tolerance is pretty tight in terms of really understanding any significance.

If you go on the relative concept, then you get caught in the same sort of thing in that you start allowing, say, a 10 to the minus 6 plant gets a 10 to the minus 7 is the only kind of thing it can tolerate as a change. Whereas a 10 to the minus 4 can tolerate a 10 to the minus 5. And it gets you lost in this sort of thing. You say there's no sort of rhyme nor reason to this that you could really make sense of in your own mind.

I suppose one could always set ceilings for things and set it at an individual speed limit and say thou shalt not and that's the end of it. But we felt that a more flexible approach that blended both absolute and relative concepts would be a better way. And Doug will walk through that, and again, in a couple of viewgraphs.

Nearing the end here, we'll go to the next one.

It's interesting to take a look at what's going on now with the contemporary PSAs. In the yellow in the viewgraph, you see the IPE reported core damage frequency information. And in the blue, you'll see the update values that have been coming about recently. And this, I believe, you have seen previously in another presentation by Duncan Brewer.

Overall, what you can see in this is that there has been, from the earlier IPE to the update studies, a general decrease in the core damage frequency. There are individual instances with some very slight increases in there as you might see. But, the general trend is downward. And I think this is actually a very good effect that we're seeing.

At this point, in trying to wrap up this part of our presentation, you can see that there's a variety of things that you need to take into consideration when you're trying to establish any subsidiary goals. And that is the fact that the core damage frequencies and CCFPs, and LERFs, have a range of values each. As you can see, they span two orders of magnitude on CDF, a couple of orders on CCFPs, and about an order of magnitude on LERF.

But, as I pointed out with the last viewgraph, the risk awareness that's taking place in the industry as it poises to make use -- poises itself to make use of these insights has resulted in a movement downward in the core damage frequencies for the plants.

All these factors, as well as the individual aspects of the different plant designs and plant specificity, et cetera, all need to be factored into whatever it is that is recommended to be used in the future.

And I'll stop here.

CHAIRMAN APOSTOLAKIS: I -- Can we go back to the Westinghouse Owners Group figure? Just a question of clarification.

You had a figure with a comparing the PSA data -- yes.

I understand the IPE value. I don't understand the current value.

MR. TRUE: This is the same data that Duncan

Brewer presented to you at the last meeting from Westinghouse Owners Group where plants had updated their PSAs since the submittal of the IPE. And, he presented two columns of data in a tabular form. What we did was graph it.

CHAIRMAN APOSTOLAKIS: Oh, graph it.

MR. TRUE: And then I added a couple --

CHAIRMAN APOSTOLAKIS: Okay.

MR. TRUE: I added a couple of other plants that weren't on his list that I had specific experience with that happened to be large core damage risk, or core damage frequency.

I want to talk just for a minute about the applications guide screening criteria. We've already -- as Tony mentioned, we've already been here before and talked about it. But I just want to talk through some of the thought processes and how we tried to balance all these factors that Jack mentioned.

MEMBER KRESS: This is Figure 4?

CHAIRMAN APOSTOLAKIS: 1.4, I think.

MR. TRUE: 4-1.

CHAIRMAN APOSTOLAKIS: 4-1?

MEMBER KRESS: 4-1.

MR. TRUE: Or, 4.1, or whatever the nomenclature is here.

MEMBER KRESS: It's in Chapter 4.

CHAIRMAN APOSTOLAKIS: It's close.

MR. TRUE: The -- basically there are three regions which are an area where, from a screening standpoint, we would initially say that a result would non-risk significant. A middle category of further evaluation required. And then an upper category of unacceptable. And the things that are probably most relevant to this are the slopes and the discontinuities in the graph.

First of all, it's fairly obvious that we make a break at 1 times 10 to the minus 4 as a change in baseline core damage frequency, or a plant involving a baseline core damage frequency above 1 times 10 to the minus 4 gets treated differently than a plant that has one below 1 times 10 to the minus 4.

That's an acknowledgement of the subsidiary safety goal and I personally believe is a large reason why we see the WOG data trending in another direction as that there has been an intent on the part of the utilities to want to get into a region where they are judged differently. And, just the presence of a threshold like that is a forcing function to lead the plant's interest in reducing risk.

MEMBER POWERS: Is the bar at 1 times 10 to the minus third a barrier there or is that -- does that white region continue out ad nauseam?

MR. TRUE: It was not intended initially as a bar. However, there is another criteria in the guide that says that CDFs above 1 times 10 to the minus are considered extremely high and should not be entered even temporarily unless there are very strict controls.

So, in effect, it's a cut off.

CHAIRMAN APOSTOLAKIS: This -- are you done, Dana?

This figure is to be used when the owners are to make a change that will increase the core damage frequency, correct?

MR. TRUE: It could be used that way. It could also be used to evaluate the value of a risk reduction major. For example, if you had a feature you were interested in adding to the plant that would reduce risk and it fell into this region, that would say that that would be a potentially risk significant reduction. More than 10 percent change would be a risk significant reduction for 1 times 10 to the minus 4 plant.

CHAIRMAN APOSTOLAKIS: How can you do that? I mean, if you're moving to the left, it seems to me you will always be at least as good as you are now. Not true, or can you make it worse?

MR. TRUE: But this is --

CHAIRMAN APOSTOLAKIS: When you reduce core damage.

MR. TRUE: Right. This is the change, percent change, absolute value of the percent change. So, if you had a feature or a backfit, or something that was being evaluated, if that was going to result in a 1 times 10 to the minus 5 core damage reduction for a 1 times 10 to the minus 4 baseline plant, that would be considered potentially risk significant. If it was less than 10 percent, it would be potentially non-risk significant.

CHAIRMAN APOSTOLAKIS: What? I must be missing something.

Let's say your plant is a 10 to the minus 4 right now. And you're considering a change that will reduce that by a factor of 3, by an order of magnitude.

MR. TRUE: By an order of magnitude?

CHAIRMAN APOSTOLAKIS: Yes. Where are now? Where is that point?

MR. TRUE: Well, that would be a 70 percent reduction in the core damage frequency. So, it would be up here somewhere.

CHAIRMAN APOSTOLAKIS: And why does it require further evaluation? Moving in the right direction.

I think --

MR. TRUE: At 10 to the minus 4, that's true. But what if you're at 10 to the minus -- I mean, I agree. If you were at 1 times 10 to the minus 4 and you had a 70 percent reduction, that would be fairly obvious that the further evaluation would conclude that's a good thing.

CHAIRMAN APOSTOLAKIS: So then, 10 to the --

MR. TRUE: Unless it costs -- on the other hand, unless it costs a bazillion dollars to implement.

CHAIRMAN APOSTOLAKIS: Cost is not here. And that's a separate issue. Which is an important issue.

MR. TRUE: That's what the further -- but, further evaluation includes an assessment of cost benefit.

CHAIRMAN APOSTOLAKIS: But, isn't it really the intent of this to be used when you're doing something that may increase the core damage frequency?

MR. TRUE: As I said, it can be used both ways. We discussed both applications.

I think in the context of most of the pilot applications for risk informed regulation like IST changes, ISI changes, those kind of things, it's being evaluated in the pilot projects as a major of risk increase. But I think it was designed by the authors of the applications guide and by the regulatory threshold working group advisory committee, the utility executives, to be used both ways and evaluate it both ways.

Next thing I want to just briefly touch on is the slope of this line because that's obviously another key decision that we made.

And there -- We decided in putting this line in that it should be a non-constant risk contour. In other words, up here it's a 10 percent change and down at the 10 to the minus 6 level it's 100 percent change.

We also considered other functions where we had a step change at different levels. The problem we had with that is we introduced -- we had another discontinuity and that might be an incentive to fall on one side of a line or another. So, we wanted a continuous threshold that didn't change -- changed in a constant manner across different core damage frequencies.

Also, the utility executives that oversaw the development of this were very firm on the fact that they wanted to try and manage risk at or about the values that they had in their initial assessments. That means that if you had a low core damage frequency plant, it wasn't a license to go off and increase risks significantly. They wanted to manage their risk at or about what they had been designed at essentially prior to their initial evaluations.

So, that meant on an absolute basis, at this end of the chart, that we're controlling smaller absolute changes, 10 to the minus 6 is 100 percent change at 10 to the minus 6 versus at 10 to the minus 4 the absolute change would be 10 to the minus 5. So, we tried to build in a risk management flavor into the process.

We could have equally have drawn this line, for example, like this where it was essentially a constant risk line of 10 to the minus 5. But, that meant for plants with low core damage frequencies, they'd be allowed a factor of 10 increase in risk and we didn't think that was an effective risk management incentive.

MEMBER POWERS: This is, of course, admirable that you take a very conservative position on managing your risk. But, from a regulatory point of view, somebody overseeing you, I don't think you want the slope, do you?

MR. TRUE: I think Tony -- as Tony said in one of his introductory slides, I think that -- I'm probably the wrong person to be answering that. But I think that the regulatory threshold working group in developing this hoped that this criteria would be adopted for regulatory uses.

MEMBER POWERS: Interesting. I mean, it just seems that you tie your hands in a way that's -- I mean, it's admirable. You're being very safe. But you may be very expensive at the same time.

MR. TRUE: Well, the other thing is, though, that when you're at these relatively low risk levels and then you go fall into this further evaluation required category, and that generally would involve things like cost benefit analysis to decide whether it's a good thing to do. When you're at low risk levels, it's very hard to justify very significant cost impacts, either. So, there's also sort of a built in incentive.

MEMBER POWERS: In the non-significant regime, the only thing that dictates is cost benefit, right?

MR. TRUE: No, that's in the further evaluation.

MEMBER POWERS: No, but I say, if I'm making a change in the plant that falls in the non-significant, non-risk significant, the only criteria, then, is cost benefit?

MR. TRUE: Yes. Right. Hadn't thought about it that way.

CHAIRMAN APOSTOLAKIS: There's one other question I have, Doug. I have a plant at 10 to the minus 6 and I'm considering a change that will change that frequency by 90 percent, or even 100 percent. Some very near the top of that line. Clearly, I'm restricted now. I can go up to 2 ten to the minus 6 perhaps, but that's about it.

Then one of my-- No?

MR. PIETRANGELO: That's not what that means.

CHAIRMAN APOSTOLAKIS: So, that --

MR. PIETRANGELO: I mean, when you get into this white block, it doesn't mean that you can't make the change. But I think --

CHAIRMAN APOSTOLAKIS: Yes, you evaluate it.

MR. PIETRANGELO: Well, with the -- this is when you would start, and the staff had a question on this on July 18th. When you would start considering packaging measures that would also reduce the risk at the same time. Because the goal is to stay in the green.

CHAIRMAN APOSTOLAKIS: Yes. But the point is that if I am considering a measure that is very close to 100 percent, then I may need further evaluation so managers will come in and look at it. That's all.

So, the young guy says, well, this change can be broken down to 20 steps. And I will put five, six months between each steps. So, now the changes of 20 changes, each one being about 8 to 10 percent. Everything is non-risk significant. I can all the way to 10 to the minus 4 and nobody's looking over my shoulder.

MR. TRUE: We're going to cover that.

MR. PIETRANGELO: We're going to cover that later.

MR. TRUE: We're going to cover that. Because we were worried about that, also, and the guide actually does address that.

MR. PIETRANGELO: CDF 3.

MR. TRUE: Yes, I think we better move on or we're not going to even come close to that in our hour.

The LERF chart is exactly he same. The cliff is now at 10 to the minus 4 instead of 10 to the -- Or, 10 to the minus 5 instead of 10 to the minus 4, reflecting, essentially, a factor of 10 difference, if you like for defense in depth purposes.

I'm going to go through a simple example. This is an example that we presented at the workshop for the industry back in December. Just brought it out again to walk through for your understanding of how this is going to be used.

Let's say for the purposes of the example we have a design change to improve some operational aspect. Nothing regulatory involved. Just an operational improvement. A new motor operated valve to a risk sensitive system that improves operational flexibility for one reason or another. But it does introduce a new system -- a new component to the system which has new failure modes and it has some effect on system reliability. However, only at power operations.

We -- and I'm limiting it to power operations just to make the example simple. It could equally apply to shut down.

So, we model that into the PSA. We find that our base case PSA result was 5.3 times 10 to the minus 5. Our base case LERF was 1.8 times 10 to the minus 6. With the new MOV, they've each gone up a little bit. CDF has gone up a little under 10 percent and LERF has gone up around 5 and a half percent.

Then we turn to our charts. We take our baseline CDF. That gives us a maximum threshold in our green region and our application falls within that screening criteria which says it's potentially a non-risk significant change from the standpoint of CDF. And, the same thing is done for LERF.

But we're not done. The numbers, themselves, don't drive the whole decision. It's still incumbent upon the licensee to look at the results from a qualitative standpoint. Not just what the numbers say but what's underlying the numbers coming out of the PSA to get the insights from the PSA.

And these are different from defense in depth and design consideration. These are what the PRAs are telling you about the risk impacts.

And, we postulate a series of questions that may apply for a particular application. What action scenarios are most impacted by the change? Are they new, previously unconsidered events? If you've now increased your core damage risk by 9 percent, was that all due to some new sequence that you never previously considered? And now you have a new relatively dominant contributor. Or, was it one that had been previously negligible that had been in there and you had looked at before but you previously perceived to be unimportant and now is much more important?

Are there other considerations that may mitigate the calculated change in risk that weren't accounted for? You may have calculated 9 percent but that was on a bounding basis or it was -- didn't account for some operational factors you put in place prior to implementing the particular change.

Likewise, are there other unquantified risks or benefits associated with the change? And then also, are there any new issues raised like common cause, spatial, or human interaction type events?

MR. PIETRANGELO: And that's primarily why they're called screening criteria and not acceptance guidelines because there's a lot of other work to do after you get done interpreting the results in the criteria.

MEMBER POWERS: I get confused some times over exactly what the subsidiary goals are. But for some reason I had in mind that this large early release fraction was limited. The goal was 10 to the minus 6. But you have your cut off at 10 to the minus fifth?

MR. TRUE: Right. There is a subsidiary objective that has been decided by the staff of a large release frequency of 10 to the minus 6, which has generally been correlated to things like causing a early fatality. In the applications guide, since we don't have level 3s to deal with all the time, we went to a different definition of large early release frequency which was all releases of certain mechanistic description, early and unscrubbed. And we upped the threshold to 10 to the minus 5 to capture those. So they aren't exactly the same.

It's more reflective of the CCFP difference of .1 in that we've got a factor of 10 difference between our core damage cliff and our LERF cliff.

MEMBER POWERS: Well, it seems to me that what you're confronting here is the non-widespread availability of technology for doing level 2 and level 3 kinds of analyses. It's not nearly as accepted technology as for doing level 1 and calculation of CDF. So, you have to do something and you did something.

MR. TRUE: Yes. We did something. And we think LERF is a reasonably easy metric to calculate and extract from PSAs for an analyst familiar with the --

MEMBER POWERS: From a level 1 type PSA.

MR. TRUE: Level 2 PSA.

MEMBER POWERS: -- 2.

MR. TRUE: Yes. It includes bypass. I mean, in general terms, it includes bypasses, failure of isolation and the phenomenology that could lead to large early failures of the containment.

MEMBER KRESS: Every site is treated equally here.

MR. TRUE: Every site is treated based on its mean, based on core image frequency and LERF.

MEMBER KRESS: So I mean, the population is not considered at all.

MR. TRUE: Correct.

MEMBER KRESS: Or the meteorological conditions.

MR. TRUE: And I think the main reason we're comfortable doing that is as Rick Sherry's presentation showed that earlier and some of the information I'm going to present in a few minutes will also reiterate.

We feel like there's margin with the safety goals already and if we're controlling ourselves at the CDF and LERF level, we know that will keep us safe relative to the actual safety goals, so we didn't feel like we needed to track the population effects in our metrics.

CHAIRMAN APOSTOLAKIS: How about the uncertainties here? What role?

MR. TRUE: We're going to get to that.

CHAIRMAN APOSTOLAKIS: Going to get to it?

MR. TRUE: I apologize, but we have a whole discussion that.

CHAIRMAN APOSTOLAKIS: Well, your last couple of slides are really loaded, aren't they?

MR. TRUE: Okay. Defense-in depth comes up in every application in PRA technology and we have been formulating thoughts and Tony talked briefly about them in the last ACRS meeting and we presented a white paper to you on the subject.

Basically, in terms of maintaining defense-in depth, we think there are four different and fundamental objectives. The first is consideration of defense-in depth in terms of fission product barriers and we want to make sure that we maintain that defense-in depth. We don't compromise that.

The second form of defense-in depth which is often mixed in and muddled with the fission product barriers is redundancy, and I guess it's our belief that the changes in redundancy are impacts, operational changes in particular that affect redundant components. Really need to be considered in terms of the frequency of the challenge to that redundancy and that is things that where you have lots of redundancy for low frequency occurrences, you ought to be able to take advantage of that. Otherwise, you completely undermine the whole probabilistic basis on which a PRA is used and you're going to work yourself right back into a single failure criteria.

The next is that one of things that undermines the whole concept of redundancy is common cause failures and we want to make sure in any application that we're not introducing new common cause potential because that would really undermine our original design basis.

And then we want to also make sure we're not significantly eroding our deterministic margins. Such areas where we have little margin, we're using the PRA to completely destroy that margin and put us into jeopardy deterministically.

We also believe that operational impacts should be considered different than configuration and design impacts, and that is that criteria for defense-in depth you use for changes like to a testing program or maintenance program or operational decisions should be considered differently than those things that are affecting your design that are going to be permanent fixed known changes in the plant design basis.

And as in all the poly plants and endorsed in the applications guide, we see the expert panel plan, an important role in helping PSAs address these things, and I think that there is probably some value in expanding how this gets implemented and how these principles get applied, but we feel like these guiding principles are the direction they had on the defense-in depth, blending defense-in depth in.

Okay. Turning back to your question, George, about the 20 changes versus 1. The applications guide criteria are applied on an application-by-application basis, and we wanted to make sure we had in the guide some means to capture the fact that you might be doing successive changes, so the guide endorses a maintenance and update process which involves a PSA update at least every two refueling cycles. Some plants do it every refueling cycle or even annually, some do it every two.

The updated results, including the impacts of applications, are then compared to the permanent change criteria, so over that two refueling cycle basis, you accumulate all the changes you've made to the plan, risk reducing measures as well as potentially risk increasing measures and you compare your new core image frequency to your old core image frequency, calculate the delta and

LERF and compare that to the permanent change criteria. So once every three years, you have to reevaluate your permanent change. Now, over time, you certainly could see after three more years you might get a change.

CHAIRMAN APOSTOLAKIS: For your new basis --

MR. TRUE: But your new base gets new set, but every time it changes, you have to go back and assure yourself that change was not really significant, both quantitatively and qualitatively.

CHAIRMAN APOSTOLAKIS: So for a 40-year lifetime, you can do that 13 times?

MR. TRUE: Yes, you could.

CHAIRMAN APOSTOLAKIS: By the way, you're talking about the permanent changes.

MR. TRUE: Yes.

CHAIRMAN APOSTOLAKIS: What role does time play here? What if on the way to the permanent change, you know, for a period of a few weeks, your core damage frequency is way up there, do you have any criteria for that?

MR. TRUE: Yes. We haven't focused on this presentation.

CHAIRMAN APOSTOLAKIS: That's much later?

MR. TRUE: No. It's not in this presentation.

MR. PIETRANGELO: It's another meeting.

CHAIRMAN APOSTOLAKIS: It's another meeting?

MR. TRUE: We have criteria for temporary changes.

CHAIRMAN APOSTOLAKIS: Yes.

MR. TRUE: Temporary changes are non-recurring changes and that's done on the basis of core image probability and larger released probability which is essentially the area under the curve of the frequency versus time, with also an instantaneously threshold, the 1 -- -3 threshold --

MR. PIETRANGELO: For an instantaneous or --

MR. TRUE: Configuration specific core image frequency.

CHAIRMAN APOSTOLAKIS: Now, maybe a naive question, but this PSA guide is for the time not used for the utilities. Right? How does the -- get involved in that or should they get involved at all?

MR. PIETRANGELO: They should get involved when we submit applications for making changes in the regulations or the licensee made in the review of the basis for what the licensee has presented. Part of their development of the reg. guides is specifically aimed at that so that we have a common understanding of what the staff finds acceptable for a particular application.

We didn't ask for staff endorsement of the applications guide direct because there wasn't any regulation we were responding to.

CHAIRMAN APOSTOLAKIS: Yes, that's why I'm asking the question.

MR. PIETRANGELO: But if the licensee's going to use PSA as part of the basis for a change to his licensing basis or to the regulations and that's why we're doing all this stuff, to have a common understanding of what it's going to take as part of the basis to get that change through. So when we developed --

MEMBER MILLER: Ultimately, you end up with the NRC endorsing this guide in some way?

MR. PIETRANGELO: Well, we've talked about that and again, we did not ask the staff to endorse the applications guide in toto because there wasn't any regulation we were responding to, but for a specific regulatory initiatives like risk-based IST or ISI where there's regulations dictating or covering the programs that the licensee has to go through and the licensee uses as part of his basis risk analysis to support the change, and there's a legitimate rationale for the staff to review that part of the basis for the change.

CHAIRMAN APOSTOLAKIS: So this is the industry's version of a regulatory analysis. Is that correct?

MEMBER MILLER: Regulatory guide.

MR. PIETRANGELO: The applications guide is really a reference, a starting point to help to get consistency in risk ranking and risk significance evaluations to have the maintenance and update process consistent and interpret the results in a coherent and consistent manner so that we don't have to re-invent all these things for every individual application that comes down the pike.

CHAIRMAN APOSTOLAKIS: I know, but the regulatory analysis basically does the same thing. Right? You consider a change and I remember there was a figure with a condition contained when failure probability and core damage frequency and depending on where you are, you make certain decisions and again, there were also some qualifiers that you shouldn't look just at the number. So that's your version of that, it seems to me.

MR. HOLAHAN: I think they're not exactly comparable in the sense that the regulatory analysis guidelines are meant for generic applications, meant for changing rules and stuff. This is plant specific, so in that sense, the regulatory guide, understand your review plan that we're working on are more comparable in function to the applications guide.

CHAIRMAN APOSTOLAKIS: They're dealing with the same problem, changes.

MR. HOLAHAN: It did it with the same problem.

MEMBER KRESS: Could you clarify what you said about transient changes in the probability? You said you used the integral under the curve, frequency versus time. Of course, that's infinity. Do you have a limit on the amount of time or limit on the baseline above something?

MR. TRUE: Let's say you have a situation where you need to enter a particular configuration for some length time, a limited length of time, and that's going to have an increased level of risk. It might be used for a one-time tech. spec. change or something like that where it's a known length, a known configuration of the plant.

What the guide says is to calculate the change in core image frequencies associated with that and the length of time and take the product of those two.

MEMBER KRESS: Okay. So it's the integral over that time?

MR. TRUE: Of that time -- of the change.

MEMBER KRESS: And you have a criteria on how big that can be compared to the baseline?

MR. TRUE: Right.

MEMBER KRESS: A percent of it or something?

MR. TRUE: It's actually on an absolute basis.

It's 10 to -6 for core image frequency and 10 to -7 for LERF and there are three bands again, a lower band which is -- significant, middle band evaluation or whatever than the upper band.

Okay. Let's go to uncertainties because this is going to be undoubtedly an interesting discussion. Okay.

I think I've heard this committee on a numbers occasions talk about --

CHAIRMAN APOSTOLAKIS: Doug, we are really running out of time. I mean, we know this. Do you want to speed it up a little bit?

MR. TRUE: Yes. Okay. Then we'll go to the next one.

CHAIRMAN APOSTOLAKIS: Yes.

MR. TRUE: Rick already presented a number of the concepts.

CHAIRMAN APOSTOLAKIS: Yes.

MR. TRUE: Now, our typical log normal distribution which is reflected in results, there's a large overall uncertainty, but the uncertainty with respect to the mean is relatively smaller and if we compare ourselves to the safety goal as Jack's earlier slide showed, there's a significant margin and most importantly, this mean is small compared to that margin.

We have a bunch of data that shows that, same data essentially that Rick showed, and more data that compares the 95th to mean, same data.

The margin data which --

CHAIRMAN APOSTOLAKIS: We need that again.

MR. TRUE: -- we already saw, so those margins are small compared to the uncertainties.

And then graphically, that same graph shows the NUREG-1150 results with large overall uncertainties, in some cases up to even a factor of 10,000, relatively small changes from the mean, but a large margin to the safety goal, which tells us, we think, two things. It tells us that based on the other work that Rick showed, that uncertainties do not jeopardize a safety goal and it tells us that if we control ourselves in CDF and LERF, we have confidence that we're not going to go trampling on the safety goals and that we can manage our risk at those levels rather than at the safety goal level.

CHAIRMAN APOSTOLAKIS: And these are the uncertainties we have quantified, of course?

MR. TRUE: Yes.

CHAIRMAN APOSTOLAKIS: We don't have to worry things we have not. Right?

MR. TRUE: Right. In conclusions, we think that the screening criteria try and address all the necessary issues and that they're adequate and appropriate for applications. We think CDF and LERF are appropriate figures of merits and they help address -- safety goals.

The uncertainties we've already talked about. Mean values would be acceptable for the screening criteria and defense-in depth. And we think most of all that the screening criteria in the applications guide provide a long-term insurance that will meet the safety goals in the long term and the risk management philosophy will remain intact.

MR. PIETRANGELO: Any questions?

CHAIRMAN APOSTOLAKIS: I guess not. Well, dealing with uncertainties, I mean, you dealt with a different kind of uncertainty with a big picture, but my question was the core damage frequency itself is an uncertainty band. Right?

MR. TRUE: Right.

CHAIRMAN APOSTOLAKIS: And the change may have an uncertainty itself, I mean, the -- part?

MR. TRUE: Right.

CHAIRMAN APOSTOLAKIS: So it may have a mean value of 50 percent, but there may be some uncertainty about that. How does that figure in this?

MR. TRUE: What the guide suggests that sensitivity studies should be done to investigate how the mean value might change for that particular change to make sure you understand how the cause and effect is.

CHAIRMAN APOSTOLAKIS: The expert panel really will make the decision, some sort of an expert panel? It's zealous objective decision at the end, is it not?

MR. TRUE: Yes. I mean, if you can show then in all your sensitivity studies that the change is always in the green area, then it becomes less subjective. If you have some sensitivity cases where it's well above, then it has to become subjective.

MR. PIETRANGELO: George, let me just summarize real quick how we think those criteria are going to be used and this came out of our last task force discussion following your July 18th meeting when we sat down and talked about this.

Our expectation long term and I think you've seen it in the WOG data, we've asked the other owners' groups to put together similar tables from the IPE value and the current day value.

We expect the long-term trend to be down on CDF and LERF because now we're using the tool, we're aware of the risks, we're managing it, as opposed to before where we didn't know what it was, so just the impact of measuring it and using the tool we have will drive the long-term trend down. We expect to be able to demonstrate that once we get all the data together.

Now, at the higher end of the spectrum, the 10 or the -4 plants are plants just a little bit over. The criteria says you can make a very, very small change, almost imperceptible on an absolute basis. Okay? And that would be done when there's either a burden reduction or some kind of economic benefit that's substantial, one that would be allowable to have a very, very small increase in risk.

Again, as you move leftward on the spectrum, plants with lower baseline CDFs and LERFs would be able to make small changes or increases when there's an economic benefit, but for the most part, the long-term trend is going to be down and uncertain as this is where there's an application where we can focus our resources, get more efficient, all the things that the commission says in the policy statement, there may be small increases in risk.

Again, though, the final including bullet there is that we stay with the criteria and basically trend towards that green and provide long-term insurance that the safety goals are going to be met, and that's what we're all interested in.

CHAIRMAN APOSTOLAKIS: And the only criteria and really that matters at this stage is the core damage frequency?

MR. TRUE: Actually, I think the LERF criteria --

CHAIRMAN APOSTOLAKIS: No. But I mean, below, you would not want to consider anything below that?

MR. TRUE: You mean like unavailability goals for --

MR. PIETRANGELO: But those are already, you know, those are derived. A lot of the maintenance rule performance criteria are derived from the numbers used and the PSA, so they're pulling out.

Again, we finally have a context that's coherent across the board where you can have the nexus to safety and also have the safety goal out there with the assurance that you're meeting it, so it does tie together ultimately.

CHAIRMAN APOSTOLAKIS: Any questions? Okay. We'll take a break. Fifteen minutes.

(Whereupon, off the record at 10:30 a.m. until 10:47 a.m.)

CHAIRMAN APOSTOLAKIS: Okay. Our next presentation is from the Combustion Engineering Owners Group on risk-informed tech. spec. pilot application.

MR. HACKEROTT: I'm Allen Hackerott from Fort Government Station. With me is Ray Schneider from ABB-CE and in the spirit of not focusing on the numbers, don't focus on the numbers last. I'm planning to skip quite a few of them. The package is fit together for completeness. I appreciate the offer to me to be here to discuss our CEOG applications.

The main thing we want to discuss today is the decision process we used and what we've learned and how we used the decision process with the practical applications.

We also at the request of the ACRS will discuss our cross comparison process that was part of our decision process in our applications. We can go to slide 5, the handout.

This is somewhat of a new process for group submittals, the tech. spec. AOT extensions that we submit as well as the other applications that we're doing and have done. Basically, plan analysis is done across an industry group and it's all summarized in a single report. The analysis goes in with all the data to all the plants in a single report.

The main benefit of this is it provides an inherent credibility check. It also provides a spectrum results based rather for a decision on not just a single plant, so you have a whole group of plants. In this case, all the CE plants to base a decision on.

Slide No. 6, don't have it for the moment.

MR. SCHNEIDER: I realize it's difficult to see, but at least I'll keep count of them.

MR. HACKEROTT: All right. Slide No. 6, we use a blended approach which I think now is evolving into the relatively new term of risk informed applications. And in the blended approach, we basically start with the justification of the need, why are we asking for the change, and that can be ALARA considerations, operational flexibility and other reasons we'll discuss later.

Then there's consideration of deterministic design basis issues and this consideration, depending on the application, can be fairly thorough.

The PSA assessment. We look at the risk at power and in order to consider as broad a spectrum a risk as possible, we look at transition risks, particularly for tech. specs. and also lower mode risks. Now, those are quantified as best as the state of art -- but they are approximately quantified, so they're not directly comparable with the power risks, but they can be used in the decision process and I'll talk about that later.

And as a result of this understanding we get by looking at the design basis, licensing aspects we well as the probabilistic aspects, we end up identifying compensatory measures or contingency actions that can be used for incorporating the change we're requesting in the actual operation of the plant.

I'd like to go to slide 8. Skip slide 7.

The steps for the cross comparison process that we use both for applications specific cross comparisons because we do cross comparisons with specific application. We also do them globally for general PRA certification are set forth here.

First thing we do is we take an initial guess at identifying an appropriate set of metrics or parameters for the application to compare it, and those parameters are then calculated by the individual plant PRA groups with their living PRAs, because they of course have the best knowledge of the plant specific insights, so those calculations are done and those results then are compiled.

And then those reviewed by a PRA panel which, so far, has been our PSA applications working group. That's representatives from all the PRA groups of all the CE plants. And we resolve those differences during a panel.

Now, in any point here, usually here, we go back and sometimes set a new set of metrics because any time we answer questions we usually end up with more questions than we started with, and from that, we determine the important plant features or modeling assumptions that are driving the answer or importing the answer and we can focus on those.

The depth of the cross comparison in how far you go in resolving all the differences is really commensurate with the application, and this allows us to focus on the parameters that are important to conclusion and make sure that we have both a depth of understanding there as well as a breath to make that there isn't any phenomena that we haven't considered.

I'd like to go to slide 10, skip slide 9. For the AOT extension applications, control and planning of the maintenance activity is more important than the duration because the duration is specified in the AOT. And the COG members all recognize and all have implemented controls that are PRA based that will control the unavailability in conjunction with the maintenance rule.

And reasons for AOT extensions are the -- integration of risk in the maintenance planning. Right now, a lot of maintenance planning is done soley with consideration of minimizing time. It allows longer maintenance to -- allows you to -- examples are it allows you to consolidate maintenance in one outage instead several because you have longer time and that prevents tag-out errors and it's also a lot more efficient. Allows sufficient times. Some AOTs just aren't long enough to perform any preventative maintenance or corrective maintenance processes that are warranted from a risk basis.

And allows planning for restoration if required. The risk of a lot of components isn't dominated by the demand on that component needed in 10 seconds or a few minutes. Sometimes it's up to a few hours. With a longer duration, you can do the work in such a way that you can do the work more in series instead of parallel and it will allow you to take plans for restoration of the piece of equipment because for the majority of the risk of having that compenent -- could be something that you can actually restore, if it's planned, and certainly, doing work on components of power allows more available at shutdown.

Slide 12, skipping slide 11. The SIT change. The SIT is the safety injection tank and CE nomenclature. Westinghouse calls them accumulators and B&W calls them something else. Anyway, they're passive tanks.

The deterministic considerations of our application are SIT, basically functions to mitigate a large break LOCA. They dump at relatively low pressure, 200 and 600 pounds, depending on design and for the reflood phase of the large LOCA.

Realistically, unavailability of 1 of SIT, 1 SIT out of 4 won't make any difference in mitigating a large design basis LOCA. Radiological releases are also bound by the existing source term.

The PSA evaluations confirm that the SITs have very little impact on risk. Those large LOCAs do not dominate real plant risks.

MEMBER POWERS: You've said the word realistically. Does that mean that if you do the calculation following the more conservative practices of the standard review plan that the unavailability of 1 SIT would impact the ability to respond in the accident?

MR. HACKEROTT: Ray comes from the Appendix K branch. I'll let him answer that.

MR. SCHNEIDER: We didn't do the analysis. The reason we didn't take the liberty to say that it wouldn't even under those circumstances is because the calculation wasn't done, but based on all of our gut feel on the seeing the calculations, 1 SIT would not even be a problem for meeting Appendix K.

MR. HACKEROTT: Slide 13 is a graph of increases in core damage frequency per day -- out of service. Basically, all these values are very low. That's the first important insight and the differences are due to modeling assumptions which I'll discuss in the next slide.

Slide 14, please. Results from the cross comparison is basically all the plants modeled the SIT functions to be the same. The SITs at all CE plants had the same function, that was injection and the low pressure phrases of the large LOCA.

The PSA differences are due to modeling factors, not plant uniqueness. Most CE plants realistically model it the unavailable -- 1 SIT during a large LOCA. It didn't impact core damage frequency.

A few plants used a difference assumption or basically their model would indicate that if you had a large LOCA and a SIT was unavailable, that would lead to core damage.

The variability in addition to the success criteria I just discussed is largely due to differences in the initiating event frequency for a large LOCA. That parameter has a lot of industry uncertainty and a variety of PRA analysts chose different values from different sources.

In this case, the results of probabilistic analysis could be calculated essentially hand, at least to get order of magnitude approximation.

The reason for some of the conservative assumptions, particularly with respect to the SITs here in the PRA models is the PRA models always usually start when you build them with the design basis assumptions, then you refine the PRA model as through usually many evolutions, and the risk of SITs would show up in the refinement process because the risk is low, so it's not unusual as an artifact to the way models are produced to have conservative success criteria buried in the model where they haven't shown up. It's only when you do applications like this that you may start to see conservative assumptions that would affect the answer. I think this was evident here.

Briefly, the cross comparison provided for this case and understanding of how the design basis assumptions and the Appendix K assumptions were using the PRA model, PRA analysts took some time to understand the Appendix K analysis a little better to make sure that the way we model was consistent with all the insights that the Appendix K and design basis analysis had. It also gave us confidences of behavior in the phenomena radically addressed in the PRA.

Slide 16. The AOT change is the low pressure safety injection pump, RHR for other PWRs. This is the low pressure injection system. Deterministic considerations, very similar. Operation of one of the LPSI subsystems is adequate for a design basis LOCA accident. The radiological releases are again bounded and most importantly, LPSI provides a backup means for core heat removal when the plant is at lower modes. It also is for PWR is the primary means, actually the only means in some modes for removing decay heat.

Some of the compensatory measures that the PRA analysis would indicate even though not really risk driven were that PM on LPSI subsystem MOVs should be performed individually. That means you can always have at least one injection path available.

Also, if possible, you should do maintenance with the injection valves in the emergency or open position, and there's also some small increases for HPSI and LPSI out at the same time.

This is a graph of core image frequency per day for LPSI pump out service.

CHAIRMAN APOSTOLAKIS: How do you get that day?

MR. HACKEROTT: Per day? It's just the metric we chose.

CHAIRMAN APOSTOLAKIS: How do you calculate?

MR. HACKEROTT: We take the LPSI pump out of the service in the model and resolve it, so you fail a LPSI pump or a LPSI train and resolve the model the look at the change.

CHAIRMAN APOSTOLAKIS: But the rest of the PRA is not on a per-day basis. Right?

MR. HACKEROTT: That's correct.

CHAIRMAN APOSTOLAKIS: So it's really the --

MR. SCHNEIDER: You take the compenent and you get it per year, but the thing is, since we're only looking at the AOT change, we're only interested in the day and the worth of it each day.

MR. HACKEROTT: Per year, you multiply them by 365.

CHAIRMAN APOSTOLAKIS: No, but I mean, the rest of it, core damage frequency is sort of an average over the year.

MR. HACKEROTT: Yes.

CHAIRMAN APOSTOLAKIS: So it's not strictly per day. This does not provide you the core damage frequency on a particular --

MR. SCHNEIDER: This is the increase of the --

MR. HACKEROTT: For just this component out of service for a day.

CHAIRMAN APOSTOLAKIS: Yes.

MR. HACKEROTT: Nothing else.

MR. SCHNEIDER: That's correct.

MR. HACKEROTT: So it doesn't include interactions with other components. Anyway, these numbers as with the SIT are relatively small and the variation in numbers are understood. I'll discuss those, a couple slides.

For the LPSI pumps, there was a difference between corrective preventive maintenance. The numbers for preventive maintenance were all very small. There was a variation in some slightly higher numbers for corrective maintenance, the difference mainly being in treatment of common cause, given you have one component fail, there is a higher chance the other one has failed depending on how you chose to -- the common cause.

Next slide, please.

CHAIRMAN APOSTOLAKIS: Say that again. Common mode, values like presence of a common cause, what did you just say?

MR. HACKEROTT: Corrective maintenance. CM is corrective maintenance. For corrective maintenance, that's when one train has failed. The other train is more likely to have a higher failure rate than from common cause because whatever mechanism failed in the first train, may exist in the second train. So depending on how you model that makes a difference on what the corrective maintenance values are.

CHAIRMAN APOSTOLAKIS: How do you model it?

MR. SCHNEIDER: The metric that we used was for preventive maintenance. It assumes random common cause is still active, but for corrective maintenance, we assume that it was a common load failure or common cause failure, so that we increased the failure rate to the beta factor. We increase the failure rate as if the component had failed due to common cause, so that's why there's a higher probability of failure of the second LPSI.

CHAIRMAN APOSTOLAKIS: So the failure rate is lambda plus beta lambda?

MR. SCHNEIDER: Well, it's basically beta at this point.

CHAIRMAN APOSTOLAKIS: Lambda plus beta?

MR. SCHNEIDER: Just beta because as I said, it's a metric. The metric was if you had a common cause failure, there's a high probability now that the other component failed and what does that do to the risk profile, so it was an artificial metric to get an idea. Otherwise, most corrective maintenance has no difference between preventive maintenance and corrective maintenance if there's no relationship between the two components.

So PM covers all of those kind of corrective maintenance actions also, so we defined and this is consistent with the NRC discussions, we defined a situation where we artificially assumed that the failures a common mode failure and that that is the failure mode, and so the beta is the failure rate.

CHAIRMAN APOSTOLAKIS: No, beta is -- isn't it?

MR. SCHNEIDER: Well, yes, but beta --

CHAIRMAN APOSTOLAKIS: Beta lambda.

MR. SCHNEIDER: Okay. The beta lambda would be the failure, but you've already failed the component.

CHAIRMAN APOSTOLAKIS: Well, you already failed one.

MR. SCHNEIDER: Right.

CHAIRMAN APOSTOLAKIS: But you're worried about the occurrence of the event itself. But I'm not sure that's the correct use of it though because --

MR. HACKEROTT: Again, this isn't a calculation of an actual risk. It's a calculation of a way to query the model to get insights for cross comparison purposes. And I think maybe pulling back to a little bit of a bigger picture, the interesting thing is there are variations certainly in the corrective maintenance and the way common cause is modeled, but if you're in a real plant and you have one LPSI pump that's failed, it really doesn't matter what you've chosen for a common cause failure because shutting the plant down when you have to rely on the LPSI pumps for decay heat removal is the right decision. So independent of when you're doing a comparison, the way these things are used to compare between staying at power and shutting down, this really is irrelevant.

MEMBER MILLER: It's really irrelevant?

MR. HACKEROTT: Yes.

MEMBER MILLER: Okay. I'm confused, too. You assume the common cause failure basically was you're not modeling. Let's say the pump failed for a certain reason.

MR. HACKEROTT: Okay.

MEMBER MILLER: And then you assume that's a common cause failure for the second pump. That's your assumption, but you've not modeled that a priority necessarily. Is that right?

MR. HACKEROTT: No. The failure of the second pump was beta lambda, wasn't it?

CHAIRMAN APOSTOLAKIS: -- plus beta lambda.

MR. HACKEROTT: Well, lambda was one in this case.

MEMBER MILLER: Okay. So you assume lambda's one.

CHAIRMAN APOSTOLAKIS: No. No. No. One plus beta lambda.

MEMBER MILLER: One plus, I think that was right.

CHAIRMAN APOSTOLAKIS: So the change is really negligible because beta is going to --

MEMBER MILLER: Right.

CHAIRMAN APOSTOLAKIS: So whether it's done to the -4 or 1.1, then the -4.

MEMBER MILLER: So you're assumption --

CHAIRMAN APOSTOLAKIS: --

MEMBER MILLER: I see. Your assumption in the end doesn't matter.

MR. HACKEROTT: Yes.

MEMBER MILLER: You could assume any failure rate and it would come out the same conclusion.

MR. SCHNEIDER: It's not exactly that. The assumption was we did assume that there would be a common cause failure and that the other pump had failed and I think we said it to beta, just the beta. That's why you're getting the higher numbers. Otherwise, you wouldn't see anything.

MR. HACKEROTT: It's discussed in the reports which I looked at for many months.

MR. SCHNEIDER: And again, the metric is to just -- I'm sorry.

MEMBER MILLER: And where do you obtain beta from then?

MR. HACKEROTT: It's what the individual analysts used.

MEMBER MILLER: So you go back to the original model to find beta?

MR. HACKEROTT: Yes.

MEMBER MILLER: And what if he had not analyzed the common cause failure there?

MR. HACKEROTT: And you'll find that in some of the plants, they didn't consider common cause, but that's part of the cross comparison process. This gives us insights into how we model common cause that go back to refine the model.

And importantly, again, for the decision process, for tech. specs., for a real plant, whether you want to stay at power or shut down, it really doesn't matter because whatever your risks are at power, they're higher at shutdown for this particular case.

MEMBER MILLER: All right.

MR. HACKEROTT: Okay.

MR. SCHNEIDER: Again merely for the PM, basically the numbers we should be focusing on are the PM numbers. This is why taking -- the extended.

CHAIRMAN APOSTOLAKIS: I think the interpretation of beta is it's the fraction of events or failure of events that involve two or more components. Right? But if one of them has failed, then the other one because the condition -- one or failing if it's within that's class, so that has 1 + plus beta x lambda.

I don't think the condition or the probability of the second component is 1 + beta x lambda. A priority, what we're saying is beta x lambda is the rate of seeing these events and they involve failure of both components, so if you see one --

MR. HACKEROTT: Yes.

CHAIRMAN APOSTOLAKIS: -- and it's one without those events, the other one either has failed or is about to fail.

MR. SCHNEIDER: Right.

CHAIRMAN APOSTOLAKIS: But the condition or probability, in other words, is close to 1.

MR. SCHNEIDER: Right. It's beta.

MR. HOLAHAN: No. It's beta. It's beta. It's not 1.

CHAIRMAN APOSTOLAKIS: It's the fraction of failures that involve -- yes, you can --

MR. SCHNEIDER: So that's right. It's just another metric of --

CHAIRMAN APOSTOLAKIS: I don't think so.

MR. HACKEROTT: You don't know whether the first failure was common cause or not, but there's a certainly a probability it was and that works out to be --

CHAIRMAN APOSTOLAKIS: Well, shouldn't the first thing to do be to look at the failure of mode, the failure of cause and try to figure out whether that's indeed a failure?

MR. HACKEROTT: That's what you would do in a real case. The pump fails, you look at why, make an estimation of whether you have common cause. Again, this is just metric to calculate various ways to look at risks to give us the understanding of the -- teachings. This is one of the things we looked at.

CHAIRMAN APOSTOLAKIS: See, you're operating now knowing that one train is down. Okay? And you don't know whether that was a common cause failure or not.

MR. HACKEROTT: That's right.

CHAIRMAN APOSTOLAKIS: So you're saying that the condition or rate of the other one is still beta lambda which really a negligible correction really.

MR. SCHNEIDER: What we're saying is there's about a 10 or 20 percent chance that the second --

CHAIRMAN APOSTOLAKIS: --

MR. HOLAHAN: -- second go down.

MR. HACKEROTT: I think it's the dominant element of unreliability that --

CHAIRMAN APOSTOLAKIS: Or one is already down.

MR. HACKEROTT: One is already down.

CHAIRMAN APOSTOLAKIS: Okay. So the failure of the next one or the other one, failure rate will be what? Lambda.

MR. HACKEROTT: Beta.

MEMBER KRESS: It will be the probability of having a common cause failure.

MR. SCHNEIDER: Right.

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER KRESS: By definition and that's beta, isn't it?

MR. SCHNEIDER: Right. And again, it's a metric and in reality, what would happen is the plant would assess whether it's a common cause failure and then if they know it to be a common cause failure, they then have two trains out, so then it goes into a different AOT, and then they have different actions to follow, but this is just a way of putting the metrics on that.

MR. HACKEROTT: Which happens to take you down where you need both those pumps which is something else we'll deal with later.

CHAIRMAN APOSTOLAKIS: It's .1.

MR. SCHNEIDER: Yes. So just to give us an understanding of the issues.

MR. HACKEROTT: Slide 20. In this case, the cross comparison provide confidence that the power risk of LPSI unavailable is small compared with the shutdown alternative. That's what I've been trying to say. Differences in modeling were again the initiating event frequency for a large LOCA and the success criteria.

There were some other subtleties. Some plants created using LPSI as a backup for HPSI as a recovery action and that was particularly important for plants that had twc HPSI pumps. Some of our plants have three HPSI pumps, so that should open the data.

It also gave us insights which we've revisited recently on preventive maintenance, corrective maintenance, having to do with common cause.

MEMBER MILLER: Did you discuss those insights somewhere in your papers that we discussed today?

MR. HACKEROTT: Yes. They're in the reports. It comes up a little more on the diesels.

MEMBER MILLER: Okay.

MR. HACKEROTT: Yes. It comes up on the diesels again.

Insights from the PSA cross comparison process, basically LPSI functions the same for all plants which it has a negligible impact on that power risk. The PSA differences, large LOCA -- frequency, assumptions on common cause made a difference. Large LOCA frequency and success criteria.

Next slide, emergency diesel generator. Design considerations are basically that the generator at all plants provides power following a station blockout and this need for power applies for both power and lower modes.

Most CEOG plants have provisions for independently powered alternate decay heat removal capability. Some have swing diesels, combustion turbines in the switch yard, diesel driven aux feedwater pumps that depend on AC power and unit cross tie capability for multiple units.

The PSA results show a small potential risk increase associated with an at power maintenance of a diesel generator, but these risks can be controlled or offset by contingency actions and planning. And also if you look at the bigger risks comparisons between power and shutdown alternatives, the risks can actually be a benefit.

Next slide.

MEMBER MILLER: That you determine through the transition risk analysis?

MR. HACKEROTT: Partially, yes. Mainly shutdown the power comparisons.

This is the metric we chose for this. This is the plant response given the loss of all site power, so the model at each plant was already given loss of all site power once the conditional core damage frequency and these are the results and the differences we'll explain the next slides.

This is both corrective and preventive maintenance again. Corrective maintenance and preventive maintenance for diesels are very similar.

Where there is some slight differences, that's due largely to multiple unit capability for cross tie. And those correspond real well. Plant K has a -- methodology that's significantly different than the rest.

Slide 27. Insights from the cross-comparison. The diesel functions are basically the same for all CE plants. However, backup power from the switch yard turbans are cross-tie capable, etc. And other decay heat removal capabilities do make a difference.

The differences in the PRA are due to multiple versus single unit, the available alternate power and how it's modeled, and loss of off-site power frequency. Plants with single units with no independent backup equipment for decay heat removal at higher risk associated with those that don't.

That's not much of a surprise. And a big thing in PSA modelling was treatment of run failures where the run failures were considered to occur at times zero or some distributed time after time zero, and also consideration of recovery actions, most specifically the recovery of off-site power and how those things were modelled.

The cross-comparisons provided an understanding of the features and how we all modelled features of the AC power system and how the modelling sophistication, mainly again a recovery action, affected the results.

And the uncertainties in the initiating event frequency and modelling assumptions do not change the validity of the overall conclusion, even though they were variable. Loss of off-site power frequency and recoveries to the overall conclusion is still valid.

Both from the PRA and the -- considerations, a lot of contingency and compensatory measures were identified for the diesels that will be used in terms of the maintenance rule to control risk for either a corrective or preventive maintenance entry of a diesel.

Certainly, the initiating event frequency, loss of off-site power, switch yard work, weather, state of the grid, state of nearby power plants and switch yards is very important.

Maintenance should be performed with no other simultaneous maintenance activities. Some plants have included no surveillance or even routine rotating of pumps. And routine operation things are curtailed during diesel outages to prevent any commission errors or bumping into electrical cabinets and causing perturbations.

Compensatory measures, depending on the activity, can be put into place to restore the diesel because there are several plateaus where diesel recovery can help you depending on the sequence that sometimes go up to eight hours or longer.

You can also assure that the other systems that are important with the diesel out of service or during a station blackout, make sure those systems are tested and available prior to or after a failure of a diesel.

Insights from the cross-comparison process both for an application and globally. They provide a cross-check of results. It finds errors. It finds differences in modelling assumptions.

It clarifies the impact of these assumptions and inherently considers uncertainties by doing comparison of results and how independent analysts have considered success criteria and other modelling things that drive the differences and the results.

CHAIRMAN APOSTOLAKIS: So, what are the first order uncertainties?

MR. HACKEROTT: It's the first look at what the variations are by looking at how the analysts have handled it. Next slide.

CHAIRMAN APOSTOLAKIS: We're running out of time. So, if you can skip a few?

MR. HACKEROTT: Sure. We're doing applications for HPSI's, containment spray system, and AFW system. And we have done some of these. These all focus on different parameters.

The HPSI focuses attention on small/medium LOCA success criteria and modelling assumptions and also feed and bleed once through core cooling. And we're comparing differences to these.

Containment spray system focuses on assumptions on sump water cooling and containment integrity. So, in doing the comparisons, we have to resolve differences and understanding of these parameters.

And the AFW system focuses on once through core cooling and steam generator heat removal functions and the way modelling is done to support those.

The goal of doing all these comparisons is to improve our PRA models and assure that the results in these are scrutable. These graphs are fairly self-explanatory.

These are some metrics we chose to do some comparisons. Some of them are pretty well thought out and show us some insights real quickly. Let's go to the summary.

The PSA evaluations requested range from typically risk beneficial to risk neutral. Corrective maintenance of power can be partially or totally offset by the risk, by comparing the risk of shutdown or mode transitions and the repair of the associated equipment at the shutdown state versus repairing at power.

And small increments of increase in power at risk can be offset by compensatory measures, contingency measures that are identified as part of the process.

CHAIRMAN APOSTOLAKIS: Would you want to use the PSA Applications Guide somewhere?

MR. HACKEROTT: We didn't need to. One reason we chose these applications is because when we first looked at these, which was three years ago, such a guide was in the early stages.

CHAIRMAN APOSTOLAKIS: No, no. I'm not asking why you didn't use it. But now that it's available, could one go back and use the results of the criteria they used there to justify this?

MR. HACKEROTT: The LPSI pumps is my favorite. When you're comparing at power risk to shutdown risk, there's a risk benefit of staying at power for a certain amount of time.

So, an extended AOT for corrective maintenance of a LPSI, or when you compare a LPSI, doing maintenance online to maintenance at power, if you look at the big picture, there's a positive risk increase.

And that doesn't even show up on the chart. It's below the axis.

MEMBER MILLER: So, if you use the guideline, it would just stand that --

MR. HACKEROTT: And all these risk increases that we're showing are metrics we used just to get insights to compare risks and to compare models.

So, assuming that we take the full AOT, as you observed in the model, what we did is for the models is we took the component out of service, left everything the same, and came up with the risk increase.

Well, that may or may not represent a real plant configuration. Putting that on a criteria, what does that mean?

MR. SCHNEIDER: I'll go one step further. If you're talking about just plotting the numbers we showed you on that kind of graph, it will come out all green.

That means if that's what you're looking for, we've plotted the stuff on it. We're all within their criteria. But we feel that we have a much more thorough understanding of all the issues involved and what the trade offs are and what the benefits are and why we're making the decision. But we're also agreeing.

MEMBER MILLER: What you're saying is all your analysis is going to be risk beneficial or risk neutral, so it would stay in the green. Is that what we're saying?

MR. SCHNEIDER: Essentially.

CHAIRMAN APOSTOLAKIS: Now, the decision is based on these increases in CDF per day?

MR. HACKEROTT: The report contains a number of --

CHAIRMAN APOSTOLAKIS: Or the average over the year?

MR. HACKEROTT: The report has for the full AOT once a year for what plants expect to do, there's a number of calculations in the reports.

CHAIRMAN APOSTOLAKIS: But I am not sure that the EPRI figure is a place for something like increase in CDF per day.

MR. SCHNEIDER: We look at the CDP's, the core damage probabilities, on an integrated basis, which is what he was talking about. We look at the LERF values in terms of the impact on the major release paths.

We look at the CDF's in terms of the yearly impact of having an extended maintenance AOT because it will be a yearly impact on the maintenance on a global average basis.

And we also look at the single AOT risk by just pulling out -- suppose we take the full AOT for this piece of equipment, what actual probabilistic delta did we add to the risk profile?

So, we look at it from all pertinent angles. And among those, some of the NEI guidelines fall into it.

CHAIRMAN APOSTOLAKIS: This is not necessarily inconsistent with what --

MR. HACKEROTT: No, no.

CHAIRMAN APOSTOLAKIS: Because that was the screening criterion anyway. So, you're supposed to do more.

MEMBER MILLER: Is the CDF per day just a matter of convenience so you can integrate the risk easier?

MR. SCHNEIDER: Well, because we're looking at AOT's here. And so, we're talking about taking it out from three to so many days. So, we felt that the day would need a lot more than looking at the year.

Because if I had a year, then you'd say but you're only taking it out for only a couple of days. And then you'd say but what does it look like if you took it out for -- it would look like you're taking it out for the full year.

So, we kind of chose this presented in a daily basis, but it's really units.

MEMBER MILLER: It's just a matter of units.

If you looked at AOT in terms of fractions of years, you could use CDF per year then.

MR. SCHNEIDER: Right.

MR. HACKEROTT: And again, what's the meaning of having the component out with nothing else out for the duration of the allowed AOT, once a year? That isn't an indication of how we're necessarily going to use it or how it will be used in any given year.

So, that if you did that, that could be construed as, "Gee, this is what the numbers are going to be." And that isn't true. It could be better or worse than that.

CHAIRMAN APOSTOLAKIS: Okay. That's it? Anymore?

MR. HACKEROTT: Let's go to the last slide. The joint applications that we've done provide an efficient means both for us and the regulator, the industry and the regulator, an efficient means for integrating risk insights into regulation.

The current applications with the associated cross-comparisons and the blended approach are commensurate. The quality is commensurate with the applications that we're asking for now.

The cross-comparisons provide insights that improve plant specific models. We're learning a lot about

PRA techniques and about our models that are fed back in living PRA's which is very valuable.

We're learning a lot about PRA techniques, most notably many of the initiatives, transition risk, and some of the shutdown risk. And the cross-comparison itself, was activities that were born out of the need in doing these applications.

So, the applications are fostering this. And most importantly perhaps, the understanding of the technology and how you actually apply it comes out in this process.

MEMBER MILLER: It may be more important is the fact that you are applying it.

MR. HACKEROTT: Yes. We'd like to emphasize that. Applying it now doesn't require -- a lot of the things that are discussed don't matter to certain applications. These are among them.

MEMBER MILLER: Question on the cross-comparison. You said it identified modelling errors. Did you identify a lot of modelling errors? Or is that a small --

MR. HACKEROTT: I'll talk about the one I already talked about. That was the conservatism in the safety injection tank. It was an error. It didn't make any difference in the bottom-line number.

But it was a conservatism. And that isn't correct in PRA.

MEMBER MILLER: I guess maybe more important, did you identify any modelling errors that really made a difference overall?

MR. HACKEROTT: It made a difference to the SIT application.

MEMBER MILLER: I mean, a lot of modelling errors? A small number?

MR. HACKEROTT: I don't think we found much that would affect the bottom-line number too much. There's a lot of things that would shift stuff around.

MR. SCHNEIDER: By and large, we caught conservative assumptions that may distort impressions. But in terms of errors, they really weren't like IPE-related errors.

They were errors when they had to deal with cut sets that were virtually negligible, but now you're bringing them to the top, they may not have cancelled them out. So, that when they presented their results, it looked like they had a lot more sequences than should have been there.

MR. HACKEROTT: Let me give an example from my plant. I was on the low end of the LOCA frequencies. I think that number's probably right. But based on seeing the spectrum of LOCA frequencies comparing everyone's basis, we actually came up --

Another project we're doing is PSA standard guidelines for the CEOG. And I've increased my large LOCA frequencies based on this. I won't confess it's an error, but I was on the low side. And I'm happy with my new number. So, that's an example. There's a lot of them.

CHAIRMAN APOSTOLAKIS: Any other questions? Thank you very much.

MR. HACKEROTT: Thank you.

CHAIRMAN APOSTOLAKIS: And the next presentation is from the NRC staff, overview of pilot applications. Mark Rubin and Mr. Cheok.

MR. BUTCHER: Dr. Apostolakis, Mike Cheok is going to make the presentation. Mark Rubin is not here today.

What we propose to do is to take a little bit of liberty with the agenda there under item five. There are a good many issues there. We would like to discuss those issues in the context of perhaps the fifth bullet.

And that is, go right at the technical issues and what insights we're getting into those technical issues from the pilots. And to the extent that the committee or subcommittee wants to hear more about what the overall objectives or the technical details of a specific pilot are, then Mike can expand on that.

CHAIRMAN APOSTOLAKIS: Sure.

MR. CHEOK: Good morning. I'm Mike Cheok, and I have Bob Youngblood sitting beside me.

CHAIRMAN APOSTOLAKIS: From where?

MR. YOUNGBLOOD: From Scientech Contracting.

MR. CHEOK: As Ed has just mentioned, I'm just going to basically concentrate on the issues that were brought up in the July 18th meeting and discuss how the pilot applications are addressing these issues.

I'm going to use the same set of slides that were handed out on July 18th. And I have not made too many changes. Also, if you have any questions on pilot specific applications, all the task leaders from the each application are sitting in the audience.

The first issue I'm going to discuss is the scope of PRA. Basically, what's acceptable risk when we have partial scope PRA's? As you all know, we all have mostly Level I PRA's.

Most of the IPE's and most of the PRA's come in with Level I and Level II interface event trees. Some come in with a Level II PRA, but a lot of them don't.

So, how do we apply these PRA's, and how do we use them in risk-informed regulation? First of all, I guess we had discussed the use of partition factors. And as far as the use of partition factors is concerned, when we are looking at the absolute CDF, the use of partition factors would be applicable.

For a lot of the applications that are coming in, which are basically risk ranking type applications, we do not believe that the use of partition factors would yield correct insights.

CHAIRMAN APOSTOLAKIS: I'm not sure I follow this. Is this one of the issues that Mark Cunningham raised and talked about last night?

MR. CHEOK: Yes, it is. Basically, it's scope of the PRA. What should we need? Do we need a Level I? Do we need a Level II? Do we need external events? Do we need the shutdown PRA?

If we don't have those PRA's, what could we do? And I guess one of the resolutions was the use of partition factors.

MEMBER POWERS: Could you tell me what a partition factor is?

MR. CHEOK: I could, but would Mark like to take a shot at this?

MR. CUNNINGHAM: In the last briefing, we talked about the idea that if you have an overall core damage frequency goal, for example, that if the safety goals that's somehow derived or based on or related to the safety goals, the safety goals talked in terms of them goals being related to total plant risk.

So, you have a goal, if you will, that's trying to encompass accidents initiated at full power, low power, fire, seismic, or whatever.

MEMBER POWERS: Sabotage, national events.

MR. CUNNINGHAM: Well, sabotage, the commission ruled out basically among a few other things. So, the question then becomes, if you are trying to deal with a PRA and use a PRA that does not have the full scope of internal events, fire, seismic, low power and shutdown, the idea is you may have to partition the acceptance guideline of the core damage frequency goal to reflect the fact that part of the PRA is missing.

So, you may have to subdivide whatever goal that might be in to finer elements to reflect that. That's the concept that Mike is talking about.

MEMBER POWERS: But how are you going to do that?

CHAIRMAN APOSTOLAKIS: Rick tried something this morning, right?

MR. CUNNINGHAM: That's right.

MEMBER POWERS: But Rick failed miserably because he has absolutely no -- he doesn't have a shutdown risk assessment.

MR. CUNNINGHAM: I'll agree.

MR. CHEOK: And I think the issue of partition factors is still being discussed. It's one of the options. And this is one way we are trying to say, hey, look, maybe this is what we can use from the pilots or even from something else that maybe partition factors might not be the way to go. Or else, it could be, but let's do something different.

MEMBER POWERS: Okay. It could be used if we had a clue what the risk partitioning factor was?

MR. CHEOK: Right.

MEMBER POWERS: It's not an extraordinarily helpful concept.

CHAIRMAN APOSTOLAKIS: Yes, let's pursue this a little bit. I still am a little confused by the words there. How is acceptable risk defined for plants with partial scope PRA's where the acceptable risk has already been defined?

Do you want to pass judgment whether that particular plant meets the goal, or the acceptable risk goal? Right? That's what you mean by that?

MR. CHEOK: Correct.

CHAIRMAN APOSTOLAKIS: Right. And the partitioning will be part of the definition of acceptable risk, or will it be based on actual PRA results? In other words, if a plant gives me a partial scope PRA and excludes say fires, then based on this partitioning, I will be able to have a rough estimate of what the fire contribution is?

Or I will completely forget about that and say based on the partitioning, I will only compare their results with the corresponding subset of the goal that applies to those results only?

MR. CUNNINGHAM: I think what we were talking about last time was more of the latter type of thing.

CHAIRMAN APOSTOLAKIS: The latter, okay. And the last question is, why do you say that the last two bullets are general observations from pilots? How did the pilots help you here? I mean, that's something that you could do without? Any pilots.

MR. CHEOK: That's true. I guess you can. But I guess you can use the pilots to point it out also.

CHAIRMAN APOSTOLAKIS: I don't see how.

MR. CHEOK: I mean, we use the pilots to do a lot of things. And as far as this issue is concerned, this is one thing we observe from the pilots.

CHAIRMAN APOSTOLAKIS: The pilots you observe from the IPE program? Most plants have a basic Level I PRA? The pilot has nothing to do with this.

MR. CHEOK: You're right.

CHAIRMAN APOSTOLAKIS: Okay.

MR. CHEOK: In that sense.

CHAIRMAN APOSTOLAKIS: For determination of absolute risk, risk partitioning could be used. The pilots have nothing to do with this. That's a statement.

MR. CHEOK: Right.

CHAIRMAN APOSTOLAKIS: So, both bullets don't belong under general observations from pilots.

MR. CHEOK: How about general observations?

MR. CUNNINGHAM: I think what it amounts to is the pilots confirmed what your common sense told you. Many of these applications you can't use risk partitioning because you'll just get half the answer.

Now, the next slide points out that even if you could figure out how to partition it, you would find that the analyses that the pilots had to present to us didn't address many of the areas where you would try to partition the risk anyway.

So, as a practical matter, I think the overall message that's coming out of this is that you're going to have to come up with some other tool in a risk-informed environment other than just the IPE in order to make the decision because there are going to be elements of risk that you're not going to be able to get insights from the IPE or the PRA that's available.

That's the message. That's where all this is going to go. When he gets to the end of the three slides here, that's what you're going to come away with. I think you got that from the CE owner's group earlier too, that there's a lot more that goes into this decision-maki than just cranking numbers out of a PRA.

CHAIRMAN APOSTOLAKIS: No, I agree with that. But it's just that I thought I was missing something when he said general observations from the pilots. I mean, these are just observations. Now, the pilots may confirm them and so on. That's fine.

MEMBER MILLER: Or they didn't disagree with them.

CHAIRMAN APOSTOLAKIS: But that's not here yet. It is forthcoming. Let's see. Pilots. Very quickly, can you summarize what the pilots are?

MR. CHEOK: We basically have four pilots now. The first one is IST, which is in-service testing. We have in-service inspection, graded QA, and technical specifications.

CHAIRMAN APOSTOLAKIS: So, what does it mean then that most pilots have CDF's that approach that of the safety goal subsidiary objective?

MR. CHEOK: Basically, what this means is that the pilot plants that are coming in that the applications

I just mentioned have core damage frequencies and the PRA's that approach your IE-4 numbers.

Basically, what this points out is that if we are going to regulate based on a IE-4 number and talk about risk increase, risk neutral, the pilots would be sitting right on the borderline, and we're talking about risk neutral maybe, applications for most of these pilots, if you decide to stick with an objective for IE-4, for instance.

CHAIRMAN APOSTOLAKIS: Maybe I had misunderstood. When you say one pilot is on in-service inspection, you are addressing that particular issue, right?

MR. CHEOK: That's correct. We have two plants --

MEMBER MILLER: You had a specific set of two plants.

MR. CHEOK: That's correct for IST. And each plant will have their own PRA to support the application.

CHAIRMAN APOSTOLAKIS: Why does this fire or seismic or so on, why is that relevant to your application?

MR. CHEOK: It's relevant because when I have to write an evaluation on this application, whether I have to say that this pilot now -- the application that this pilot's doing will not exceed a certain risk number or else if it exceeds this risk number, it has to come in with an application that is risk neutral, for instance, if you decide to go that route.

CHAIRMAN APOSTOLAKIS: Have we defined the risk neutrality?

MR. CHEOK: No, we haven't. This is basically using the pilots to, hey, look, this is where we are headed with the pilots. How do we want to address this issue?

MR. CUNNINGHAM: If you recall, Dr. Apostolakis, from the last presentation, one of the issues we talked about is if you had something like a $1x10^{-4}$ goal, would you treat a plant differently in terms of how much allowable risk would be -- how much change in risk would be permitted if that plant was better than that goal or worse than that goal?

So, I think part of Mike's point here is that you have some plants that are right on the edge, if you will. And the question is, well, if they are on that edge, and we'll come back to that this afternoon, do you treat them differently?

Do you say in that circumstance they are only allowed to have risk reductions or risk neutral changes? Or do we allow increases?

CHAIRMAN APOSTOLAKIS: Wasn't that another issue though? It is not the issue we're discussing, which is how is acceptable risk defined.

MR. CUNNINGHAM: It was probably the next issue down, if you will. All of these are so interrelated, it's difficult to say. But you're right. It was probably two or three slides later in our presentation.

MR. CHEOK: Basically, all I'm trying to point out here is that a lot of plants actually sit on the borderline. And I guess if you remember from the IPE presentations given by Mary Drovin, she was stating that the average CDF for all the IPE's came in at 7^{-5} for the internal events alone. So, you're talking about a lot of plants sit right by the IE-4 objective.

MEMBER MILLER: What if you introduced the use of the guideline that we heard about earlier today?

MR. CHEOK: I didn't hear you.

MEMBER MILLER: What if we introduced the use of the guideline that we heard from industry earlier? Would you come to the same conclusion here?

MR. CHEOK: I guess the conclusion I would come to would be a lot of the plants would be towards the IE-4 number on the guideline, and they wouldn't be allowed, if you were to use their criteria, more than a ten percent increase without doing additional calculations.

MEMBER MILLER: You would move them into that uncertainty region between the green and red?

MR. CHEOK: A lot of them would fall in the green, correct.

MEMBER MILLER: They're sitting on the edge of the green?

MR. CHEOK: That's correct.

CHAIRMAN APOSTOLAKIS: But coming back to your figure here. Wouldn't you say that the shutdown estimate itself is a partial result? I don't think it was a complete job. And Dana Powers keeps coming back to that issue. Right, Dana?

MR. CHEOK: That's correct. It's not complete --

CHAIRMAN APOSTOLAKIS: So, that in itself is a partial result?

MR. CHEOK: That's right.

CHAIRMAN APOSTOLAKIS: As opposed to perhaps the internal events of power?

MR. CUNNINGHAM: But you also may recall in the shutdown PRA's for Surry, with the initial screening analysis of the other modes, show that they were a good bit less in risk significance or small contributors to core damage frequency than the mode that's reflected in that $3x10^{-5}$.

That was mid-loop operation. In the case of Surry, that stuck out like a sore thumb. In the case of Grand Gulf, it was a little bit different.

So, it may not be too much of a problem here, but it could be in -- the incompleteness is not much of a problem here. It could be in other circumstances, other plants.

MEMBER POWERS: And it's very, very important to recognize that it is simply a frequency screening that was done, that we really don't understand risk because we don't understand consequences under shutdown --

MR. CUNNINGHAM: They're talking about a core damage frequency there. The mid-loop operation PRA that was performed for Surry included a calculation of consequences. The screenings did a rough calculation of consequences.

MEMBER POWERS: I will agree they included a calculation of consequences. I will not agree that we understand consequences.

MR. CUNNINGHAM: There are a lot of factors that are murky shall we say. But there was a risk calculation done for this mode.

MR. HOLAHAN: But meanwhile, while we're

focusing on the one that has the number, you should notice that the others have no numbers. So, we're still going to be faced with how do you make regulatory decisions in the face of a lot of blank space?

Do you say we shouldn't be making any decisions until we spend the research time on analysis and have licensees doing all these things? Or are we going to find a way to deal with that? That's the policy question.

MEMBER KRESS: And you normally deal with those kind of policy questions by being highly conservative and estimating the shutdown risk in bounding fashion.

MR. HOLAHAN: Was that a question or a statement?

MEMBER KRESS: The way you normally deal with that kind of policy statement is to estimate the shutdown risk in a bounding fashion to be highly conservative. Right?

MR. HOLAHAN: No, I'm not sure that's the best way to deal with it.

MEMBER KRESS: Is there another way? I mean, I can't think of another way.

MR. CUNNINGHAM: Again, at last month's meeting, we talked about two options here. One is what you were talking about basically is can you just build in something that has some margin built into it for conservatism, if you will?

Another is try to be more realistic. And one of the downsides of being more realistic is just what you say. How do you do it given the real, especially in the area of shutdown, a very great lack of information on very many plants on this mode.

MEMBER KRESS: It would be real nice to have that information for the other plant types. That might be what we're learning from this pilot study.

MR. CHEOK: More scope issues. Basically, this is insights from the pilots again. The first bullet addresses how useful is a Level II PRA. Comanche Peak added 32 valves, this is the IST program, added 32 valves to the high safety significant list.

Based on Level II considerations, Palo Verde added 24 valves. Grand Gulf in the GQA application added two new systems to the safety significant system just based on Level II considerations.

It should be noted that some of these do not have Level II PRA's. They just have the Level I/Level II interface trees which they use the insights of to come up with these conclusions.

The second bullet deals with use of fire PRA's. Using a fire PRA, Comanche Peak identified an additional 20 valves that became important. Palo Verde using an expert panel didn't identify any valves to be put in the more important list.

I guess I'll talk about what this means later on in the conclusion section.

MEMBER POWERS: Are you going to discuss in the conclusions the reliability of expert panels for making these determinations?

MR. CHEOK: I guess I will, but basically, if the expert panel has got the correct information, they can make very good decisions.

On the other hand, in certain cases, I think in this fire PRA case it looks like we might need the PRA itself as opposed to just an expert panel. But that's based on a very limited study of the pilots right now.

MR. BUTCHER: It might be useful to say a little bit more about that. We've kind of focused on those cases where in these pilots we've tried to do some independent analysis. The staff has tried to do some independent analysis.

In some cases, we have IRRAS models that the utility was not using. They were using their own model. And some things might not be modelled in their PRA. Or for one reason or another they might come to a conclusion that it didn't show up from the risk insights, that it ought to be in the high safety significant category.

The staff would do an independent analysis using a different model, come to the conclusion that it should be in the high risk category.

But the staff was very gratified to find that the licensee's expert panel put it in the high risk category just based upon the kinds of considerations that didn't come out of the risk analysis itself. It just came out of good sound engineering judgment.

So, I think for the most part, we've seen that the expert panels can offset and compensate for some of the limitations of the PRA in scope. And so far, we haven't seen any egregious examples where it didn't compensate for it.

I've seen some very egregious examples of where the PRA, the risk insights, were not very precise and, in fact, weren't done very well. But the expert panels in every case compensated for it.

I don't know. Mike, did we see cases where they did not compensate for it other than this one that I guess the jury's still out on the fire analysis?

MR. CHEOK: I guess in all the pilots, the expert panel tended to be in the conservative side. And so they tended to add more components than needed to be. So, we did not. We have not seen any cases where the expert panel has not picked up on any systems or components that we thought should have been in there.

MEMBER POWERS: That is really an extraordinarily powerful conclusion to come to. And not understriking. It would not surprise you that panels would tend to be more conservative than the numbers would allow because I think they integrate more on their mind than what we can calculate.

MR. BUTCHER: And we sense that that would be very important. The confidence we had in these expert panels just because of the number of blank spots you saw in the previous slide that we've spent a lot of time focusing on the details of models and what the acceptance guidelines would be.

But as a practical matter, the models that exist today don't have the level of precision that would allow us to apply that kind of acceptance criteria from a risk standpoint. So, if you're going to make regulatory decisions, you have to be able to turn to some other part of the process.

And expert panels is very, very key. And every chance we get, we try to do an independent analysis, our own risk analysis, to see if our risk insights are different from the licensee's analyst because there's a great deal of variability.

And then we try to see rather the process the licensee used was able to compensate for the limitations of the risk analysis. And so far, the results have been I would say heartening.

MEMBER POWERS: That sounds to me like extraordinarily good work that you're doing here. I wish it were displayed like in a viewgraph where you could see the length and the breadth of that checking and independent verification that you're doing.

Because I think you get some insights on a critical role that's coming up where a lot of people are putting reliance on expert panel judgments and things like that and questionable models. And I think you're getting the proof of the pudding here.

MR. HOLAHAN: In that area, one of the things we'll have to decide ultimately is -- I mean, if expert panels are going to play an important role what's the regulatory guidance and what's the staff's role?

With these pilot applications, we can afford to actually have our staff out there watching the panel function and looking in detail into what they're doing. But whether that is something that's practical as a long-term regulatory approach, we'll have to look at that pretty carefully.

MEMBER POWERS: You always run into a problem that when you have a high visibility task and you assign very highly-qualified and expensive people to an expert panel and there are lots of people looking over their shoulders, those panels go to great lengths.

When you translate that into everyday operation for more mundane decisions and expert panels are made up of people with less experience and lesser qualifications and nobody's really looking over their shoulder, does it work well then too? And that's an extraordinarily difficult problem to handle.

MR. CHEOK: Continuing for shutdown, Palo Verde added 22 components to the high safety significant list. Comanche Peak added 15 components. Grand Gulf using the ORAM code added one safety significant subsystem.

None of the pilots identified any components that became real important as the result of anything other than fire.

Early conclusions from the pilots, from the results we see, we think that a good Level I, Level II interface program from the PRA would be sufficient to provide insights on containment systems as to their importance in risk.

Full-fledged Level II analysis would be nice with containment event trees and all. But again, if you have a good expert panel, you can get away without a full-fledged Level II PRA.

For risk ranking purposes, shutdown PRA's would be useful, but the fact that you do not have a shutdown PRA right now we feel can be compensated for as mentioned earlier by the use of an expert panel.

The critical thing in here is that we need to be sure that the expert panel is aware of all the operating states in shutdown and also be aware of all the success paths needed in each shutdown state.

CHAIRMAN APOSTOLAKIS: Again, you say preliminary conclusion. These are general conclusions? I mean, in general Level I/II interface, these are available --

MR. CHEOK: These are conclusions from what we see from the pilot results. In other words --

CHAIRMAN APOSTOLAKIS: Which pilots? All the pilots?

MR. CHEOK: All the pilots, correct. When we see that a pilot uses a Level II PRA versus one that uses just a Level I PRA with the Level I/II interface trees, we see that they come up with similar conclusions.

When we see that a pilot that uses insights from a shutdown PRA versus one that uses a very structured expert panel process, I think we see that they come up with similar conclusions.

CHAIRMAN APOSTOLAKIS: I guess I have to understand better the circumstances where this happens. What is a Level I/II interface tree?

MR. CHEOK: Basically, a lot of Level I trees stop right where you come to core damage, the Level I/II interface trees include containment systems like the containment sprays or the fan cooler units.

These systems do not affect core damage, but they will actually affect your plant damage states later on. But they include them in the end of the Level I event trees. And basically, a lot of plants use these Level I/II interface trees to partition the end states into different plant damage states.

CHAIRMAN APOSTOLAKIS: So, all the pilots are showing right now that if you have these interface trees, you don't need the Level II PRA?

MR. CHEOK: All the pilots right now basically are dealing with risk categorization where they are trying to determine if components are safety significant or non-safety significant.

And since the containment systems themselves are treated in the Level I/II interface trees, that gives you sufficient insights right now as to whether those components are important or not.

MEMBER FONTANA: Do these plants have Level II PRA's?

MR. CHEOK: Some do and some don't.

CHAIRMAN APOSTOLAKIS: But for other applications, this conclusion may not be valid. Correct?

MR. CHEOK: I believe that for applications that you might depend a lot on let's say the timing of a release then perhaps you would need a more detailed Level II analysis where you have the containment event trees to show you what constitutes the timing of the releases treated more in detail.

CHAIRMAN APOSTOLAKIS: How does this now help us with understanding the issue? I mean, all this is under the first issue, right?

MR. CHEOK: All this is under the issue the scope of the PRA, what scope of PRA's do we need for plants to do risk-informed regulation. In other words, if I just have internal events full power PRA, does that mean I cannot do any risk-informed applications?

Or does it mean that I have to come in with a full-scope Level III PRA if it considers shutdown, fires, and all external events before I can even begin to get into this risk-informed regulation arena?

I guess what these pilots are showing us is that in a lot of cases, we do not need a full-blown Level

III PRA to support the conclusions that they're trying to come up with.

MEMBER FONTANA: Tell me again what the conclusions that they're trying to come up with are?

MR. CHEOK: The conclusions that we are trying to come up with are basically do we need a full-fledged, full power and shutdown PRA? Considering all -- do we need a full-blown Level III PRA before plants can come in with applications?

MEMBER KRESS: Where your acceptance criteria is on core damage frequency, and you want to restrict it to essentially staying in that green area. But NRC may have a different green area.

CHAIRMAN APOSTOLAKIS: Is that your implicit assumption here, that the core damage frequency is really the driver?

MR. CHEOK: That's correct.

MR. BUTCHER: Well, I think it would be useful to expand it. It's one of the drivers. And the other considerations that make it a full-scope analysis as opposed to a full-scope PRA, there are other options to make it a full-scope analysis other than full-scope PRA.

And what you want in risk-informed decision-making is a full-scope analysis. Now, it may be that part of the analysis is performed by an expert panel. Part of it is performed through some simplified approach like the containment interface trees.

So, we don't want to leave any misunderstanding here. It needs to be a full-scope analysis, but not necessarily a full-scope PRA.

CHAIRMAN APOSTOLAKIS: And the other thing that is not clear to me --

MEMBER MILLER: Excuse me, George. Just one question on that.

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER MILLER: Full-scope analysis means full scope of the system in question? Is that what you mean by full-scope analysis?

MR. BUTCHER: Well, it's a full-scope analysis with regard to the application. In this instance, it's IST. And there's IST that relates both to containment systems, and there's IST that relates to emergency core cooling systems.

So, it relates to the specific application. In this case, the application for IST is the way the PRA is using the processes two ways. It's first used to identify which components are most risk-significant.

That includes both containment, Level II considerations, Level I considerations. And then finally, once you've decided what changes you're going to make in your IST program, you've got to make some overall assessment as to what the impact, the cumulative impact of all these changes are.

Because really we're not doing one valve. We're doing them all. So, there's two aspects of the analysis. And I guess we haven't spoken yet to the cumulative part of it.

MR. CUNNINGHAM: But that comes back to what we were talking about before. If part of the cumulative assessment is assessment of the impact or in core damage frequency of all of these IST changes, for example, the question then becomes if they come in with or less than --

CHAIRMAN APOSTOLAKIS: But this does not address that, does it? All you're saying is that you can make reasonable decisions using an expert panel that we'll use in the Level 1 and two Interface 3s.

I'm trying to make the connection between the issue. How is acceptable risk defined for plants with partial scope PRAs and with your conclusions?

MR. CHEOK: Okay, let me --

CHAIRMAN APOSTOLAKIS: Again, are your conclusions based only on the IST pilot or all the pilots?

MR. CHEOK: They are based on all the pilots.

CHAIRMAN APOSTOLAKIS: All the pilots. Is it conceivable that there may be other situations, level PRAs would be necessary?

MR. CHEOK: I guess I'm trying to think for the IST, the graded QA and the ISI pilots, I believe that the conclusion on the Level 2 PRA would be valid for typical specifications if the systems were to involve containment systems. Actually I'm not quite sure, but it might have to in a more detailed Level 2 PRA.

CHAIRMAN APOSTOLAKIS: The second bullet seems a little clearer because at least it starts out by saying, for component categorization -- But the first one is so general, so are there any assumptions behind it for conditiors that are not stated there? You just mentioned -- You said that for ISE this is a valid conclusion.

Is that what you said?

MR. CHEOK: Yes, that's what I said.

CHAIRMAN APOSTOLAKIS: But there may be other situations where it may not be.

MR. HOLAHAN: If you remember the way the guidance documents are going to be structured as one general document, but we've decided that there should be guidarce documents on each of these pilot type applications. So that says inherently the one document isn't going to cover all possible applications.

What it means to me is, when a 5th application category, and a 6th and a 99th, we'll have to ask ourselves whether the issues raised here are sufficiently similar to one of the ones that have already been done that those guidelines apply, or whether you need to write another guidance document. If we want to deal with emergency planning, I'm not sure that any of the things we've learned from the pilots has much to do with that. So you might have to develop another guidance document and ask yourself a whole lot of questions that would apply in that circumstance that don't apply here.

CHAIRMAN APOSTOLAKIS: But again, the issue was, how is acceptable risk defined for plants with partial scope PRAs, which have led to this partitioning issue, right?

MR. CUNNINGHAM: Yes. That's one of the subissues, if you will, or related issues.

CHAIRMAN APOSTOLAKIS: Now, is it obvious to everyone else that these things address that?

For component categorization you're saying that I don't need shut down because I can do it based on the partial results they have.

How is acceptable risk defined? That doesn't deal with acceptable risk, just the component. And for the first one it's even more obscure to me.

MR. HOLAHAN: What it deals with is the

decision-making process for each application.

MR. DINSMORE: This is Stephen Dinsmore from NRR. I'm doing the ISI and the greater QA ones, and I'll just give it a shot here.

ISI is going to submit a submittal and we have to approve the changes with their proposal, so somehow or another we have to include the full scope of the PRA and the decision to give them permission to do these changes. So what ISI does is they use their internal event PRA, then they specifically expert panel to include seismic considerations, power considerations and those kind of things. So I guess what we're talking about here is that's enough work to have to do a full scope PRA analysis before we can say, okay you've given us enough that we can write an SE and you can make your changes.

CHAIRMAN APOSTOLAKIS: I understand what he just said. The problem is with the conclusion.

Now in your case, do you think you will need a full scope PRA to do that?

MR. DINSMORE: I don't think we'd improve the situation because it would just make it a different problem. The problem we have now is to trust that expert panel or not, whereas if we had a seismic full scope PRA we have to figure out what that is. That's a different problem.

CHAIRMAN APOSTOLAKIS: But as I remember the Combustion Engineering owners group did this analysis for the allowed outage times, they found that the risk of power went up but the shut-down risk went down. And in that result loss qualitative considerations was beneficial.

Why would you do that if you didn't have shut-down numbers?

You have to identify yourself again.

MR. SCHNEIDER: Ray Schneider, ABB-CE.

What we did for like the LPSI case, among the things we did is sensitivity studies where we showed that just even minor changes to the LPSI liability, like in the order of 1 percent, more than offset the impact -- If you would use a LPSI for immediately entering shut-down would more than offset the impact of doing a weeks worth of maintenance at power.

For the LPSI case itself -- Because the LPSI is part of our shut-down cooling system -- what you would be doing, if you did the maintenance on the LPSI in shut-down you'd be substantially increasing any risk available. So even though we don't have full shut-down PRAs you can make a logical conclusion based on the importance of the component in the shut-down mode.

CHAIRMAN APOSTOLAKIS: But you did have some estimate of the risk.

MR. SCHNEIDER: Well we had transition estimates and we had --

CHAIRMAN APOSTOLAKIS: At shut-down too.

MR. SCHNEIDER: We had shut-down estimates also. But the key -- I think it was based on incremental impacts of like looking at a mid-loop situation when you just look at what happens if I have one pump unavailable and you did a very simplified model as to what the impact is of two shut-down cooling pumps versus one shut-down cooling pump. So you can do a very simplified overview as to what the importance of that particular pump is without having a full baseline because you're only looking for the increment.

So as long as its focused on the application and it is not a lot of interactions for that particular component -- like for the shut-down cooling pump it's clear. It's required for mode of operation for shut-down; that you can basically do the simplified analysis to make a judgment.

CHAIRMAN APOSTOLAKIS: And that's what the second bullet is saying?

MR. SCHNEIDER: I'm not sure what the second bullet is saying.

CHAIRMAN APOSTOLAKIS: And do a reasonable qualitative assessment. I thought we went beyond that.

There's a difference a complete analysis and a relatively crude analysis, and no analysis at all. And you guys did whatever you needed to do.

MR. SCHNEIDER: We do what we felt was important to make a point.

CHAIRMAN APOSTOLAKIS: It was not just qualitative.

MR. SCHNEIDER: Right.

MS. RAMEY-SMITH: Ann Ramey-Smith, Office of Research. I just want to make a couple comments.

I think that what Mike Cheok was talking about and what Steve Dinsmore elaborated on has to do with the kind of analysis that is being conducted. And that you can address containment performance issues without doing a "Level 2 PRA". You can do a qualitative assessment to get information, insights into that. That's a slightly different issue though with whether or not to include information or the contribution of containment performance when you're evaluating the current level of risk associated with a particular plant, or whether you should include insights and information from such an analysis in your acceptance guidelines.

Level 2, let's say with low power and shut-down. Remember one of the issues that we talked about last time we had a meeting was the issue of the safety goals and were the safety goals intended as measures of total plant risk versus some subset of total plant risk. We assumed, based on the guidance that's provided in the safety goal policy statement itself that we're talking total plant risk, and so we're with the expectation that our acceptance guidelines will derive from those safety goals. We're trying to figure out a way of how do you assess a plant's specific application using those guidelines or some deviation of those guidelines to look at the total plant risk. And that's where we get into the issue of partitioning and how can you an existing PRA and somehow add to it some estimate of what you don't have so that you can make a comparison with this acceptance guideline that's based on total plant risk.

CHAIRMAN APOSTOLAKIS: But that again is different from what I see on the screen. I mean I understand what you said and I think that's right.

MR. HOLAHAN: I think to me the first and second bullet on the slide say the same thing, which is that you can't ignore areas or things that were not in the PRA scope. You can't ignore fire seismic and other things. But that there are approaches for dealing with them which can help you make appropriate decisions even lacking a full scope analysis. I think both of those bullets say that in different ways.

CHAIRMAN APOSTOLAKIS: In some instances, not always.

MR. HOLAHAN: Well, what we're here to talk about is we've been talking about these things in a philosophical sense, and what we're saying is, we're also getting some experience from the pilots. The preliminary conclusions are conclusions from the pilots for the pilots that say, in thinking about these things you have basically three choices. You can ignore things that haven't been analyzed. You can partition which basically says I'm going to allocate some risk even though I don't know it applies in this case or not, or -- I guess maybe there are four possibilities.

The third possibility is you can do something that is a substitute for a full analysis. And I think that's what this says, is you can make pretty good decisions with a substitute. And the fourth issue can say, I'm not going to make any decisions until I've got a perfect analysis.

CHAIRMAN APOSTOLAKIS: I guess part of my problem is that I think the description of the issue is much broader than what we're discussing. I have no problem with what you just said, but when I look at the issue, how is acceptable risk defined for plants with partial scope PRA, I think that's a much higher level issue.

MR. HOLAHAN: I guess the other thing I should say about the definition of the issues is, we spent some time over the last three or four weeks since our last meeting trying to standardize what the issues are, because in effect what we had was, each team working on each pilot was identifying a number of issues. Those issues were not always expressed in exactly same words or same context. The issues that we referred to the Commission as policy issues were not exactly literally the same issues that were being dealt on the pilot applications. So we spent some time trying to standardize the questions -- what exactly are the questions. And I guess I'd say since Mr. Thadani signed it out we have an official Rev 0 list of the key issues, and we're going to try to keep up that formal list. But what you have here is, these are the slides that we presented to the committee last month so the terminology as to what the issues are I think is a little bit influx.

CHAIRMAN APOSTOLAKIS: Let me tell you what I understand from the way the issue's stated, and maybe that will be an insight as how a third party can look at it.

How is acceptable risk defined for plants with partial scope PRAs?

Here comes a plant and does internal events and fires, and only at power. And they come up with 6×10^{-5}. And I have to decide now whether this plant meets the goals or not. That's how I read this. They have a partial scope PRA and I have to make a decision whether the risk is acceptable or not. And I think you're addressing a different issue with the plant, which is not necessarily a bad issue, but it's a different issue, is it not?

MEMBER MILLER: It seems that the issue they're addressing is, if you have a partial scope PRA can you do effective things like IST and ISI.

CHAIRMAN APOSTOLAKIS: Which is a different issue.

MEMBER MILLER: Different issue. The CE group said the same thing.

DR. SEALE: Because it's a matter of fact if you look at the next slide it will tell you about a quality judgment that is made with regard to what would constitute the basis from making a risk base decision.

CHAIRMAN APOSTOLAKIS: Which one?

DR. SEALE: The next slide.

CHAIRMAN APOSTOLAKIS: Yes, but that's different. It says for risk ranking.

What is acceptable? I'm not proposing any change. I receive a PRA, and it's not full scope; it doesn't include all the molds. I have some numbers. The way I look at the issue is, can I make a decision regarding a compliance with the Commission's goal.

Isn't what this is? How is acceptable risk defined for plants with partial scope PRAs.

DR. SEALE: Let me give an example on that. I guess in IST for instance, let's say the licensee is trying to determine if a valve -- whether they can relax the test intervals on the valve.

CHAIRMAN APOSTOLAKIS: That's a different issue. You're raising now a new issue. You are saying they're about to make a change and I want to evaluate that change. And I'm saying that's not my issue.

The way I read it is, you did your PRA. It's not complete, and I have safety goals that are suppose to apply to everything, except sabotage.

How do I make a decision?

DR. SEALE: But let me continue with this example. If he has the full scope PRA he can determine the effect of the risk on that valve. If he doesn't have a shut-down PRA he can do a qualitative analysis using let's say the success paths and determine that now this valve is not in the success path of any of my operating states, which now means that it will not affect my shutdown risks. I can now conclude that for this valve my shut-down risks is zero. On the other hand, if he had determined that it wasn't a success path in the shut-down space he would basically not relax this valve and so the changed risk in this case would be zero.

So using this we can basically determine that the number he had come up with might change in risk has not been affected by shut-down considerations.

CHAIRMAN APOSTOLAKIS: Well that's not what I said.

DR. SEALE: That's not what you said.

CHAIRMAN APOSTOLAKIS: Right.

Coming back to Slide 3. How is acceptable risk defined for plants with partial scope PRAs. I'm not talking about IST. I'm not talking about any changes. I'm not talking about what combustion has done, or the PSA applications guide. All of these are considering changes. Forget about changes.

What is the base, the risk that the plant imposes? Without any changes, the way it is.

The way I read this is, if the PRA's partial scope can I say anything about the plant's compliance with the safety goals.

Am I the only one who's reading it this way? Maybe I'm wrong.

DR. SEALE: We're talking about the pilot applications and all of the pilot applications involved the assessment of the effective change for good or bad.

CHAIRMAN APOSTOLAKIS: Well then first --

DR. SEALE: So that's a question we're talking about here. The question you're raising is a more fundamental one. It is the fundamental question of can you ever really make a complete risk assessment relative to the safety goal if you don't have a full scope PRA.

MEMBER FONTANA: Are you saying that the pilot applications are not properly chosen to answer that question? Is that what you're saying?

CHAIRMAN APOSTOLAKIS: No, I'm not saying that.

MEMBER KRESS: I think George is getting to the fact that even when you look at the acceptability of the change you have to have some absolute number to compare it to and that's your acceptance criteria. And that gets right back to George's question, how do you decide what the acceptance criteria are, even for a change.

MR. CUNNINGHAM: If I might, since I'm the one that put the slide up last time.

What we were talking about last month and the question as Mike has it on his slide, was in the context of that we are facing a situation where changes to the licensing basis are being requested, and in that environment then you ask the question what's our acceptable level of risk, and then very much related to that is, if the plant does not meet that goal or that guideline do we treat it differently than we treat a plant that is better than that goal. That was the context of this specific question.

MEMBER MILLER: So if we take this question totally out of context it's the wrong question?

MR. CUNNINGHAM: It's not a wrong question.

MEMBER MILLER: It's the wrong question for the issue we're dealing with here though.

MR. CUNNINGHAM: It's a very fundamental question that relates to how you interpret the safety goals and the fact that we have a distribution of plant results around safety goals, and are we willing to live with that as it is, and/or should things be done. That's the question you're getting I think.

CHAIRMAN APOSTOLAKIS: So when you say as it is then this is the question I'm raising here. I mean, no changes. And we are proposing -- You guys are about to re ommend to the Commission that the safety goals should be restated, be applied to -- Right?

MR. CUNNINGHAM: No. The question we're

trying to answer is, in the context of dealing with plant specific applications for license changes, we're trying to interpret the goals to define some sort of an acceptance guideline that says, if a plant's at this level then it's good enough. It's a narrower question than the ones you're getting at.

CHAIRMAN APOSTOLAKIS: But then we should make that very clear; that the pilots are addressing narrower questions.

MR. CUNNINGHAM: None of this is related to the more basic question that Dr. Seale, basically as he said it.

CHAIRMAN APOSTOLAKIS: So this is not intended to be a general issue, it's intended to be only in this context.

MR. CUNNINGHAM: In the context of --

DR. SEALE: Exactly.

CHAIRMAN APOSTOLAKIS: And when is the general issue going to be addressed?

DR. SEALE: Well at last meeting we talked about it some, and we said we'd talk about the pilot applications today.

CHAIRMAN APOSTOLAKIS: Wasn't the question, how do the pilots help us address the general issue. That was really the question.

DR. SEALE: Well, but there was also the question of responding to these specific requests for changes that were directed toward --

CHAIRMAN APOSTOLAKIS: Sure. As long as we define the boundary conditions then we are --

MEMBER FONTANA: It sounded like the presumption here is that these plants have been licensed and de facto meet --

CHAIRMAN APOSTOLAKIS: Exactly. And now you want to change something and you're addressing the question. But that's not really the issue here.

MR. HOLAHAN: Remember we already have a backfit rule and we have guidance on what constitutes a substantial and cost beneficial improvements. That's what the regulatory analysis guidelines are. Those were developed to be generic and not necessarily plant specific, although I think the guidance, the thought that went into them applies equally to individual plants as it does to rules or issuing bulletins. But I think the action we're talking about here, developing this regulatory guidance and maybe changing the safety goal to make it clearer how to apply PRA on a plant-specific basis naturally reraises this issue. It's not that we're incapable of dealing with it now, but it's subject to clarification.

CHAIRMAN APOSTOLAKIS: I thought it was a much more general issue.

Would you go to Slide 4, please, so that we'll finish on time.

Okay. If I look at Surry, and the goal is 10^{-4} and I have internal 10^{-4}; fire contributes a little bit shut-down, so the total is 1.35×10^{-4}. Seismic is missing. Today we are not addressing the question of what should I do with this. They're not proposing any changes, they're just coming here with these numbers.

MR. CUNNINGHAM: Correct. This afternoon we'll talk about the issue --

CHAIRMAN APOSTOLAKIS: This afternoon we'll talk about it.

MR. CUNNINGHAM: No, no. We'll talk about the issue as if Surry is 1.35E-4 and your goal is 1E-4, should I treat that plant, Surry, differently because it's 1.35 than if it were 6×10^{-5} or 1×10^{-3}, if they're coming in to request a change to their license.

CHAIRMAN APOSTOLAKIS: But if they don't do that --

MR. CUNNINGHAM: If they don't do that --

CHAIRMAN APOSTOLAKIS: -- nothing?

MR. HOLAHAN: Well, no. Let's talk about two different things.

CHAIRMAN APOSTOLAKIS: There's a third one. It's incomplete. Seismic is not there.

MR. HOLAHAN: We're developing guidance to help us make better regulatory decisions on applications, but some of the fundamental questions that we have posed to the Commission and that we all are talking about apply equally to whether there are changes or whether you're looking at the plant as it exists.

CHAIRMAN APOSTOLAKIS: right.

MR. HOLAHAN: So this question for example about, should the Commission's safety goal have application on a plant-specific basis, once you answer that question you can't ignore it. It applies to more than just changes. And so I think after that question is answered it will influence what a staff does with the knowledge that some plant may be above 10^{-4}. Not that we would ignore it now. We have regulatory analysis guidelines and we've done backfits. We would continue to do those. But I think the answer to that question will influence how you do that in the future as well as how you deal with applications.

CHAIRMAN APOSTOLAKIS: Okay. I don't know. Maybe everybody understood that. But maybe it would help by rephrasing these and say, for requested changes or for changes, how is acceptable risk --

MR. HOLAHAN: In fact we have rewritten all of these questions and all of the key issues.

CHAIRMAN APOSTOLAKIS: Awaiting Thadani's signature.

MR. HOLAHAN: Well he signed them once. And we would be glad to give the committee a copy of the list. We recognize that there will probably be Revision 1, 2 and 3. As we learn more we'll refine the questions.

CHAIRMAN APOSTOLAKIS: I don't know how everybody else feels, but I'm really ready for lunch. A break.

MR. HOLAHAN: For the purposes of scheduling the meeting, but what Mike is presenting I don't think it's crucial that he covers every single issue. What we really want the committee to understand is that we are attempting to face up to these tough questions in the pilot application and we're using it as a learning tool.

CHAIRMAN APOSTOLAKIS: And I think the most important message from the discussion of the last 20 minutes is, that the question should be stated very clearly and precisely, because people may interpret them differently.

(Whereupon, the foregoing matter went off the record at 12:32 p.m.)

A-F-T-E-R-N-O-O-N P-R-O-C-E-E-D-I-N-G-S

(1:35 p.m.)

CHAIRMAN APOSTOLAKIS: Let's see. We have until 2:45. Do you think you can cover everything you want to say?

MR. CHEOK: I'll try. I think Ed wants to start off with a couple of questions before I restart.

MR. BUTCHER: Let me see if I can give a little context to the rest of the stuff that Mike is going to present here. He's going to try to get down to some nuts and bolts on what we're learning directly from the pilots, but it might be useful to think of this conversation in the context of there's a lot of things going on in risk-informed regulation and that's basically what the staff's focus has been, is how can we move forward in risk-informed regulation?

Risk-informed regulation, as it says in the policy statement, is applying risk insights to all regulatory matters. That's inspection, enforcement, and licensing actions like revisions to the IST program. And what we're beginning to see is that the level of sophistication in your risk analysis is dependent upon the specific application.

Now there are going to be some applications where it's very important for us to have maybe even as far as a Level 3 PRA with full uncertainty analysis, but what we're learning is there are some relatively easy applications of risk insights that can be done through a combination of the kinds of things we talked about this morning. It turns out that those are the ones that the licensees are most interested in early on, because there's a financial payback for them and those are the ones that are on our plate. We have licensing amendment applications and we have no choice but to process them and to the extent that they rely upon risk insights, we have to consider those. That's what the law requires.

So that's largely -- we're trying to use the pilot applications that are on our plate now to gain insights into the more complex and the more difficult applications of risk insights that are also a part of the PRA implementation plan so you have to listen to Mike's remarks in the context of what he's learning about a very, very small subset of risk-informed regulations.

CHAIRMAN APOSTOLAKIS: Yes, and I have no problem with that as long as it's also stated very clearly here, yeah, I think that was the problem.

MR. BUTCHER: We'll do better in the future.

CHAIRMAN APOSTOLAKIS: By the way, do you have any written documents on the pilots that maybe we can look at and get a good idea as to what you are doing?

MR. CHEOK: I'm not sure what you mean by "written documents." We have the submittals and no, we do not have any safety evaluations out yet on the pilots.

CHAIRMAN APOSTOLAKIS: The submittals are available to us?

MR. BUTCHER: They're public information. If you can identify any particular one you're interested in, if you're interested in IST, we can do that.

CHAIRMAN APOSTOLAKIS: Yes, let's look at that. How many pilot projects are there? Five? Six?

MR. CHEOK: There are four general categories of pilots: IST, ISI, QA and the tech specs, so we have several plans in each for those pilot projects.

MR. BUTCHER: There's a gradation in the sophistication of analysis too. The risk -- what we call risk ranking categorization is probably a better way to say it where you're attempting to determine which system's components and structures are most significant risk standpoint and then grade your regulatory activities accordingly.

Those are relatively, let's say robust uses of insights and they require less sophistication. Now in the case of the AOTs where you're changing surveillance intervals and allowed outage times for equipment, they require a more detailed analysis. So maybe if you wanted to get a sampling, take the ISI, I mean the IST, and the tech spec work that the CE talked about, review those and you have two different categories of applications.

CHAIRMAN APOSTOLAKIS: Okay, good. Thanks. So you have about 40 minutes.

MR. CHEOK: I'll go through these as quickly as I can.

CHAIRMAN APOSTOLAKIS: Can you skip any?

MR. CHEOK: Yes, I can. I can skip several of these.

The last thing I was going to say about scope was that for the external event PRAs received from the power study, the initiator actually contributes more than 10 percent of the core damage frequency. It would be a lot better, it would almost be essential that we do have the PRA as opposed to rely on the expert panel and there are four reasons that I listed there as to why we think the PRA would do a much better job.

It's just that the external initiators, we do get, come up with a different mix of plant initiators which would basically now give you, would skew your relative importance of the components compared to the internal initiators.

The second point there is that the plant configurations could be altered by the initiator. You would lose mitigating systems in addition to the initiator. The third point is that the external event initiators would have spatially dependent common cause failures. The fourth point there is the components lost during these initiators are non-recoverable.

So what I'm trying to say is the insights we get from the internal events, PRAs are not going to be directly applicable for the external events and will probably need to do an external events PRA to get the correct insights.

CHAIRMAN APOSTOLAKIS: Do the larger uncertainties in the external event PRAs play any role here or it doesn't matter for risk-ranking?

MR. CHEOK: For risk-ranking, we do not believe that it matters and I think we have a slide later on that discusses uncertainties and risk-ranking.

Quality of PRA, again I'm going to go real quickly on this. What's the required quality for PRAs? In our opinion, when we reviewed these submittals, we think that the quality of these PRAs used in the submittals is a little better than better than average PRA quality. I guess simply because the people with the better PRAs tend to come up with -- their confident in their PRAs that they come up with to use in their applications.

CHAIRMAN APOSTOLAKIS: Question on this, actually a better comparison would be to compare the quality of these pilots with the IPE or PRA, but the same plans submitted, not the general PRA of the whole population.

MR. CHEOK: Some of the pilots actually use the IPE PRAs. Some use an improved version of the IPE PRAs. A review of the SEs, the safety evaluations of the IPEs basically from the pilot plan submittals will give us good insight as to what I guess we thought was adequate or not adequate in the original PRA and we also do, as I mentioned in the next slide a focussed-scope review of the PRAs relative to the application, whether the PRA itself can support the application in question.

We focus our review on the components and the events that are duly affected and also on what we call the compensating events, events that might effect the relevant SSCs.

You had brought up only today an example of, I guess, the Zion. We had a 3 minus 4. That would be a case where we actually could look at what's causing the 3 minus 4 and it's that one sequence or sequences that's causing the 3 minus 4 is going to be affected by this application.

CHAIRMAN APOSTOLAKIS: Did anybody do

uncertainty analysis, by the way, in those submittals?

MR. CHEOK: Some of them did, but none of them came in with a full scope uncertainty propagation through the whole model.

Most of them addressed uncertainty by use of sensitivity analysis, basically on what, on events like common causes, human errors and recovery factors, to show that parameters like that do not, will not affect their conclusions which they submit.

CHAIRMAN APOSTOLAKIS: Now let's talk about the quality again. The issue is what is the required PRA quality for an application?

And what is the process to review this quality?

MEMBER CATTON: How do you define it?

CHAIRMAN APOSTOLAKIS: Did you get any insights into that? I mean your bullets seem to address more or less general things like they did sensitivity studies and they had expert panels.

MR. CHEOK: One of the bullets, the first bullet, I didn't specifically mention --

CHAIRMAN APOSTOLAKIS: It varied. It says that the quality varied.

MR. CHEOK: They actually came up with some kind of a peer review document. It gives us a better feeling that someone else, a third party or somebody else, actually looked at this PRA and we do not have to worry about looking too much beyond the fact as to how, what events in this PRA will affect our application.

When we do not come in with a peer review, we will have to look at the PRA more in general.

MEMBER CATTON: But how do you know it's a good PRA now? It could be the guy down at the corner drug store.

MR. CHEOK: We actually -- we haven't done this yet, but our intent is to review the peer review report to look at the scope of the review, what was reviewed and what the findings will be.

CHAIRMAN APOSTOLAKIS: Maybe I am reading more into this, but what is the required PRA quality for an application? I thought we're going to see some guidance as to what it would, what would be acceptable to do and the insights that you're showing, the preliminary conclusions don't seem to address that.

MR. CHEOK: We actually have a draft preliminary guideline as to what we want to look for in a PRA which I'm not sure how that's going to make it into the SRP or reg guides at this point, but I guess eventually we'll have to have a set of guides as to what constitutes a good PRA. Right now, as it turns out, we are relying on the fact that maybe if it's got an excellent peer review we will look at what was reviewed by the peer review panel.

MEMBER SEALE: Well, of course you are working on the standard review plan PRA. I would assume that would be that these individual submittals at least ultimately would have to meet the requirements of that standard review plan. Is that --

MR. CUNNINGHAM: That's correct. The regulatory guide has an appendix which is a discussion of what's the necessary quality of PRA. What Mike is talking about is -- what he's been doing has been done in parallel with the writing of that reg. guide so you've got to interact now and --

CHAIRMAN APOSTOLAKIS: Right now these conclusions would not help you very much.

MR. BUTCHER: Those are some of the issues, not the answers.

CHAIRMAN APOSTOLAKIS: A good example, I think, is the CE owners group presented earlier. They used the beta factor model. If you talk to the people who work in that area they would tell you that this is sort of an old model and now we have better models.

At the same time, I don't think it would make any difference in their conclusions whether they are using beta or alpha.

So what do you do in that case? Strictly speaking, we are not using state-of-the-art. On the other hand --

MR. CHEOK: That's correct. You can make conclusions as to whether the parameter in question, I guess in this case common cause, whether it will make a difference if they use a different model and in this case, I think, the licensees have been addressing it by doing sensitivity studies on let's say common cause and showing that the conclusions they're coming up with is not affected by a whole range of values that they could use for this common cause.

CHAIRMAN APOSTOLAKIS: On the other hand, we don't want to find ourselves in a situation where people are using, not that this happened with CE, but using wrong models because it doesn't matter. We just leave it there.

I don't have the answer myself, but I think that's something that you should be --

MR. CHEOK: That's right. I think the reg guides are coming out with the standard, a list of standards in which the PRAs have to conform to for it to be acceptable.

MEMBER CATTON: When you talk about a list of standards, there are two parts to it. One is completeness and the other is are the elements properly treated. Is there going to be guidance on both of these aspects?

MR. CHEOK: I believe there is going to be guidance for both of these aspects, yes.

MEMBER CATTON: I guess we have to wait and see.

MR. BUTCHER: Mike, if you get to slide number 11, you start to get into some of the nuts and bolts, down to the fine details of things you would see in a PRA that would give you some indication of how, what the quality is and its completeness.

MEMBER CATTON: Depending on who is doing the reviewing when you take a look at one of these things. It can be done at an audit level and then you better have a lot better guidance or it could be done by somebody who is really an expert in the business and it doesn't have to be so good. I suspect that after a while it's going to be done as an audit.

MR. CHEOK: Okay, on slide 11, we're talking about the sub-issue of quality which is truncation limits. I guess the PSE applications guide put out by EPRI and NEI state that a truncation limit of 10 to the minus 4 below the core damage frequency would be sufficient and I think we're finding out in most cases it is, but in some cases it might not be.

Some studies -- this shouldn't be a surprise to most people, some studies that we have done are showing that it removes as many as 82 percent of the cut sets every time we go up one order of magnitude in truncation and at the bottom of the page there I'm showing you some examples where the truncation limit varied from 10 to the minus 8 to 10 to the minus 12 and you can see the differences in the number of sequences and the percent core damage that's captured.

CHAIRMAN APOSTOLAKIS: What does the last bullet mean? When the truncation limit is 10 to the minus 8, oh. I'm looking at 11.

MR. CHEOK: Okay, when the truncation limit is --

CHAIRMAN APOSTOLAKIS: 11.

MR. CHEOK: When the truncation is 10 to the minus 8, the number of sequences that did not get truncated out is 241 and the percent of the CDF, the 67 percent of what would be if we had no truncation.

CHAIRMAN APOSTOLAKIS: Oh.

MEMBER SEALE: It's kind of intriguing, isn't it? If you multiply the truncation limit by the number of sequences, you get 10 to the minus 6. It suggests that maybe if you cut the pie up in enough pieces, the truncation limit can be vanishingly small.

MR. CHEOK: That's right.

CHAIRMAN APOSTOLAKIS: What is the standard limit that you are using now?

MR. CHEOK: The people in the IPEs, the standard limit is 3 orders of magnitude below the core damage frequency, that's the standard practice.

CHAIRMAN APOSTOLAKIS: You are saying that's not right?

MR. CHEOK: For things like risk ranking where you depend on a lot of components, especially risk ranking using the risk achievement worth. You will need a lot more than 10 to the minute 3 truncation.

CHAIRMAN APOSTOLAKIS: But let's say that the plant expects the core damage frequency to be about 10 to the minus 5. According to the RAW that you just mentioned, they would set the truncation limit to 10 to the minus 8?

MR. CHEOK: In the IPEs they would do that, correct.

CHAIRMAN APOSTOLAKIS: So are we to believe from this that the core damage frequency in that particular IPE is only 67 percent of the actual frequency? Is that a conclusion that one can draw from this?

MR. CHEOK: This is the conclusion you can draw from this plant. I'm not sure that's a conclusion you can draw from all plants, but I believe in this case the core damage frequency was high minus fives so I guess the three orders of magnitude below would be 10 minus 9 or 10 minus 10.

CHAIRMAN APOSTOLAKIS: They would go that low?

MR. CHEOK: They would, yeah.

CHAIRMAN APOSTOLAKIS: All right.

MR. CHEOK: Again, referring to risk ranking, this table shows the effects of truncation on risk ranking, when you come up with criteria like Fussel-Vessely bigger than .01, RAW bigger than 2.

As you see, as the truncation value becomes smaller, we do capture a lot more components above a certain criterion.

CHAIRMAN APOSTOLAKIS: But what does that mean?

MR. CHEOK: I guess it means that if we are going to apply decision criterias proposed by the PSE applications guide and as proposed by NEI, we have to be very careful, when we are talking about absolute criteria like something is defined as low, if it's got a RAW bigger than 2, smaller than 2 or some things can be lower and there's a Fussel-Vessely bigger than .01 we have to be very careful about how we pick our truncation values.

CHAIRMAN APOSTOLAKIS: I still don't

understand that. I mean the Fussel-Vessely measure is really a measure of the non-uniformity plant. If you had a plant where all components were the same, a very well balanced plant, then the Fussel-Vessely measure would be the same for all of them, right?

MR. CHEOK: Correct.

CHAIRMAN APOSTOLAKIS: So the fact --

MR. CHEOK: And none of the absolute criterion, then none of them would show up and the absolute criterion of let's say Fussel-Vessely bigger than .01, for instance, but if you do have non-uniform plants then the Fussel-Vessely would obviously show you what contributes more to the core damage frequency and what doesn't.

CHAIRMAN APOSTOLAKIS: So I don't know that I'm better off by doing 117 components versus 61. Don't you think I have already captured the ones that really contribute to the risk? I mean only 61.

MR. CHEOK: Basically, I don't think we should use importance ranking related to a criteria search. We should use it to give us insights as to what components are important and what are not and that will have to factor into the acceptance criteria as to how we pick components for relaxation and not have to depend -- I mean, we will have to depend on the final risk change, for example, but not have to depend too much on just a criteria that's set on to an importance ranking measure.

MR. BUTCHER: Excuse me, if I may, what it shows to me is the importance of not relying too much on bottom line numbers. Let me use the risk achievement worth down there greater than 2. You can see at one truncation level you come up with 54 components that have a risk achievement worth and importance that would put them into the high safety significance category, simply by changing the way you do the PRA analysis you almost double, well, you more than double the number of components to meet that criteria. So when I establish criteria that are based upon PRA numbers, I have to be very careful about how I did that PRA and so again it pointed to me the importance of expert judgment involved. We have seen truncation numbers like 10 to the minus 8. What happens is when we do it ourselves at a higher number, compare what we get and what we want to add to the high safety significance category and it turns out it's the same thing that the expert panels add or so far it's beginning to indicate that the expert panels come to the same conclusion without the benefit of the PRA numbers and insights. In fact, with the wrong insights from the PRA indicating that they're only 54 components that are worth worrying about.

So to me, what this points out is is the hazard of getting too much confidence in the bottom line numbers that come out of the PRA and that further points to the importance of understanding these kinds of phenomena even to the same level or even higher level and we understand things like uncertainty.

I can understand uncertainty very, very well and if I just make this one little modeling manipulation wrong, when I actually do my quantifications, the whole result is bogus.

CHAIRMAN APOSTOLAKIS: The thing is that first of all when you go to let's say to a risk achievement worth from 54 to 230, when you have the 230 of the top 54 the previous 54?

MR. BUTCHER: It's 54 to 139.

MR. CHEOK: That's right.

CHAIRMAN APOSTOLAKIS: To 139, okay.

MR. CHEOK: They're the same 54.

CHAIRMAN APOSTOLAKIS: Still at the top?

MR. CHEOK: That's correct.

CHAIRMAN APOSTOLAKIS: Still at the top.

MR. CHEOK: No, let me take that back. They might not be at the top. They're mostly at the top. That could be some highly reliable components that were truncated about before, that if you included them they actually would leap frog some of the top 54.

CHAIRMAN APOSTOLAKIS: Wouldn't that be a more useful insight though, relative ranking rather than the number?

MR. BUTCHER: Of course, it's relative ranking. We're looking at both, but we just put the -- we could have given you the relative rankings component by component, but it's pretty staggering here when you see it thrown at you this way. It's a doubling effect. If you go to 10 to the minus 12, it becomes a tripling.

CHAIRMAN APOSTOLAKIS: But that's not surprising.

MEMBER POWERS: Could I understand something about the chart?

MR. BUTCHER: No, it's not surprising, no.

MEMBER POWERS: Maybe it's simplicity in my mind, but we have RAW greater than 2 for any one of the categories is less than RAW greater than 10? Just the number --

MR. CHEOK: Good question.

MEMBER POWERS: There are 54 components that have a RAW greater than 2, but there are 264 that have a greater than 10.

MR. CHEOK: I believe in this case when the RAW is bigger than 10 the 54 does not count at 264.

MEMBER POWERS: Okay, so it is between 2 and 9.999 and then the 264 from 10 on to infinity?F

MR. CHEOK: That' correct.

MEMBER SEALE: And 230 are up to 2.

MR. CHEOK: That's correct.

MR. TRUE: I just want to add a couple of things. One about the applications guide and another about the results.

The first is with respect to the applications guide, the applications guide makes two comments on truncation limits. The first is with respect to the baseline PSA and it's a search for the important contributors. It says as Mike stated that the truncation limits should be at least orders of magnitude below the top event probability in terms of the base PSA. But also in performing the specific applications, it does say that you should investigate truncation limit and decide whether you need to change it because this exact phenomena was known.

The thing about importance measures, it's important to understand, pardon the pun, is that the importance measures are a function of the basic event probabilities that you're trying to measure. That's why as you go deeper in truncation limits you see more components getting higher risk achievement worths because you're seeing things with lower probabilities now being brought into the results and therefore showing up in the result.

So whenever you're doing the ranking process, you need to make certain the truncation level is low enough to capture the contributors that you're trying to measure the importance of.

If you're measuring only active components, the failure rates is on the order of 10 to the minus 3, you don't need to go 7 or 8 orders of magnitude down. You can probably go 4 or 5. If you're trying to measure passive components with failure rates on the order of 10 to the minus 6, then you better go more than 10 to the minus, 10 to the 6 order of magnitude and go to the top of the probability or you won't be able to capture those contributors. So the truncation limit has to be a function of what you're trying to do with the PSA.

A third related point is this model, the South Texas model is a risk man PRA which risk man PRA are somewhat different than linked fault tree PRAs in that they include a lot of nominal sequences as opposed to minimal cut sets in a linked fault tree. That generates many, many more sequences above different truncation levels and typically they have to be truncated at a lower level than the linked fault tree PRA.

I think -- staff has probably looked at this more than I have, but most of the risk man PRAs that I was involved in were truncated more at 10 to the minus 12 type of a level than a 10 to the minus 8 level because of that known problem.

Is that right, Mike?

CHAIRMAN APOSTOLAKIS: What do you mean there were sequences that are not --

MR. TRUE: The sequences include success terms in them often that are mathematically accounted for so that both a sequence with a success and a sequence with a failure in it will lead to core damage sometimes. And so you end up with a split in multiple sequences actually being functionally the same sequences, but with a different combination of successes and failures. Whereas a linked fault tree in a cut set model only thing that comes to the top are failures and those are minimal.

CHAIRMAN APOSTOLAKIS: I thought you did that only in the seismic?

MR. TRUE: It depends upon the way the analyst puts together the front line of entries, usually it's the front line of entries that it affects, but it does show up in a number of IPEs, PSA types.

MR. CHEOK: This is basically a graphical representation of what was just said, the number of sequences increases even though your core damage frequency levels itself out after cut truncation limit.

The next issue is quality of PRA. The subissue is modeling and quantification of proposed changes. I guess here we are addressing the pilots for graded QA and to a small extent maybe ISI. In these applications, we do not really have models that can quantify what the risk change would be if we, let's say, have less QA on a component and in these cases, I guess the question is how do we determine the change in risk from this application.

CHAIRMAN APOSTOLAKIS: Wasn't there a study done several years ago where someone looked at components that were, the history, the components history, components that were under QA program and components that were not under similar strict program and they couldn't really find the difference in failure rate?

MR. CHEOK: I'm not sure if there was a study, but I believe that could be a result of a study like that.

CHAIRMAN APOSTOLAKIS: So the failures are not affected by the QA program?

MR. CHEOK: Like I said, I'm not aware of the study you're talking about, but I can read the conclusions you just mentioned.

MR. MARKLEY: George, I think you might be talked about the AEOD studies on components and stuff. I'm not sure.

CHAIRMAN APOSTOLAKIS: It was a national lab paper.

MR. MARKLEY: Pat's here.

CHAIRMAN APOSTOLAKIS: Pat, did you hear the last question?

MR. BARANOWSKY: If it's the one I'm thinking of, it was done a long time ago on some Westinghouse plants that had, I think, a main feedwater valves --

CHAIRMAN APOSTOLAKIS: You have to come here.

MR. BARANOWSKY: Pat Baranowsky. This is just going back a ways. There was a study done one time in which, if I recall correctly, some Westinghouse plants were looked at in terms of main steam isolation valves and main feedwater valves, regulating valves, I guess, that are nonsafety and have different QA requirements associated with them and I think there was a difficulty in finding any difference in reliability, but let me put something in context. Those main feedwater reliability valves are essentially in an operating state all the time and I'm not sure we'd be comparing the same thing if we looked at stand by equipment. That's all I remember about it.

MR. CHEOK: I guess the way we are attacking this problem in the pilots, at least, is that we can perform bounding calculations as to what the risk might be if we had a relaxed regulation, relaxed QA requirements, for instance, to insure that the overall risk would not exceed certain criterion we would come up with.

In these cases also, I guess, as to risk ranking, it comes into play where we can say if we can categorize the components and we can be sure that the categories do not change no matter what all the -- no matter what the assumptions or data we use, then we can be reasonably sure that components that we classified as low significant will stay there for the range of values we think the PRA parameters can go to.

The last thing it says here we will have to depend a lot on the expert panel and the process to determine things like defense in depth, to help us through the whole acceptance criterion.

CHAIRMAN APOSTOLAKIS: I don't understand how you are going to do number 1, the first bullet here when you have no models.

MR. CHEOK: I guess we can make very conservative assumptions like let's increase all failure rates from all components that has a QA relax by a factor of ten, for instance. When we are confident it will not exceed this factor of 10, we can bound the risk that way.

CHAIRMAN APOSTOLAKIS: What if the bound you get is unacceptable?

MR. CHEOK: I guess then we have to rely on something else like defense in depth type arguments. Do we have enough? Did we relax to such a point that we might lower the defense in depth? Are we smarter now how we choose our components to relax QA, for instance, that we did not now effect defense in depth.

CHAIRMAN APOSTOLAKIS: I think this is a broader issue, isn't it? What do you do when you don't have -- or when you have not modeled any particular phenomenon or process in the PRA, right?

MR. CUNNINGHAM: It's perhaps even tougher than that in this sense we're trying to -- you're dealing specifically with change in QA requirements, so it's directly at you, if you will, or directly related to the issue of the acceptability of the proposed change.

Those other things all come into play as well but this is just directly related to it.

CHAIRMAN APOSTOLAKIS: My personal opinion is that the first bullet really should not be used, what it says there, because doing the sensitivity analysis is just an open field for abuse and I don't know. Why a factor of 10 and not a factor of square root of 3? I don't know. Does anybody know? Nobody knows.

MEMBER KRESS: Square root of 2.

CHAIRMAN APOSTOLAKIS: Is better? Okay.

MR. CUNNINGHAM: But if you don't do that then what alternative do you have?

CHAIRMAN APOSTOLAKIS: I don't know. I don't know. But this --

MR. CUNNINGHAM: That's the same question facing the staff.

CHAIRMAN APOSTOLAKIS: This seems to be, I don't know whether it will resolve any problems.

MR. HOLAHAN: I mean one approach you can take is to combine your analysis with your decisions with respect to a performance-based approach. In other words, you could pick an increase for which you are capable of monitoring and assuring yourself that the failure rates are not ten times higher and by picking a relatively high number, I think failure rates, at least for some applications become pretty obvious.

So I think you can make a more or less arbitrary assumption about how bad your reliability could get so long as you had a mechanism for tracking in the future and making sure that it wasn't any worse than that.

CHAIRMAN APOSTOLAKIS: So you would rely on future performance?

MR. HOLAHAN: Rely on future performance to validate the assumptions you're making. Even though it's somewhat arbitrary, it could be validated.

CHAIRMAN APOSTOLAKIS: And if that study I mentioned is right, you will see no change.

MR. HOLAHAN: Right, and not only would you see no change, but you'd be validating the assumption. I think that's one reason why I wouldn't pick the square root of 2 because I'm not sure you would ever get any data to tell the difference between --

CHAIRMAN APOSTOLAKIS: The square root of 3 is better?

MR. HOLAHAN: The square root of 3 is about 30 percent better, I think.

(Laughter.)

MR. CHEOK: Everybody's favorite topic, uncertainty. How do we account for uncertainties in the pilot applications?

Like I said earlier, uncertainties are not quantified in most of the pilot applications.

CHAIRMAN APOSTOLAKIS: Can you ask them to quantify them? You don't have that authority?

MR. CHEOK: I guess right now we are not convinced ourselves that it is necessary, but might go down the road and ask them to quantify when we do come up with a decision, whether it's necessary. If it's necessary.

CHAIRMAN APOSTOLAKIS: You can also make the argument that since these are pilot applications they should be as complete as possible.

MR. CHEOK: That's correct and I guess there are some pilots that have quantified it and I guess the results, I'll discuss the results on the next page.

MEMBER POWERS: When you speak to uncertainties and the quantifications of uncertainties, are you speaking of uncertainties in the analyses they have done or those aspects of the analyses that could have been done, but weren't done?

MR. CHEOK: Uh, the uncertainties in the analyses that was done.

MEMBER FONTANA: I don't know in principle how you can do the first bullet if you don't have any models to work with. Sensitivity is almost defined as an output of --

MEMBER POWERS: Well, it's okay if they only analyze the analyses they have done because then ipso facto, they do have models.

MEMBER FONTANA: It explains it.

MEMBER POWERS: Yes.

CHAIRMAN APOSTOLAKIS: Well, this does not address only the graded QA issue.

MEMBER FONTANA: That's in general.

CHAIRMAN APOSTOLAKIS: So in the pilot studies, did you have any input as to what they were supposed to do?

MR. CHEOK: I don't understand the question. What do you mean?

CHAIRMAN APOSTOLAKIS: When you say some people did it, some people didn't do it. Wouldn't you need before they started doing the work and said we'd like to see this and this and that?

MR. CHEOK: Most pilots have submitted the -- most submittals came in before, I guess you were involved in the reg. guide SRP issue, those pilots that came in followed the guidelines given by the PSA applications guide.

MR. HOLAHAN: I think most of these issues have been raised through the request for additional information.

MR. CHEOK: That's correct. We did RAIs. We did raise all those issues.

MR. HOLAHAN: I don't think we have an authority problem. These applications are asking for relief from existing standards and I think we can ask any questions that we think are relevant to making our decisions. They may not want to do the analysis, but then we might not want to grant the relief.

MR. CHEOK: In the two examples I show here again they pertain to the pilots we have. The bullets for risk ranking, I guess, they do show that even though you do an uncertainty analysis, you could shift the relative positions of components up and down. Number 2 becomes number 17 or wherever, but in general, we do not shift the categories where it's ranked high or ranked low in the final list of components and in the second study which is basically a delta CDF type study, it shows when they did the uncertainty analysis issue that the PDF of the CDF is not changed very much.

The conclusions here basically, what we put down here is that the pilot approaches for addressing uncertainties is still being evaluated.

We think there are cases where we'll need a full uncertainty analysis, but we don't know, we haven't defined yet what these cases would be. However, in the pilot stage we are evaluating uncertainty on a case by case basis and I guess if you're interested we have a tech spec example here and we can show it to you in two or three minutes or I can skip it. It's up to you.

CHAIRMAN APOSTOLAKIS: You have a review?

MR. CHEOK: It's not in the slides. It's a backup.

CHAIRMAN APOSTOLAKIS: Let's keep it to the end.

MR. CHEOK: Okay.

CHAIRMAN APOSTOLAKIS: Well, actually, one of the few instances where the uncertainty distribution really made a difference, at least in one of the early PRAs was interfacing system LOCA through isolation valves within high pressure and low pressure systems.

You had two valves in the series that both had failure rate, so logically they're in parallel and because of the uncertainty distribution of the failure rate which one was very very large and if you want to go to a square of the failure rate which is this sequence, then you really have to include those uncertainties because the variance really dominated the mean values, and that's one of the pitfalls.

So there are very few instances where these things happen where the basic uncertainties for individual failure rate is so large that when you go to the logic model you really see a serious impact, so these results don't surprise me.

On the other hand, to do an uncertainty analysis now with the software tools that are available is really remarkable, so I don't know why people want to stick to point values and then have all this discussion did you need it because it was not important. I mean the data are there, the data bases are there, the software are there. All you have to do is read the manual and do it.

MR. CHEOK: I guess the software is there, but the parameters that go into the uncertainty analysis --

CHAIRMAN APOSTOLAKIS: After all these PRAs for the last 20 years, I am sure you --

MEMBER POWERS: But George, is running a bit of software that goes through and redoes your analysis a different parameter values, is that the link in the breadth of the uncertainty analysis that you'd like to see?

CHAIRMAN APOSTOLAKIS: No, I would like to go to the other issue, but this one, the point is it's routine. There's no reason to even discuss it any more. It's not like in the old days where we had to write your own program. We don't use the method of moments or Monte Carlo and we need random number generators. Now it's all part of the package. We shouldn't even discuss it and then after we do that we start worrying about the issues of what's left out.

I don't know, I think working with point estimates no it seems to me is not -- you're smiling, Bob.

MR. YOUNGBLOOD: Yes.

CHAIRMAN APOSTOLAKIS: The yes means you are smiling or you agree with me?

MR. YOUNGBLOOD: Both. I don't see why it is discussed as much as it is.

CHAIRMAN APOSTOLAKIS: Yes.

MR. CHEOK: Defense in depth. I think I might have skipped one. Everybody says we have to consider defense in depth. The question here is how do we ısure that defense in depth is maintained, especially, I guess, in the pilots when we do not have the reg. guides or SRPs to guide us.

Most pilot applications right now address defense in depth by stating that it's implicitly taken into account in the PRA and we have a low enough number, we have defense in depth.

I guess the staff position right now is that if you do relax too many components without any explicit considerations of defense in depth, you would erode away, after defense in depth.

Again, these are very early thoughts on this process, how we review against it. The first bullet says we can ensure that there's at least one success path in each -- for each application that's not been relaxed.

The second bullet says that we'll look at the four different areas listed and ensure that we have protection in each of these areas. For example --

CHAIRMAN APOSTOLAKIS: Now let me understand what the first bullet means.

MR. CHEOK: Okay.

CHAIRMAN APOSTOLAKIS: When people ask for extensions in the AOTs, right, how would you apply that to the first bullet? You would extend the AOT for one system, for another system, you would not do it and the same for defense in depth?

MR. CHEOK: I guess that's what the first bullet would say or you basically have compensatory measures to insure that you have --

CHAIRMAN APOSTOLAKIS: But that wouldn't make sense. I mean the whole risk is affected so insignificantly.

MR. CHEOK: This is the part. I think we agree with you that the first bullet actually -- but that's just an option.

CHAIRMAN APOSTOLAKIS: Wouldn't you say that this issue of defense in depth would be much more significant in cases where you don't have models like in the GQA?

MR. CHEOK: That's right. That's how we basically can -- you're right. I did mention in the GQA slide where we said hey, absent absolute bottom line numbers we need to depend on criteria like defense in depth to help us.

CHAIRMAN APOSTOLAKIS: But when the thing is modeled in the PRA, perhaps the issue of defense in depth would not be as significant. I mean you wouldn't go as far as eliminating barriers.

MR. YOUNGBLOOD: Only to say I think that when that bullet was proposed, it was again in a slightly different context. I think some people thought it was inappropriate to classify components in such a way that no success path was all high or something. There were other contexts to that bullet, but as Mike says, it's just one of several ideas floating around.

MR. BUTCHER: Mike, before you -- could you put that slide back up again because I wanted to make note of the fact that from a risk and form regulation perspective, our definition of defense in depth is perhaps maybe a little bit different than people have seen before. Also, it appears to me to be a little bit different than what NEI presented this morning. So I just wanted to make note of that fact there.

You can take those layers and directly correlate them to the different levels of PRA. The first two bullets I guess you could put in the level one category. The second one, level two. The fourth one level three.

I suppose you could require a level one ranking and then a level two ranking, and then a level three ranking, and preserve defense in depth that way if you wanted to do it entirely rigorously and mathematically.

MR. CHEOK: Another way we can look at defense in depth is actually use the PRA and start looking at cut sets. Depending on what the initiator is, ensure that we have enough cut sets available that have not been effected by the application.

I guess in this example we show here, that if we have a severe accident, which implies that the initiating event frequency would be low, we now can have a single failure criteria that we need, maybe to ensure that two elements of the cut set do not get effected by the application.

For the more anticipated occurrences, maybe we need three elements of the cut set that's been affected by the application. For sequences, where we have large early releases, again, we might have three numbers -- elements of the cut set that's not effected.

Again, this is an avenue we are looking at, but we have not exactly decided what we're going to do yet.

MEMBER POWERS: But the operative thing is that you believe you can do -- you can look at a risk analysis and a vulnerability analysis and decide whether you have an appropriate level of defense in depth.

That is, you don't see defense in depth as being somehow outside of that.

MR. CHEOK: No. I don't think we can see it as something outside of that. I think we can look at it actually using the PRA itself.

MEMBER POWERS: So you think the PRA carries with it all the information you need to understand defense in depth?

MR. CHEOK: The PRA carries with it a lot of the information that we need to ensure that we have maintained defense in depth.

I have five minutes. So I guess I'm going to progress to these slides here. Acceptance criteria. I guess the question here is when we look at the pilots, what are we looking at as far as what's acceptable for the change.

CHAIRMAN APOSTOLAKIS: Have you -- I noticed that you haven't really addressed the issue of performance criteria so far. When you say acceptance criteria, you assume that you already have some performance indicators or that's part of the --

MR. CHEOK: Yes. I think if you look at this page where I have all the bullets, implementation of a performance-based feedback loop is the last bullet in there. I think that's part of the acceptance criteria we would be looking at.

CHAIRMAN APOSTOLAKIS: In the previous slide, you asked the question what acceptance criteria should risk informed obligations be evaluated against. Do you mean risk informed and performance based?

MR. CHEOK: I guess right now I mean risk informed. I'm not including performance based into it.

CHAIRMAN APOSTOLAKIS: Why not?

MR. CHEOK: I guess the pilots that are coming in right now are not at performance base as such.

CHAIRMAN APOSTOLAKIS: So when are we going to learn about performance?

MR. HOLAHAN: Well, I mean we're going to talk about it later.

CHAIRMAN APOSTOLAKIS: Okay.

MR. HOLAHAN: But let's not mix things up. I think maybe the acceptance criteria is one thing and the performance element I think is not part of the acceptance criteria. It's probably more related to validating that the acceptance criteria and the decisions of the analysis are really coming true in the future. So it's an implementation issue.

CHAIRMAN APOSTOLAKIS: Or from the past, somebody may come and say the reason why I want this change is because of my history. Right?

MR. HOLAHAN: But you still might want some performance element to show that history will continue.

CHAIRMAN APOSTOLAKIS: Sure. I mean performance indicators don't apply only to the future. You could use your past history to try to make an argument. Then of course you have to live up with it.

MR. CHEOK: Okay. Basically the six bullets here say that for a pilot to be acceptable, it has to be checked against the risk significance, CDF, large release. There should be assurances of maintenance of defense in depth, assurances that the change will not result in risk outliers, assurances that the accumulative effects of all changes will not affect -- will not be above certain criteria. Consideration of deterministic factors, this is where your expert panel comes in, and implementation for performance based feedback.

CHAIRMAN APOSTOLAKIS: Oh. So you do worry about performance.

MR. CHEOK: That's right. We do.

CHAIRMAN APOSTOLAKIS: You just don't know how to do it yet.

MR. CHEOK: Well in this sense we do. We basically do a -- we are proposing and a lot of the pilots are proposing this monitoring type to see how the components are behaving after implementation in a trending type analysis to show that the numbers that they have used in the risk analysis are actually correct.

CHAIRMAN APOSTOLAKIS: So they are proposing as measures of performance. If they are doing that.

MR. HOLAHAN: If they are doing that. Are they proposing that or are we encouraging them to propose that?

MR. CHEOK: I think in IST, they will be doing that. I guess the IST pilot is sitting right there. Hussein, would you like to say something about that?

MR. HAMZEHEE: Hussein Hamzehee with TU Electric. There are three terms that are already included in the process that should take care of the performance based. One is the living or updated PRAs or IPEs. Every two or three years we update them, you are going to lose your updated failure rates and reliability data. If you have some bad actors, it will come up.

Now George may ask, well but PRA may not be that sensitive without giving piece of equipment. That is correct too. But then we have a maintenance rule. Maintenance rule is basically based on performance

If things start performing below their threshold, then they are going to be moved up. Then we are through looking at the safety significance systems or components, safety significances, risk significant systems or risk significant components between those comparisons, we're going to get some feedback loop.

The third and most important part is the expert panel. We may -- the PRA may say that the given piece of equipment is not important. But in our analysis, many times when we're sitting in the expert panel meeting, there were a few of the operations people that would survey them in it. This piece of equipment on main feedwater we had a few failures with it. Let's keep them in the more safety significant category. If the problems are resolved, then we move them back.

So these things are already built into the process. But one has to pay attention to it so that it doesn't get left out or messed up.

CHAIRMAN APOSTOLAKIS: The last part is really the decision making process. But they use as performance measures past failures.

MR. HAMZEHEE: So if the process is complete, you can never miss the bad performers.

MR. CHEOK: The last point is how do we integrate deterministic factors into our decision making process. The pilots are all using the expert panel to do this.

What we are finding out I guess in the review process is that for this expert panel to work, there has to be a process that's well defined systematic and scrutable.

The expert panel will have to have the appropriate qualifications and it has to be fed the appropriate information.

I guess last but not least, both probabilistic and deterministic factors have to be considered.

CHAIRMAN APOSTOLAKIS: Just out of curiosity, because the expert panels have been praised a lot today.

MEMBER CATTON: By whom?

CHAIRMAN APOSTOLAKIS: By people who spoke up. There is a whole lot of literature showing that experts have biases, you know. This classic paper on heuristic biases, heuristics and biases by Tertsky and Kanniman. This is something, you know, whenever we elicit expert opinions we have to really be careful to make sure that there is no systematic under or over estimation of the quantities of interest.

Do these biases apply to expert panels? I mean is it possible that the expert panel will be wrong?

MR. CHEOK: I guess the answer would be yes.

It's possible the expert panel would be wrong. But I believe that if we have a process that's well-defined enough that they have to basically make certain decisions based on certain information that they get, then there's a less likelihood that they could be wrong.

I mean I guess the key here is to have a process that's well defined, and the fact that they get the correct information supplied to them.

MEMBER SEALE: I understand that you are in the process or you are attempting to develop a set of requirements or criteria for what you expect from the expert panels.

MR. CUNNINGHAM: Yes, sir. That is correct.

MEMBER SEALE: I think we mentioned this back when we first met on this issue, about the quality of the expert panel.

Will you be able to share that with us any time soon?

MR. CUNNINGHAM: The next subcommittee meeting.

MEMBER SEALE: Maybe we'll apply to the ACRS too.

MR. CUNNINGHAM: That's up to you.

MEMBER POWERS: But, George, I think that there is going to be an inherent bias in any expert panel that is assembled. I'm not sure that the bias that comes first to mind is all that bad. I mean I think that you have ingrained within the nuclear industry, a safety culture that will lead people on expert panels to have a bias in the direction of conservatism in the face of less than complete knowledge. More so than you would on an arbitrarily selected group of technically skilled people. So I think there is an inherent bias, but it probably should concern me less.

Fortunately, it sounded like this morning that they are actually getting some data that can be compared, expert panel performance versus either licensee analyses or independent analyses by the staff that we can compare and see if there is a bias in the direction of over conservatism.

I think that should figure prominently in any future meeting, to look at that kind of data.

CHAIRMAN APOSTOLAKIS: Who is doing this?

MEMBER POWERS: It sounded to me like the staff is doing this.

CHAIRMAN APOSTOLAKIS: The staff is doing it.

MR. BUTCHER: I would have to say it's on a pretty qualitative basis. It's not statistically supportable.

MEMBER POWERS: I think this is going to be inherently a qualitative thing.

MR. BUTCHER: I think some of the pilot, maybe Hamzehee might want to speak to that, because the utilities are quite comfortable with it. They are quite happy with the results they are getting out of their expert panels. They like the idea that there's somebody to stand behind these numbers.

CHAIRMAN APOSTOLAKIS: Don't misunderstand me. I'm not saying you shouldn't use expert panels. I think they are an essential part of the process.

I mean I noticed several times today that people said PRA gives you this, but you don't really believe it but you have the expert panel to take care of it. I think sometimes it's the other way around. The expert panel may look at PRA results and say gee, we didn't think of that. So it's really a two-way street.

But I was just wondering, I mean, for example, coming back to what Dana said. One of the major findings I guess from all this process of 1115 and everything else is that who sits on the panel is much more important than how you process the opinions or the judgements and so on and so on.

MEMBER POWERS: Well I think the finding is not only -- has to do with the breadth of experience on a panel, but actually structure and modus operandi effect.

I mean there's a mathematical theory on how to influence the outcome of a panel's judgement. It seems to work pretty reliably.

CHAIRMAN APOSTOLAKIS: But the first and crucial step is the selection of the experts. But maybe when you put together your guidelines, we'll address that.

Okay, we have two.

MR. HAMZEHEE: Hussein Hamzehee here with TU Electric again. Since we have gone through an extensive expert panel, I just wanted to make a few points.

One, when we say expert panel, the definition may be different from what the old school of thought was about the expert panel.

Maybe in the past, whenever you said expert panel they would all be expert let's say with performance of an MOV, and they would all, for instance, try to come up with the failure rate for that. So one person would say X, one person would say Y, and one person would say Z. There was some mathematical expression to put all these ideas together and come up with a number that data was not available for.

So the only thing you could do was using the expert panel opinion. We could call it expert solicitation.

Here is slightly different. When we say

expert panel, we don't mean that there are 10 experts on the same subject. The problem we have these days in the nuclear industry within utilities is that not one person knows or can have information about thousands of components at a given nuclear plant.

So what we do is we say all right, when we want to make a decision we want to make sure we have a representative from a PRA so he can explain the results. We have a representative from the operations with an SRO background who knows exactly what our day to day problems. We have a representative from the IST, for instance, for this example, that knows why we have the IST requirements, how they were derived, and what the potential impact would be if they were changed, and so forth and so on, design engineering, maintenance engineering.

Then as a collective population, we have all the knowledge that we need for that plan to make decisions. So that's the definition, as opposed to the old definition of expert panel.

The other thing that I would like to mention is the fact that we do need some kind of systematic documentation of how information should be reviewed by the expert panel, mainly because you get what you tell them you were looking for. If the information is not adequately transmitted to the expert panel, the results may not be adequate. So to some degree, we need to know how the process should be systematically controlled.

On the other hand, if you try to come up with the exact cookbook of telling these expert members how to think and how to come up with ideas, then you are defeating the purpose of expert panels, because you are taking that right away from him to think the way he is comfortable with thinking.

So one has to be careful as to how much of cookbook mentality we'd like to come up with the expert panel.

MR. DINSMORE: Yes, Stephen Dinsmore. I thought I'd just give you a quick number from one of the DISI projects. They did the safety significant calculations and they came up with about 60 piping segments which they consider safety significant. The expert panel added another 30 because they were worried about the consequences of the possible pipebreak. So they do tend to add a chunk back in.

MEMBER SEALE: Did they knock any out?

MR. DINSMORE: No. They didn't. They are allowed to, though, but they have to justify it.

MEMBER SEALE: I understand.

CHAIRMAN APOSTOLAKIS: Is that it? Are you finished four minutes ahead of schedule?

MR. CHEOK: I thought I was late.

CHAIRMAN APOSTOLAKIS: That's why you finished four minutes early. Thank you very much.

MEMBER POWERS: That's a new subtle ploy we have. We give the speakers the wrong time. A little lying goes a long way.

CHAIRMAN APOSTOLAKIS: Next one is on changes in IST and ISI requirements. I see you only have two view graphs.

MR. BAGCHI: That's right.

Good afternoon. I am Goutam Bagchi. My branch has responsibility for in service inspection program. I have my colleague here, Mr. Richard Wessman. He is chief of mechanical engineering branch. He has responsibility for in service testing.

So that I am not misunderstood, I want to make it very clear that I am addressing the item on the agenda, which is changes in the ISI, IST requirements. The pilot plans do not have a requirement as of yet. The only requirement there is is in the regulation, 10 CFR 50.55a. From that, all the requirements flow.

We are in the very early stages of discussions with the industry group. There is a logic behind the pilot application, how many plants and so forth. Perhaps that is not all that relevant for today's discussion, but a quick run down through that is helpful sometimes.

NEI has come together with a guideline for ISI, as risk-informed ISI, as well as risk-informed IST. Embedded in that are methodologies that are applicable to these processes.

In case of IST, it is essentially one approach. Did I say IST? Yes, in case of IST it is essentially one approach. In case of ISI, there are two approaches. Following that logic, we have three pilot plans for ISI, but we have two pilot plans for IST.

The scope of both ISI and IST come from section 11, as I indicated in the first bullet. I think you will appreciate that the current method is deterministic. They have very prescriptive criteria with respect to what needs to be in the testing program or in the examination program.

Embedded in the rule itself there is a provision that when an acceptably -- when a method is proposed which provides an acceptably safe and high quality program, then that could be authorized by the office director of NRR.

So the staff plans to invoke that requirement and look at these pilot plan applications on that basis. When we are through with our review and the programs get modified, we will then make a recommendation to the office director and prior to issuance of acceptance of the program, we would have to report to the commission because the commission directed us to do so.

The biggest deference between the ASME methodology and the scope of the pilot plans is really that it is, the pilot plans are looking at more risk sensitive components and they are going beyond the routine ASME class one, two and three scope. It is picking up more risk significant items. So that's the basic difference.

In case of ISI, the intent is to go into the scope of the maintenance rule, but it is not that clear cut in case of IST.

The review process are going through these pilot plans, provides us with a step-wise pre planned method to convert the existing ISI/IST programs into more risk-informed programs. Interaction with the pilot plans would then contribute to our better understanding of what kind of criteria we need to write in the standard review plan and regulatory guides. As you already know, the regulatory guides have been prepared by staff in the office of research. The standard review plans are being developed by staff in the office of Nuclear Reactor Regulation.

Staff will inform the Commission of the

approach to approval of the pilot programs. This is the Commission SRM as I mentioned earlier. Pilot plans will be expected to modify programs to conform with the final reg. guides. NRC will endorse with limitations as necessary risk-informed code cases that are also being developed by ASME.

When we have -- I think we are due to give you the draft, first draft of the reg. guides and SRPs sometime this fall fairly soon. At that time, we can discuss it further.

CHAIRMAN APOSTOLAKIS: Questions?

MEMBER SHACK: I just recall reading one of the NUREGs I guess that was done at PNL in research when they were looking at this. They had some rather interesting results, as I recall, on the components that were risk significant. My immediate reaction was that there were very different components that were being inspected now. That is, you really did -- this was a drastic change in the program.

But the components that seem most risk significant also seem the most difficult to inspect. Is somebody looking into essentially a qualification program? You know, you may now be able to inspect the right component, but can you actually inspect it?

As I recall, they were big massive valves that

I could only envision inspecting with a portable LINAC or something.

MR. BAGCHI: Well, what about the buried pipe that may be most significant to risk service water system, for example.

Those are difficult questions. We're not going to know all the answers until we get there. Surely there are questions you have already asked, that risk-informed components that are identified through these programs, what if you couldn't inspect them? What are the alternatives? Yes, those are questions that are on the table right now and we are discussing with various folks on that.

MR. BALKEY: My name is Ken Balkey. I'm from Westinghouse. I have chaired the ASME research efforts on both risk-based in service inspection and in-service testing which are being used to formulate code cases with in ASME section 11 for ISI and code cases in the ASME O&M code for in-service testing. The work is also being used for the pilot plans. We're building off that effort as well.

There were just two points I'd like to make or bring a perspective. I held my comments until now. This morning, you saw the presentation by the NRC that had -- didn't have a full scope PRA. You know, it had the internal events, but you may not have had seismic or shutdown.

I just want to bring the message, if you take a look at how programs are scoped now, they are not using any of that information. They are using some deterministic information. Even just bringing the internal events is a tremendous piece of information or insight that helps make these programs to be more effective.

We had both our books reviewed, the research documents reviewed by folks who were involved in the beginning of writing the ASME codes and standards 25 years ago. They feel that this information, they wish they would have had it 25 years ago because it helps to really focus the inspection effort on the true areas of risk significance.

The other point I just wanted to make, and I also on a slide from the prior presentation by Mike Cheok. The in-service inspection is a more difficult application than the in-service testing. The in-service testing, you have a number of the pumps and valves already modeled in the PRA. When you go to in-service inspection, you do not have all the piping segments modeled in the PRA. The passive components may factor in through the initiators of the small LOCA, medium LOCA, large LOCA. But for the most part, you don't have them all in. We've had to use a different process.

The ASME has recommended the use of these statistical fracture mechanics models. Now we have stated here that these models are relatively new and they need thorough review. I'd just like to clarify that the use of probablistic structural mechanics or statistic fracture mechanics has actually been around for as long as the PRA developments.

In fact, there have been a number of regulatory initiatives already approved that use probabilistic fracture mechanics as a supporting base. As such is in the pressurized thermal shock role, work done to support leak before break in piping. In fact, there's an SER from the NRC to Westinghouse using probabilistic fracture mechanics to set intervals on turbine generator disk cracking.

Also, a number of industries such as like fossil plants, who have had very serious catastrophic pressure boundary failures over the past few years. I was at a conference just two months ago. There was extensive probabilistic structure mechanics work helping to address the aging effects in these components. That is why we have moved to that because if you look at passive components for plants that are less than 20 or 25 years old, things stay relatively even.

But if you look at the fossil industry passive component failure rates start to go up when you get into the 30, 35 year, 40 years of operation. That's one of the reasons we want to use the probabilistic structure mechanics model, to get a handle on the aging effects for the pressure boundary components.

The challenges, not too much that's new, but the models to date primarily have been used by specialists and practitioners. What we're trying to do are get those models out into the utility staffs just the same way that PRA is used routinely throughout each of these utilities. We're working real hard and we've done it in the pilot plants for the ASME method. The utilities are actually running these models.

The question is, in some of the models we've developed a more simplified than those that were done in the past to support efforts under like the leak before break argument. That's where I think the review is, that we're in fact today out in Portland, Oregon. They are going over benchmarking of the simplified models versus the more complex models that were used to support prior licensing actions.

So I just wanted to go on the record to provide those clarifications. One other item too is that the ASME would like to meet at an appropriate meeting in the future to summarize. These would be the leaders of the section 11 code, the ASME operation and maintenance code, to discuss the code cases being developed and how that fits into the framework that Dr. Bagchi just summarized.

CHAIRMAN APOSTOLAKIS: Are you requesting meeting with the subcommittee or with the full committee?

MR. BALKEY: It would be with the subcommittee at a future time.

DR. BAGCHI: May I make one more observation? Mr. Balkey has talked about this, the research approach for the ISI, and also the same thing applies to the work Westinghouse owners group methodology. But there is another methodology on the table which is far less quantitative, somewhat qualitative and proposed by EPRI. We're reading that methodology as well.

But in the spirit of what this committee does or this group does, ACRS, I would like to keep more closer touch with Dr. Shack, if you are interested in looking at the methodologies for ISI. Perhaps we'd like to take the opportunity to discuss with you some of the details as they develop.

CHAIRMAN APOSTOLAKIS: Anything else? Thank you. Take 15 minutes.

(Whereupon, the foregoing matter went off the record at 2:58 p.m. and went back on the record at 3:18 p.m.)

MR. CUNNINGHAM: We have two parts to the presentation this afternoon. I'm going to go back and revisit and elaborate on a little bit more two of the policy issues that we discussed at the July 18th meeting. These are the risk issues, if you will, on dealing with use of safety goals that we've been talking about already, and then the question of the need for risk neutral changes and that type of thing.

Gary will come a little bit later and talk about the performance-based regulation.

I should note that on here that in the agenda we had some other items that we had thought we should cover with the subcommittee, but we took them off, basically, because we thought we wanted to make sure that we covered each of the big policy issues with you and had time to discuss them with you.

This issue -- when we were here last time we actually -- this is a slightly different set of options that we have from before. The issue, again, is can we use the Commission's safety goals, which have been historically used in the context of generic decisions facing the staff, can we use those goals and subsidiary objectives in plant-specific applications? And, if so, how can we do that?

We had three options with the subcommittee when we met with the subcommittee in July. The first was that yes, we thought we could expand upon, or derive from, the existing goals and subsidiary objectives some sort of acceptance guidelines that would be useable for plant-specific applications.

The second one was to try to establish some sort of a relationship between plant-specific changes and keeping the goals generic and try to develop some sort of an elaborate relationship between those plant-specific applications and generic goals.

The third option was to basically take the application of safety goals as it is in the reg. analysis guidelines and just apply it verbatim to the issue of plant-specific licensing changes.

And the fourth is one that we added based on the discussion we had with the committee in July, where some of the discussed suggested that perhaps we should redefine or define some new plant-specific safety goals that consider site characteristics, for example, or redefine the safety goals in the context of a societal risk, and that type of thing.

We continue to believe that option 1 is where we think we want to go. I want to touch upon that just a little bit now.

Had Rick Sherry not given his presentation this morning, we could have come through and given a similar presentation from some of our staff on trying to develop subsidiary objectives and things for use in plant-specific applications based on the QHOs and other things. And I think there's two or three observations from Rick's presentation that I think help reinforce if you will the case that we had that we think we can use the existing goals and subsidiary objectives in a way in plant-specific applications.

Again, as Rick said, that the top-down approach, if you strictly work from the QHOs, can leave you in a situation where you can have fairly high core damage frequencies in some plants, higher probably than is tolerable for the Commission, and that's part of the reason that we have a 10^{-4} core damage frequency subsidiary objective is because of that recognition.

The core damage frequency subsidiary objective can control core damage frequency and risk for accidents that have relatively small consequences, but you need some sort of a large release frequency type of goal to control the high consequence sequences. So the bottom line from Rick's, and I think this is just something we tend to agree with here, is that it takes several things. It takes a couple of things, two objectives probably, to control the core damage frequency and risk in the appropriate way.

So I think everything that Rick said this morning is a reinforcement of what we believe is -- the option 1 that we laid out is a viable option we're pursuing.

At this point, we can either continue talking about some of the other things. Or do you want to stop and talk about that issue per se, since we will be asking for a letter that says what your opinion is on the issue that we've raised?

MEMBER KRESS: Well, the one thing that seems to be a little bit sticky is how you define the LERF, and that's the one you need to give a little more thought to.

MR. CUNNINGHAM: That's right. And we are working through a process to -- in a sense much like Rick was talking about this morning, where you work from trying to calculate conditional consequences of events and try to derive from that --

MEMBER KRESS: Sort of back that --

MR. CUNNINGHAM: Back out a large release frequency.

MEMBER KRESS: I think that would be a

reasonable way to do it. You have to worry about the things like Dana said. There is shutdown risk where you've got -- that's a controlling set of elements.

MR. CUNNINGHAM: That's right. And one of the complications of things like shutdown risk is that -- one of the key points here is that, in general, the individual early fatality QHO controls the consequences of -- but in shutdown events, there can be circumstances where the latent goal might come into play. So you have to work all of that, and we have some folks that are trying to work that. And, again, we think we can do that, so we think it's feasible.

MEMBER KRESS: I personally would like to see the LERF reflect the site characteristics, meteorology and population. Now, that's a personal preference.

MR. HOLAHAN: I think we're aware of your --

(Laughter.)

-- thoughts on that subject.

CHAIRMAN APOSTOLAKIS: Speaking of site --

MR. HOLAHAN: What I would say is the policy issue I think can be separated from some of these technical aspects. The policy issue that we need to settle first is whether there should be any plant-specific applications, any plant-specific guidelines. And I think we could separate that from the issue of exactly what it should be.

MEMBER KRESS: Absolutely.

MR. HOLAHAN: And I think, you know, for September I think it is our goal to get to the Commission with something that says -- at this stage says yes, you ought to apply these thoughts on a plant-specific basis, and it would reflect some element of core damage frequency and some containment performance or large early release, and as a policy matter hope that we could get that settled with the Commission.

And then some time between September and December, while we're trying to lay out a lot of the other technical issues in the guidance documents, we could use that time to work on, you know, what exactly it ought to be.

MR. CUNNINGHAM: I should just make one other point, by the way, that we talked -- there was some discussion this morning of the large release goal that is discussed in the safety goal policy statement. That's a goal that the Commission asked the staff years ago to investigate, which is a one in one million chance of having a large release, and whatever that meant. We're not constraining ourselves at this point to trying to hold to that particular goal.

Several years ago there was a lot of work done to see if that was a practical goal, and it just had had many problems and we basically told the Commission we wanted to abandon that specific approach to large release. So that has kind of gone by the way if you will, the one in million of a large release. We're talking about something --

MEMBER KRESS: One of the reasons that -- one of the problems, though, is because you were trying to do it not on a plant-specific basis. When you go back to a plant-specific basis, some of those problems with that thing goes away.

MR. CUNNINGHAM: Well, if I recall correctly, there were some calculations done where you tried to do it on a more plant-specific basis, and it -- I guess one of the problems was that it conflicted with other Commission guidance.

MEMBER KRESS: Oh, that was always there, yes.

MR. CUNNINGHAM: That's right.

MEMBER KRESS: Yes.

MR. CUNNINGHAM: The other Commission guidance was do not create a new goal which is --

MEMBER KRESS: Yes.

MR. CUNNINGHAM: -- a de facto new quantitative health objective because it is so much more --

MEMBER KRESS: No matter where you --

MR. CUNNINGHAM: That's right. It was so much more conservative that it became a new goal, and that -- there was just no resolution to that conflict, so we just stopped that particular approach.

MR. HOLAHAN: But at this stage, I think we have the opportunity to revisit that subject.

CHAIRMAN APOSTOLAKIS: You told me, Mark, some time ago that the issue of societal risk had been discussed, and that the regional goals were considered and rejected. Can you summarize what the arguments were?

MR. CUNNINGHAM: There may be others who can remember it. If you look at the safety goal policy statement, when the Commission approved it there were additional comments provided by two of the five commissioners, Commissioner Bernthal and Commissioner Aselstein.

And at least one of them discussed the issue that the formulation for, in particular, the latent fatality goal was such that it became, in a sense, independent of population. And that was the concern that was raised, and I believe as Commissioner Bernthal made the comment in his -- made the comment that this would still permit siting in Central Park, if they wanted to, because of the formulation of the goals.

I don't know a lot of what went on in that time in terms of the particular debate and why they decided not to do it that way. But I know even at that time in the -- that was 1986, that that was -- in the years before 1986 that was discussed a great deal, but I don't know exactly why it wasn't pursued.

I'm looking at Joe Murphy. He's --

MR. MURPHY: Well, let me add a general thought. I think, as the Commission started, the idea of setting the qualitative and quantitative health objectives at a tenth of the natural frequency of either early fatalities or accidental deaths or of latent cancer fatalities in the United States was initially perceived as being societal.

As we implemented those, in fact, they turn into individual risk. I'm not sure that was done with a great deal of intent, until we got to the final closing when, as Mark said, it was pointed out that this was a problem. But it didn't handle the high population sites. But I think the decision was made to go ahead with what we have and handle those concerns separately.

CHAIRMAN APOSTOLAKIS: Now, when you say utilize existing subsidiary goals, I mean, what we have, the numbers we have now, right?

MR. CUNNINGHAM: The existing subsidiary

goals. We're talking -- well, we're talking about the two quantitative health objectives, the core damage frequency, and some sort of a containment measure, either some sort of a large release type of thing or a CCFP type of approach. We think we can work from those two and utilize those in a plant-specific basis. I think it's feasible to do that, and we think that's the right way to develop the acceptance guidelines that we've talked about several times today.

Basically, we're interested in either getting your agreement or disagreement or whatever. If you want to ponder, we can ponder. If you want me to go on, I'll go on.

MEMBER KRESS: Do you want an answer from us now, or do you --

(Laughter.)

MR. CUNNINGHAM: If you've got an answer, that's --

MR. HOLAHAN: Well, you should also remember that we're on the agenda for tomorrow. So you have time to think about, you know, what are the last few items we ought to discuss. But --

MEMBER POWERS: Well, Mark, you've listed down four options here, and you've said you're in favor of option 1. Have you also drafted up some sort of a piece of paper that says the pros and the cons and why you rejected 2, 3, and 4?

MR. CUNNINGHAM: We are in the process of doing that, yes. We owe that to the Commission in September. If you'd like, we can talk briefly about each of those and give you a flavor for why it is we're not so fond of some of the others.

MEMBER POWERS: I think that would be extraordinarily useful to us.

MR. CUNNINGHAM: Okay. I was thinking we had talked about some of this before, but we'll go back. That's okay.

MEMBER KRESS: Now, could one not also incorporate 4 to some extent? I mean, those are not necessarily mutually excludable, are they?

MR. CUNNINGHAM: They're not. I guess 4 really has two pieces to it. One of it is, in a sense, a more fundamental reopening of the safety goals. If you want to consider societal risk, to me that's a fundamental change in the policy as it exists, the safety goal policy as it is. That is mutually exclusive, I think, with our intent of site --

MEMBER KRESS: Site characteristics.

MR. CUNNINGHAM: -- characteristics.

MEMBER KRESS: Not necessarily.

MR. CUNNINGHAM: Not necessarily, no. No.

MEMBER KRESS: Okay.

MR. CUNNINGHAM: Well, we could talk about that. Obviously, there are some advantages to having site-specific things. The disadvantages are that it becomes much more difficult to implement, that there is a nice advantage to having one set of guidelines that apply to all of them based on some -- however you arrive that from some basis if you will.

MEMBER SEALE: Well, then, let me ask you this to clarify. When you speak of plant-specific applications in the first option, are you talking about differences in design but not differences in location?

MR. CUNNINGHAM: Yes. This is related to changes in the licensing basis that we have talked about this morning, ISI and IST.

MEMBER SEALE: So it's to reflect the difference between different kinds of BWR containments --

MR. CUNNINGHAM: No, it's all --

MEMBER SEALE: -- things like that, rather than site.

MR. CUNNINGHAM: Right.

MEMBER SEALE: Okay.

MR. CUNNINGHAM: Right. I could start with the second one I guess and go on and say that, again, this is trying to say I'd like to -- the goal of the second would be to maintain some sort of a generic nature to the applications of the safety goals. That if we could somehow say that there is an industry average goal, which is the way that goals have been talked about in the past, and somehow going to measure plant-specific changes and decide on the acceptability of plant-specific changes, and then relate those to these industry goals.

So what it does, then, is removes the acceptance -- it takes the acceptance criteria one step removed, that each plant-specific thing is influencing an industry average. There are a lot of practical difficulties with that, but there is also questions of fairness if you will that if the industry average is dictated by a few plants, then other plants could perhaps do a great deal to change their risk or their core damage frequency and you wouldn't see any change in the industry average. But the plants that are already up near the top would have essentially no ability to move around and that type of thing.

So there were many such very practical issues that led us to conclude that option 2 wasn't a very good idea, that it's better to bite the bullet if you will and say that we ought to make -- to try to apply these on a plant-specific basis, and say that we need to move on if you will beyond this interest in maintaining the generic nature of the goals.

It's probably also worth noting that the Commission I don't think has ever told us not to use the goals on a plant-specific basis. What they've tended to say was if you want to do it that way -- our intent is that they should be used generically. But if you want to use it, then you ought to come back to us and talk to us about it before you go forward with it.

The third option of taking the present reg. analysis guidelines verbatim has a couple of problems with it. One of them was talked about a little this morning, is the difficulties in using a conditional probability of containment failure, that the .1 there is -- it has its own advantages, but it has some disadvantages as well.

The other aspect of it is that the guidelines were established in backfit space I think with the expectation that you would have a relatively small number of changes associated with any one particular plant, or a relatively small number of changes, so that the delta core damage frequency calculation would be -- you would only do those delta calculations every once in a while.

If you have the situation we're in where we're looking for changes to licensed, especially in the area of relief, you could have many, many deltas. And what you quickly run into is to say, "Well, when is the second delta unacceptable?" At some point, these are going to start to accumulate, and the concept of using a delta CDF is just -- it's very clumsy to work with, basically. So that was our rationale for not trying to strictly stay with the reg. analysis guidelines.

The fourth one, then, I think, again, there is two parts. I don't think we at least don't seem to think it's necessary to reopen the issue of the safety goals. We think, you know, to deal with such issues is a societal risk. From our perspective, we think we can go forward with this idea of using the safety goals in plant-specific applications without having to take that step.

And then the site characteristics -- I guess, again, we're probably -- I think it's a more practical thing to try to work from -- trying to come up with one that tends to envelope the goals.

Joe?

MR. MURPHY: Well, I'd like to add one more thought on the societal aspect that affected us back in the early days. Basically, it's almost a political problem with telling an individual that lives near a low population site that on an individual risk basis we are willing that that individual have a higher risk than an individual that lives near a site that has a higher population. That creates a very interesting political problem in terms of how you interpret the safety goals.

CHAIRMAN APOSTOLAKIS: Well, you could have both an individual and a society risk criterion, right? And you go with the one that's most --

MR. MURPHY: Well, you could set a ceiling on the individual risk, yes.

CHAIRMAN APOSTOLAKIS: Yes. The only member that is absent today is Mr. Lindblad, and I remember he and Jay Carroll were the ones that insisted that in our letter we say that the Commission should consider restatement of the safety goals. But tomorrow I understand he'll be here, so this -- he can explain the word "restatement."

I don't know. It seems to me your initial choice makes sense. I can't think of anything that would go against it. Usually these things come late at night when we try to sleep.

(Laughter.)

Does any member have any questions or problems?

MEMBER FONTANA: Number 1 makes sense to me, provided you don't use the conditional containment failure probability and use the large early release instead.

MR. CUNNINGHAM: I think one of the things --

just for what it's worth, I think one thing that was mentioned this morning that we may have said we would talk about this afternoon was the idea of the core damage frequency as a subsidiary goal, and that versus having it kind of put at some level akin to the quantitative health objectives, because the CDF goal is not discussed in the -- it's not cited in the policy statement. It's alluded to, but it's not cited in the policy statement.

MEMBER KRESS: That just amounts to a creative interpretation of the policy statement, I think, to do it that way.

CHAIRMAN APOSTOLAKIS: Maybe in the restatement they should include core damage frequency --

MEMBER KRESS: Yes.

CHAIRMAN APOSTOLAKIS: -- because you seem to agree with what Rick Sherry said this morning regarding the multi-objective approach. Multi-objective, you know, we can have three objectives up there, and explain how they are to be used.

CHAIRMAN APOSTOLAKIS: Yes. The safety goal policy statement as it is now takes steps along -- in that direction if you will, because -- you know, one of the issues that also came up kind of late in the debate of the safety goals is whether or not we should have a goal which explicitly says the goal shall be we will not have any core melt accidents in this country. And they kind of state that in the policy statement, but the idea that it goes to say what does that mean in terms of a quantitative sense is left to other documents and things like that.

CHAIRMAN APOSTOLAKIS: I would like to see the core damage frequency up there with everything else.

MEMBER KRESS: I would like to see it as --

CHAIRMAN APOSTOLAKIS: As a practical matter, I don't think it would make any difference.

MEMBER KRESS: And if you look at Rick's tables and goals, what you find out is essentially you are dealing with CDF and LERF. And those QHOs are just sitting over there not doing anything for you. And the problem I have with that is where they would help out is if those were really the overriding goal you could relax one or the other CDF or LERF, and you're going to get back into this question of what -- his concept was you use the one that controls.

Well, there will be some debate as -- shouldn't the QHO actu~lly control, and you allow relaxation, say, of the LERF, for example. And I think that's a legitimate question to bring up.

MR. CUNNINGHAM: We may get back into that in a few slides when we talk about the risk neutral versus increases, and things like that.

MEMBER POWERS: One feature about the quantitative health objectives that's different from all of the subsidiary goals that have been discussed is that it's time variable. That is, as society itself becomes safer over time, that goal keeps moving down. Whereas, everything else you've discussed is fixed. It doesn't change. And somehow that time variability seems like basically a good idea to me.

MEMBER KRESS: It's also site specific. That's --

MEMBER POWERS: Oh, yes. Site specific, yes.

MEMBER KRESS: That's the other thing that it has.

MEMBER POWERS: And none of the subsidiary goals that have been identified up until now carry that interesting component, those interesting components along with them. Nothing that is operationally useful in the PRA analysis gets carried along very well there.

CHAIRMAN APOSTOLAKIS: Why do you say it's site specific?

MEMBER KRESS: Well, it's site specific if you're applying it on -- the acceptance criteria on a site-specific basis. Then, those numbers you get will depend on their site, those values you get.

CHAIRMAN APOSTOLAKIS: So if in a particular place they smoke a lot we will have to have higher goals, right? Because they're --

MEMBER KRESS: That's the implications of what I'm saying, yes.

CHAIRMAN APOSTOLAKIS: I doubt that that will --

MEMBER CATTON: They'd have to do better, because some people would die from the smoking.

CHAIRMAN APOSTOLAKIS: You'd probably have national --

MR. CUNNINGHAM: Yes.

CHAIRMAN APOSTOLAKIS: -- statistics, I think.

MR. CUNNINGHAM: Yes, that's the way --

CHAIRMAN APOSTOLAKIS: I don't know how you're going to use site-specific accident rates.

MEMBER KRESS: Even if you use national accident rates to define the goal itself, evaluating whether or not you meet that goal will depend on the site.

MEMBER POWERS: Well, it is absolutely true that the assessments that you can get on natural causes or other accidents are usually broken down by region. For some reason, people in the south are very dangerous compared to people in the west.

MEMBER KRESS: Yes, we're less risk averse.

(Laughter.)

MEMBER POWERS: It's that moonshine, I think, that --

(Laughter.)

MEMBER KRESS: But that wasn't what I had in mind. I had in mind on assessing --

(Laughter.)

-- the risk as opposed to setting different values to it because of regional differences in the normal incidence of those things. I had in mind just assessing the risk, assessing whether you meet those risks.

CHAIRMAN APOSTOLAKIS: Site specific.

MEMBER CATTON: Did I understand this morning that population and meteorology are not a part of this?

CHAIRMAN APOSTOLAKIS: They're not.

MEMBER CATTON: How can you do something site specific that has health objectives --

MEMBER KRESS: That was my point, yes.

MEMBER CATTON: -- without including meteorology? I mean, look at Diablo Canyon. It's a thousand miles from anywhere. They ought to be able to do things in a little looser manner than Indian Point, for example.

MR. CUNNINGHAM: I think that was Dr. Kress's point.

MEMBER KRESS: That was my point, exactly.

MEMBER CATTON: I didn't get back in time.

MEMBER FONTANA: That's a theory.

MEMBER SEALE: That's a blunt sword, though. It can hurt you in another way, because, I mean, look at us. We're in the process now of having to change airports around, and so on, because idiots want to live underneath the approach and then complain about the noise. So far, no one has decided that it's attractive to live downwind for a nuclear power plant as a matter of preference. But we don't know that that won't be the case some time down the road and --

MEMBER KRESS: You'd get a better tax rate that way.

MEMBER SEALE: Yes, as a matter of fact, for certain industries and so on. And so to assume that a site characteristic is stable in that regard I think is maybe a little risky thing to do.

MEMBER KRESS: You just let that be part of your time variable that Dana threw in and just reassess it with time.

MEMBER CATTON: Then, what do you do that's meaningful with health objectives? They don't mean anything. If the population density doubles, what do you do? You can't refuse the same old number.

CHAIRMAN APOSTOLAKIS: You do.

MEMBER CATTON: I know you do, but you shouldn't.

MEMBER KRESS: You do, and you can, but you shouldn't.

MEMBER CATTON: In Los Angeles, the airport people had to buy a lot of houses.

MEMBER SEALE: The runway in Tucson keeps moving further and further out in the desert, because there is nothing on that end, and they keep coming in on the other end.

MEMBER CATTON: Well, that's because your local politicians bought the stuff on that end, and now they're selling it to the airport. But that's a separate problem.

MEMBER FONTANA: Well, there are two facts at work here. One, my analogy with the airplane allowable safety -- the accident rate of airplanes in 1948 was perfectly acceptable. I mean, everybody flew. But you knew there was going to be so many more airplanes, so many more flights, that if you had the same accident rates you'd have an accident every week and it would still be acceptable. But with respect to the media, it wouldn't.

And the same thing goes with reactors in a way. We're not going to have a lot more reactors in the near future, but on the other hand an accident anywhere is an accident everywhere. So in de facto, if you have an accident out in the middle of Arizona where nobody except Bob lives, that doesn't make any difference whether it's --

MEMBER KRESS: And he's expendable, right?

MEMBER POWERS: He's probably here.

MEMBER FONTANA: The goal has to be very, very, very low. And, in effect, the results have to be zero.

MEMBER MILLER: Are you arguing for option 1 or --

MEMBER FONTANA: Option 1 is good. Option 1 is a good --

MEMBER MILLER: So you're -- site characteristics because they really don't make any sense.

MEMBER FONTANA: Well, they do make sense, I mean, in a perfectly logical world. But, in fact, I think --

MEMBER MILLER: In the world you described they don't make sense.

MEMBER FONTANA: Yes.

MEMBER MILLER: I agree.

CHAIRMAN APOSTOLAKIS: The other question I think that was just raised is should these goals be tied to the total number of plants in the country? I mean, again, it's a very unlikely occurrence. But let's say that there is a crisis or something, and all of a sudden there are a hundred other plants in the works. Would the goals remain the same, or should there be a statement, "Given more or less the picture we have now, these are the safety goals"?

MR. HOLAHAN: If you go back to WASH 1400, there was -- imaging there being 500 or 1,000 plants --

CHAIRMAN APOSTOLAKIS: 1,000.

MR. HOLAHAN: -- 1,000 plants, and, in effect, the approach taken there was to say, "Well, we'll somewhat arbitrarily, but in a guesstimated sense, to say that future plants will probably be 10 times safer than the current generation." And so there won't be a continuing escalation, accumulation of risk, that the future plants will, you know, accumulate some risk but it won't accumulate a lot more than the existing collection of plants.

MEMBER MILLER: We're kind of already seeing that. If we, say, went out and built 1,000 AP600s next week, in core damage frequency they are supposedly, what, 10^{-6} -- is that -- if I remember the numbers. We'd be exactly what you're talking about, right? Current plants are 10^{-4}, and the next ones are 10^{-6}.

CHAIRMAN APOSTOLAKIS: No, 5, I think.

MEMBER MILLER: Or 10^{-5}, which is -- 5 is -- 10^{-5}, you're right, as an expectation.

CHAIRMAN APOSTOLAKIS: Right.

MEMBER MILLER: In other words, the Commission was faced with this issue when the idea of evolutionary and advanced reactor certification came up. And, in fact, certification means you could build as many as you like effectively, and the Commission decided not to, you know, reduce its goals from 10^{-4} to 10^{-5} to 10^{-6}, but set some expectation that future plants would be safer.

And the industry and EPRI guidelines have picked that up, and it basically recommended a 10^{-5} goal instead of a 10^{-4} goal. And it looks like that's what advanced reactors are probably providing, and maybe even exceeding that expectation. So I think if someone proposed to build a hundred more plants like the existing plants, then probably that same thinking would come into effect, to say that it doesn't make sense to have a hundred more plants like the existing ones.

I think we would -- you know, I'm speaking for the -- you know, I want you to imagine the approach would be. But I would imagine if a lot more plants were proposed the Commission would have some expectation that those would be substantially safer than the existing plants.

CHAIRMAN APOSTOLAKIS: But shouldn't there be some sort of a statement in the policy statement for that -- instead of saying, you know, it should be one-tenth of one percent of existing accident risks? Maybe something which is more general and say, "And given the present and foreseeable situation in the country," something like that.

MEMBER FONTANA: Yes, that's a neat way around the argument. That's a neat way around the argument when people say -- you hear people argue about the advanced plants being so much safer and they say, "Well, gee, it makes our old plants look unsafe," which they're not. This is an argument where you can justify going to advance more safer plants, because we're going to have a lot more of them. Great. Good thinking.

CHAIRMAN APOSTOLAKIS: Because why?

MEMBER FONTANA: Because you have more of them, you can justify an argument that these plants are more safer than the old plants, and then it's -- and the utility guys can't say, "Well, gee, you're making my old plant appear to be unsafe."

CHAIRMAN APOSTOLAKIS: Well, that's something to think about. I mean, whether -- since we're talking about a restatement of the goals, why don't we say something to the effect that this is the -- given the current picture and --

MR. CUNNINGHAM: I don't recall the policy statement really saying something like that. That's --

CHAIRMAN APOSTOLAKIS: It doesn't.

MR. CUNNINGHAM: Okay.

CHAIRMAN APOSTOLAKIS: So I'm raising a new issue. But it will probably -- you remember there were some calculations several years ago -- I think it was Commissioner Aselstein that was behind them -- said, you know, take the 10^{-4}, multiply it by 100 plants, and you end up with a probability of .01 per year.

MEMBER MILLER: Or every --

CHAIRMAN APOSTOLAKIS: Yes. So in 50 years or so you are beginning to have a serious probability of an accident somewhere.

MR. CUNNINGHAM: Yes.

CHAIRMAN APOSTOLAKIS: So the Commission may want to think about it.

MR. MARKLEY: I think there's one thing that's important to consider here, and that's the NRC is being criticized over the years for having rising expectations in a variety of programs. And that's something just to think about in considering stuff like this.

MEMBER KRESS: Is that what we call ratcheting?

CHAIRMAN APOSTOLAKIS: Well, another question is it may be more appropriate to discuss it in the next issue, which is uncertainty, but --

MR. HOLAHAN: Before we leave this one, could I go back to --

CHAIRMAN APOSTOLAKIS: No, we're not leaving this one. Oh, yes, go ahead.

MR. HOLAHAN: Okay. Dr. Kress's concern about site-specific characteristics and meteorology and all -- I mean, I don't like those as a substitute for CDF or large release type of goal, because I think it leaves out some defense-in-depth and prevention concepts. But I don't object to it as an additional check in the process.

I mean, for example, you might have a CDF guideline, but you might also expect licensees to use site-specific meteorology and population to check to see whether health objectives on a site-specific basis, you know, were going well beyond what we imagined, or were becoming controlling.

MEMBER KRESS: Well, that would be what -- if you followed Rick's three things, that would automatically come out of that. What I was concerned --

MR. HOLAHAN: With site-specific parameters.

MEMBER KRESS: Yes, that -- with -- yes, you'd have to go back. You'd have to do the QHOs correctly, and that would have --

CHAIRMAN APOSTOLAKIS: So site specific means population or meteorology, or both?

MEMBER KRESS: Population and meteorology, both.

CHAIRMAN APOSTOLAKIS: But in what Rick presented it was only individual risk.

MEMBER KRESS: Well, he had --

CHAIRMAN APOSTOLAKIS: So the number of people is irrelevant, isn't it?

MEMBER KRESS: He had the QHOs in --

CHAIRMAN APOSTOLAKIS: I think it would -- you would need the fourth box.

MEMBER KRESS: He had a QHO as the top level, and you --

CHAIRMAN APOSTOLAKIS: Yes, but the way they're stated now are on the basis of individual risk.

MR. HOLAHAN: Yes. You would --

CHAIRMAN APOSTOLAKIS: So whether you have a million people or one person, it doesn't matter.

MR. HOLAHAN: Right. You're saying.

CHAIRMAN APOSTOLAKIS: Meteorology is there anyway.

MEMBER KRESS: I think the population ought to come into that also.

MR. CUNNINGHAM: The population does come in in a funny sort of way, if you look at the probability of the wind blowing over population centers, and things like that, so that can affect the average --

MEMBER KRESS: Right.

MR. CUNNINGHAM: -- but that's kind of an indirect effect.

CHAIRMAN APOSTOLAKIS: But it's still individual risk.

MR. CUNNINGHAM: It's still individual risk.

DR. SHERRY: The individual early fatality risk is not impacted by the total population within my model, but how the population is distributed within that, and particularly in relation to the wind direction frequency.

MR. CUNNINGHAM: Right.

MEMBER KRESS: The other thing about that is is that works only one direction. Make sure you don't exceed that, but --

MR. HOLAHAN: Yes.

MEMBER KRESS: -- but there is a point that if you're well below that, and just barely meet these other two, that there might be incentive. What I was saying, there might be reasons to want to do some changes that go the other way, and that's not accounted for in Rick's thing at all.

MR. HOLAHAN: I'm less inclined to agree to that part.

MEMBER KRESS: Yes, well, I am too. But the industry might want to --

MEMBER CATTON: What would you do if Diablo Canyon -- if they decided to sell off some of that farmland? You know, I don't know how far away the gate is, but it seems like --

MR. HOLAHAN: I think it's seven miles.

MEMBER CATTON: If they wanted to pull it in to two miles -- and that's really nice land up on that hill looking over the water. Can't you imagine a --

MR. HOLAHAN: I'm going next week.

MEMBER CATTON: -- 5,000 square foot house sitting up on top of one of those rocks?

MEMBER MILLER: Have you got it planned yet, Ivan?

(Laughter.)

MEMBER SEALE: He's still paying for his old house.

(Laughter.)

MEMBER CATTON: That's right. It'll be a while.

MR. HOLAHAN: But I think the point is that, I mean, we're trying to reflect social values in our decision, and that means not just health effects. And regardless of the remoteness of Diablo Canyon or Palo Verde, or whatever, you're trying to judge whether society wants to have a core melt every once in a while even if no one is killed by it, and whether society wants the water to be polluted in California, even if no one is drinking it.

In our judgment -- and this is by its nature a policy matter, so it's not -- I mean, there aren't any calculations involved. As a matter of policy, I think we are recommending that core melts are bad business, and so that we think you should have a policy that's against them, even if nobody lives there.

MEMBER SHACK: Amen.

MR. HOLAHAN: And I think large release, to my thinking, is the same nature. And that's why you ought to have, you know, three types of goals or guidelines, or whatever you want to call them.

MEMBER KRESS: I think we agree with you on that.

MEMBER MILLER: Core damage also represents a financial risk.

MR. HOLAHAN: That's fine.

MEMBER MILLER: Not --

MR. HOLAHAN: But I don't think that's what society is worried about. The bankers are, but --

MEMBER POWERS: When you speak of what society is worried about, you see a lot of discussion at least about land contamination, but that seems to be a thought that the Commission in formulating their goals chose to -- I can't say neglected exactly, but deemphasized it substantially, yet it's pretty clear from any consequences -- issues you've seen that the biggest effect of a nuclear power accident is, in fact, land contamination and that indeed society worries about that.

And we get fairly graphic evidence of towns in Russia that are unoccupiable for the next 50 years, and things like that seem like an undesirable thing. And you see in the European -- Western European countries where they have taken land contamination, in fact, more seriously than they have human dose effects.

What is your thinking about that? And when you go to an individual plant, you've got some latitude now to redress history a little bit.

MR. CUNNINGHAM: I guess if we go back to what we're thinking about in option 1, we're just saying we don't think we need to -- in order to accomplish what we're trying here in plant-specific applications, we don't need to revisit those issues. We think we can implement it as it is. It's a --

MEMBER POWERS: It's the way you view societal risk. You say --

MR. CUNNINGHAM: Yes, that's right.

MEMBER POWERS: -- "It's a step beyond, and I'm not prepared to take it."

MR. CUNNINGHAM: And if the Commission chooses to get into that that's -- you know, they've discussed many of those -- previous commissions have discussed that many times, and this committee -- previous incarnations of this committee have discussed that many times. And it kind of came to whatever the policy -- whatever happens to be the policy statement as it was set up 10 years ago.

MR. HOLAHAN: My personal view is I think those are worthwhile things to pursue, but I think they will take a long time. If we really do tackle them, I wouldn't want to hold up other things we're trying to do in using risk insights to wait for those issues to be sorted out.

MEMBER KRESS: Yes, that may take a long time.

MR. HOLAHAN: Kind of the difference between -- you know, what we said is our major objective in all of this is to make better regulatory decisions, and I think we can make better decisions without solving societal risk and land contamination issues. But maybe we can make, you know, best decisions if we were to tackle those issues. I just wouldn't want them to be impediments to making progress in the next couple of years.

MEMBER MILLER: I think that's a good point, that using option 1 we can make a lot of progress today and wait for -- whatever other option we may wait for five years and may miss a lot of opportunities.

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: Is it really the issue whether the Commission's goals can be referenced, or that they should be? I mean, they can.

MR. CUNNINGHAM: Well, there's both parts. One is there should be, because we're trying to back away from a generic use. And then this can be is that, practically speaking, can we come up with some sort of criteria? Or do we get ourselves into the box that happened a few years ago on the 10^{-6} of a large release, where it just -- it really couldn't be used in any practical sense without having to redefine the QHOs. So there is both elements to it.

CHAIRMAN APOSTOLAKIS: Hasn't the question of can been answered already in the generic applications?

MR. CUNNINGHAM: For --

CHAIRMAN APOSTOLAKIS: It's really a matter of should.

MR. CUNNINGHAM: I think it's a matter of should. It's probably more a matter of should now, yes. It's not a capability issue. It's a policy issue, not whether --

CHAIRMAN APOSTOLAKIS: Yes. I get the impression that you have a favorable committee here with option 1.

I started saying earlier that there is one other issue that perhaps belongs to the next issue, but this is the completeness of the risk assessment. When you state -- when a federal authority states a safety goal, should that authority worry about the capability of the technology to assess the appropriate metric and then compare it with the goal?

Now, Mark told us some time ago that sabotage, for instance, is excluded. And I assume it will be excluded here, too. Is there anything else, or should there be a statement? I mean, if I were to go by the letter of the law, and I saw a safety goal that said, you know, core damage frequency such and such, and I go out and they tell me that it's a consensus among the experts in the field, that there are several issues which are not in the PRA -- we had one earlier, the quality assurance. You know, it's not clear how it affects it, if there are other issues related to the organization, and so on.

But if I went by the letter of the law, I would shut them down, say, "You can't demonstrate you are meeting the goal." And yet we don't do that. So I wonder whether there should be something in the statement that gives some flexibility.

MR. CUNNINGHAM: Well, part of that it's just -- the nature is this is a statement of policy which is not a regulation, and that type of thing. So there is -- you don't have a legal basis to shut somebody down, because they don't meet the safety goal policy statement.

MR. HOLAHAN: Well, at the moment, it isn't possible not to meet the policy goal statement, since it doesn't apply to individual plants.

CHAIRMAN APOSTOLAKIS: But if it does --

MR. HOLAHAN: Well, if it does, that's why you have to be clear about what it is. Is it a guideline, or is it something else?

CHAIRMAN APOSTOLAKIS: Well, so this, then, a question that should be addressed in this first issue.

MR. HOLAHAN: Yes.

MR. CUNNINGHAM: Yes.

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: We have not addressed it, though, have we? Or have I missed it? When you say "goals," you assume that everybody understands what the goal is as opposed to a criterion?

MR. HOLAHAN: Yes. I think that was implicit in what we were --

CHAIRMAN APOSTOLAKIS: Okay.

MR. HOLAHAN: -- where we're coming from.

CHAIRMAN APOSTOLAKIS: And Gary just raised a couple of good questions. Does this mean that you can shut them down if they don't meet -- I mean, okay, a goal is something that you really don't have to meet verbatim so to speak. You don't have to be exactly below 10^{-4} --

MEMBER SEALE: You aspire to the goal of --

CHAIRMAN APOSTOLAKIS: You aspire to it. But at which point do you draw the line and say, "Hey, enough is enough"? Is that part of the policy statement, or is it a technical issue that is for later?

MR. HOLAHAN: I think the way I envision it plants have a current license. Presumably, they are meeting their current requirements, so the burden of proof is on the staff to say the plant is not safe enough to continue to use the license it has got. I think the regulation that applies in this case would probably be 50.109 -- in other words, a backfit requirement. Either the plant should do more or -- be required to do more or shut down.

We have an existing regulation that calls for such a backfit analysis to demonstrate a substantial improvement and cost justification. And we have some guidelines currently on how to do that. It seems to me that when we write, if we write, plant-specific safety goal or safety, you know, guidance criteria it will influence how we implement 50.109.

The goals that we expect people to use in making their decision seem to be the same guidance that you use in implementing the existing regulation. But I think because you had a policy it wouldn't automatically do anything to the plants. It would just give some guidance as to how would the staff go ahead and use the existing backfit requirements to say, "We expect more of these plants."

CHAIRMAN APOSTOLAKIS: Would or should there be a statement there regarding unacceptability? I mean, okay, the goal is something you are striving for. But a factor of 10 higher than that, it's a no-no, or you don't want it.

MR. HOLAHAN: Well --

CHAIRMAN APOSTOLAKIS: Or you would rather leave that up to the judgment of the staff?

MR. HOLAHAN: I would rather leave that up to the regulations.

CHAIRMAN APOSTOLAKIS: How about time?

MR. HOLAHAN: Because that's very much a regulatory decision. I'd rather not handle that in the policy.

CHAIRMAN APOSTOLAKIS: We heard earlier today a presentation where CDFs were presented on a per day basis. We --

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: What if that number is significantly higher than the goal, but it's only for three days a year? Now what do we do?

MR. HOLAHAN: Well --

CHAIRMAN APOSTOLAKIS: In other words, can we deviate from the goal significantly for very short periods of time? Or that's, again, part of lower level guides?

MR. HOLAHAN: I think your goal is the same, and to me the goal is not only expressed in units of per year, per reactor year, but it really means the average over a fairly long period of time, a year or a cycle. So these individual deviations don't bother me as long as they don't accumulate to the extent of, you know, exceeding the guidelines. And so I would expect, you know, the frequency, of course, will exceed the yearly average every once in a while.

CHAIRMAN APOSTOLAKIS: See, that's --

MEMBER MILLER: The question is how much would you --

MR. HOLAHAN: Well, because of the shape of the curves, I think it's probably high spikes of small frequency.

CHAIRMAN APOSTOLAKIS: One day in a year is 1/365th, right?

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: So for one day --

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: -- a plant has 365 times 10^{-4} core damage frequency. How much is that? 3.65 times --

MEMBER SEALE: So it's .03.

CHAIRMAN APOSTOLAKIS: Yes.

MR. HOLAHAN: Well, at a certain point, the arithmetic doesn't work. But --

CHAIRMAN APOSTOLAKIS: Well, but I'm taking an extreme case.

MEMBER MILLER: Well, taking an extreme -- just multiply it --

CHAIRMAN APOSTOLAKIS: So in one day I have a core damage frequency which is almost 400 times greater than the goal. The average --

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: -- over the year is still --

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: -- now what do I do?

MR. HOLAHAN: If you really believe in probability theory, it doesn't make any difference.

CHAIRMAN APOSTOLAKIS: Well, I don't.

(Laughter.)

Have you ever been to Las Vegas?

(Laughter.)

MEMBER CATTON: It gets even worse if you consider taking something off line for an hour. You get almost a one. So --

CHAIRMAN APOSTOLAKIS: I mean, no, if you really believe in probability theory, you know what a mean value means. So, you know, you know that a mean is a mean, and you can have extremes, and so on.

And, in fact, that's -- if you look at the famous gambler ruin problem, that's what is killing most people at gambling places. Their variance is so large that they hit their ruin point before the casino, because the casino has infinite resources. It's a classic mathematical problem.

MR. HODGES: Some of that is also why we try to maintain more than just limits on the core damage frequency and some other -- you also talk about maintaining defense in depth --

CHAIRMAN APOSTOLAKIS: Yes.

MR. HODGES: -- and other parts of -- other limits.

MEMBER MILLER: Your current deterministic regulations will limit the case that George talked about prior to --

MR. HODGES: They don't --

MEMBER MILLER: Yo. can't take three out of four channels out of service for one hour.

CHAIRMAN APOSTOLAKIS: Yes, but then people may come back and argue on the basis of the average core damage frequency that, in fact, they can do that.

MEMBER MILLER: No, they --

CHAIRMAN APOSTOLAKIS: Then you have the defense in depth weapon.

MR. CUNNINGHAM: Right. That's why we have the deterministic and the probabilistic aspects of this.

CHAIRMAN APOSTOLAKIS: So what you are saying is that this may be an issue that would be handled at the lower level. It doesn't need to be mentioned.

MR. HOLAHAN: I don't think I would handle it as a matter of policy.

MEMBER MILLER: If we were totally on a risk-based situation, we might have to worry about it. But as we've got other things going on --

CHAIRMAN APOSTOLAKIS: Again, I mean, I gave you an extreme example. But it doesn't have to be so extreme, right?

MR. HOLAHAN: If you remember NEI's guidelines, they have chosen a limit for themselves that they don't want to exceed, you know, for any period.

CHAIRMAN APOSTOLAKIS: Well, I thought that was from the average, too.

MR. CUNNINGHAM: Well, they had temporary, and then they have permanent changes. So they put some constraints on it in terms of the temporary changes, too.

MEMBER KRESS: What were the temporary ones, 10 percent?

CHAIRMAN APOSTOLAKIS: So it seems to me that we agree with the staff's opinion. And the only person absent is Mr. Lindblad, and he'll hear about it tomorrow.

MEMBER POWERS: Who never has unique views.

(Laughter.)

CHAIRMAN APOSTOLAKIS: So don't worry about it.

(Laughter.)

This is uncertainties.

MR. CUNNINGHAM: Uncertainties. Again, we talked about this last month when we laid out three options for dealing with uncertainties in the calculations and things. And the first was to allow point estimates but build in margins, if you will, within the guidelines to reflect the fact that, you know, there is a difference between point estimates and mean estimates and other such things.

The second was to go in and define how to use uncertainty analysis -- for example, using the concepts of mean values.

A third was to utilize sensitivity analysis. If I recall correctly, at least the third, in and of itself, was not highly regarded by members of the committee the last time.

So our idea is we're looking at option 2 now. I thought what we would do is --

MEMBER CATTON: But you don't want to preclude option 1, do you? If somebody comes in and says, "I don't want to do the PRA," we all agree that what I'm doing here has sufficient margin --

MR. CUNNINGHAM: No, this --

MEMBER CATTON: And that's sort of embodied in 1.

MR. CUNNINGHAM: Yes, it doesn't preclude option 1.

MEMBER CATTON: Okay. And again, you don't want to -- I mean, sensitivity analysis by itself doesn't make much sense. But combined --

MR. CUNNINGHAM: Yes.

MEMBER CATTON: -- with something else to make arguments why you don't have to do something that fits into -- becomes a part of 1. I don't think there's three distinct options here. But the focus should be on 2, I think.

MR. HOLAHAN: One of the things that we continue to come across is when we talk about the policy issues we end up arguing over a lot of matters that don't really show up in some of the applications. And we end up arguing over the hard cases, but there are a lot of easy cases. And I think where an application comes in and it's pretty clear that it's an improvement, a lot of the concerns about how did you calculate that, and what is its overall effect, are not really such big problems.

And so if there's a point estimate, or even a qualitative argument -- I mean, I would hardly turn down another diesel being added to the site because you didn't have enough analysis and uncertainty considerations.

MEMBER CATTON: You'd buy the margin option.

MR. HOLAHAN: Well, you know, what I'm trying to do is have analysis methods which are appropriate to the type of decision that is being made.

MEMBER CATTON: Exactly.

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: I think one of the issues that really should be discussed before you consider the options is -- unless it is already in the back of your mind, is there are two kinds here -- or not two kinds, that's a bad word. We have uncertainties in things that we have already modeled in the PRA and uncertainties due to the fact that some things we have not modeled.

I think the Commission statement here really refers to what we have modeled, because they talk about mean estimates. I mean, to get those you have to have a model.

MR. CUNNINGHAM: That's right.

CHAIRMAN APOSTOLAKIS: So it seems to me that if we go back to your slide 5, you say you prefer option 2 utilizing mean values, but that implies you have already some sort of a distribution. Shouldn't we discuss first, you know, how are uncertainties to be accounted for? Things that are not modeled, what are we going to do about those, and then things that are modeled.

And I think for the second model, as we agreed with you, there may be some details, but basically you have the answer.

MR. CUNNINGHAM: Okay.

CHAIRMAN APOSTOLAKIS: Things that are not modeled, though, are really something that is new, and I don't know how to handle it myself. But we certainly have to say something about it.

For example, you may have another series of options. If the goal is 10^{-4}, do you want to use a working value of 6 times 10^{-5}, for example, so that, you know, the remaining is there for things that we have not included in the PRA? I don't know. But that certainly is a different arena.

MR. CUNNINGHAM: I think you're right that what we've been thinking about here is using mean values and things like that --

CHAIRMAN APOSTOLAKIS: Yes.

MR. CUNNINGHAM: -- for what you can model in a PRA. The issue of what is unmodeled, you can use the example that you've used, or you could argue that it has -- I think it was talked about earlier this morning, if you have a 10^{-4} core damage frequency, then inherently there is margin there compared with the QHOs. So that in one sense that that may be -- to some degree, that protects you against --

CHAIRMAN APOSTOLAKIS: But that downgrades, again, the core damage frequency.

MR. CUNNINGHAM: Yes, it does. That's exactly right. It does.

CHAIRMAN APOSTOLAKIS: Which we didn't want to do.

MR. CUNNINGHAM: That's right.

CHAIRMAN APOSTOLAKIS: Another approach --

MEMBER KRESS: And defense in depth also is --

CHAIRMAN APOSTOLAKIS: Another approach is exactly to say the danger with that is, of course, that if you say that things that are not modeled will be handled through defense in depth, there may be a discouragement there from trying to actually model that.

MR. CUNNINGHAM: Yes, very true.

CHAIRMAN APOSTOLAKIS: So I don't think it's an easy topic, but really it deserves some -- I think the words will be significant. Clearly, you have to use defense in depth -- I mean, there is no question about it -- and deterministic analysis, good engineering practice, and all of that. But at the same time, there ought to be an effort to try to bring them into the PRA to the maximum -- I don't know how you would bring quality assurance. I mean, I really don't. And whether you would be able to see results.

MR. HOLAHAN: It seems to me that there is a related issue, which is if there are things that you don't model or can't model for a good reason, like you don't understand them very well, I mean, these may not be the best topics for risk reduction. It seems to me maybe we should be, you know, focusing on the issues that we understand, you know, better and that are, you know, naturally modeled and have more data supporting them, you know, in the analyses.

So when it comes across that there is some issue that isn't modeled very well, I'll be suspicious that that's -- maybe this is not the best candidate for changing the requirements.

CHAIRMAN APOSTOLAKIS: Well, that's one point of view. Another point of view is that very frequently these are the things that get you. And if you look again at the eight incidents in the control room that Mr. Pate had in his talk, a lot of the stuff that he describes there really is not modeled in the PRAs. A supervisor got involved in the details, and he was not supervising. I mean --

MEMBER SEALE: The whole human factors arena --

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER SEALE: -- that's rampant.

CHAIRMAN APOSTOLAKIS: When we do that, then we don't model it. So I don't know. I mean, defense in depth is for sure something. So one of the obvious suggestions is before you list your options here to address the issue of what is modeled and what is not modeled, and maybe develop a new list of options perhaps and think about it. But --

MR. HOLAHAN: We have a scope question, and there is some relationship between scope and uncertainty issues we have to sort out.

MR. CUNNINGHAM: That's right. We have -- there are scope and other things that we can do, though, and then there is the "other" category, as somebody calls it, some people call it sometimes.

CHAIRMAN APOSTOLAKIS: Actually, maybe there are three categories. There is one in between. You have the things that we model, and maybe we are comfortable with -- don't ask me what "comfortable" means -- things that are completely left out, and then you have things in between that are perhaps controversial. There are a number of models out there.

We rely a lot on expert opinion. We don't mean there that you will take the mean value of everybody's opinion, I mean -- so when there is significant model uncertainty, perhaps again we have to worry about how to account for uncertainties. I mean, in level 2, we certainly have one or two there that model uncertainty is significant.

MR. CUNNINGHAM: One thing we've talked about in that respect is that if you have something, you know, for example, a level 2 phenomena, then you could argue -- we could make the case in the reg. guide that says, "As you get to this point, you will use this model, unless you can argue why it's not applicable to your plant."

And if it's acceptable, then you go on, and it just -- you may perhaps have to define that model in some sort of a bounding way or something like that, but you just say it's -- "if you use this, it's acceptable," and then you go on. That's one way to deal with it.

MEMBER CATTON: Sounds like an ACRS letter some time ago.

CHAIRMAN APOSTOLAKIS: But the problem with that might be that you can -- you may not be able to define that model, and that's why many times, you know, in 1150, and so on, you went to expert opinion in --

MR. CUNNINGHAM: That's right.

CHAIRMAN APOSTOLAKIS: -- the solicitation.

MR. MURPHY: If I can add a thought, 1150 I think gives you an interesting historical perspective on this. In 1150, we used expert opinion a lot, and it was necessary to give us an estimation of the risk. In terms of making a regulatory judgment as to how we went further, we felt that that was not adequate for that regulatory judgment. So there was more research done, and we used a different methodology. We used ROAMM to try to narrow those uncertainties down and to understand the thing better, so that we had a better basis for making the regulatory decision.

So there is a different question in making the regulatory decision and in making an estimate of the risk. And one leads to the other but not necessarily exactly the same -- so we had to move forward and do something different.

And I think another example of what you're talking about is in the regulatory analysis guidelines. At that time, we were working more in terms of the 10^{-6} for early releases as we put the thing together. But if you looked at the blocks in the matrix associated with the regulatory analysis guidelines, you'd find that they are off by an order of magnitude. That was intended. That order of magnitude was a completely subjective determination put in there to account for the kind of uncertainties that we're talking about, the uncertainties that aren't modeled.

CHAIRMAN APOSTOLAKIS: I fully agree with what you said. The question is, what do you do here? I mean, an option would be there to say we'll do more research. I don't know whether that's an option here for the commissioners. I mean --

MR. CUNNINGHAM: From the Office of Research, that's always an option. But --

(Laughter.)

MR. HOLAHAN: As a regulatory decision, you could decide there are some topics on which we're not prepared to change our requirements in the absence of additional research.

MR. CUNNINGHAM: Yes.

MR. HOLAHAN: And that was -- came up last in month's meeting I think.

CHAIRMAN APOSTOLAKIS: And also, models, you know, the credibility of models changes with time as well. In the seismic area, the propagation model that one expert used in the Livermore studies 15 years ago drove the results, and now I think it's almost the unanimous consensus that our model was awfully conservative and realistic.

So, you know, if 12 years ago you decided to rely on that model, then, you know, you would regret it later.

MR. CUNNINGHAM: Yes.

MEMBER MILLER: Well, with time the models are going to get better, right?

CHAIRMAN APOSTOLAKIS: In some areas, you don't really --

MEMBER MILLER: One advantage of option 1 on the first situation is going to drive the models to become better, at least in that area.

CHAIRMAN APOSTOLAKIS: Which option?

MEMBER MILLER: The previous option, using core damage frequency as the -- once we started getting applications moving in, as the CE Owners Group is saying, they are going to improve the models. Once we start --

CHAIRMAN APOSTOLAKIS: But in some areas, it's really hard.

MEMBER MILLER: In some areas, it's --

CHAIRMAN APOSTOLAKIS: It's really very hard, yes. When you talk about seismic risk, the evidence is not there to help you do that.

MEMBER POWERS: A couple of times we suggested that you'll be able to look at an application or a submission or something and judge whether it's really suitable for changing the regulations based on risk assessment, until clearly you have in your mind some idea of where the uncertainties are tightened -- bounded that you're comfortable. Have you tried to quantify or articulate that in any way?

MR. CUNNINGHAM: I don't think we have. It fits well with what George talked about.

MEMBER POWERS: One of these things -- it's like modern art. You know it when you see it. It's -- let me ask you this question.

MR. HOLAHAN: Or even more so, you know when you don't see it. It's when it's not modeled you recognize that it's just not there.

MEMBER POWERS: You know when it's not art, huh?

(Laughter.)

Well, let me ask you this question. In a hypothetical situation, somebody comes in and says, "I want to extend the allowed outage time on a particular component because I have done a level 1 probabilistic risk assessment during normal operations, and I show a two percent change, at most, in the core damage frequency." But he offers you no insights on the importance of that particular component during shutdown. He offers you no -- he doesn't even know there is such a thing as a shutdown risk assessment and has nothing on fire and earthquakes, and things like that. Is that an acceptable -- I mean, can you make that judgment? Can you make a call when you've got that situation?

MR. HOLAHAN: I think I mentioned this morning, I mean, you could address that in four ways. One is you could just ignore those other things, which I don't think makes sense. We have talked about partitioning, which says, "Well, because you haven't analyzed those other things, you can't be at the goal. You can only be 30 percent of the goal, because we're saving the other 70 percent for the stuff you didn't analyze," or whatever.

Or you could say, "Absolutely not. I refuse to even look at your application until you've done a, you know, complete quantification of all of those other issues." But I think probably the most practical approach would be to say, "I can't accept what you've given because you have these blank areas where you've done nothing. We need at least -- if not a full-blown analysis, we need at least some qualitative assessment that says what are the implications of your proposed action on these other areas, and why does it seem to make sense."

And I think maybe we could accept that sort of combination, but I don't think we can accept having the issue not addressed. And the more we talk about it I hate to say that the partitioning approach, I think, works less well than putting the burden on the applicant to say why they think that their proposed change makes sense for the whole plant, for the whole --

MEMBER POWERS: I mean, how would you know whether they did a good job or not? Suppose I come in now and I augment my partition, say, or looked at seismic and

I used seismic screening methodology and I looked at fire, or I used FIVE. And then on this shutdown thing, well, I took what they did for Surry and I found that, well, Surry is a dangerous plant compared to mine, so I divided it by two and did that, and that's my judgment on what it is. How do you know whether it's good or not? Or adequate. Not good, adequate.

MR. HOLAHAN: Well, I mean, I think if it's a situation like that, there is enough information in those things to make a decision. I think, you know, comparison to other people's analysis and an argument that this is why it applies, this plant is or is not similar to Surry, sure it's, you know, judgmental. But, you know, what I would expect is that sort of argument would make sense to me if the result of it is showing that these unanalyzed things are unimportant.

MEMBER POWERS: Yes. I didn't say that, but --

MR. HOLAHAN: If you are trying to argue that I didn't analyze it very well, but it's really important, and I expect you to sort of accept that it's -- the balance comes out about right, I think you would probably say no. But I think we accept qualitative arguments. There are sensible qualitative arguments, so long as it's -- you know, you are showing that something is relatively unimportant.

MEMBER POWERS: Wouldn't you feel more comfortable dealing with this if you had the equivalent of a NUREG-1150 for shutdown accidents and --

MR. HOLAHAN: Sure.

MEMBER POWERS: -- fire analyses and things like that?

MR. HOLAHAN: Sure.

MEMBER KRESS: That would guide your judgment a whole lot.

MR. HOLAHAN: Sure. It would help in saying, well, I think I really understand what is important about those issues. I am convinced that mid-loop operation in PWRs, or that motor control centers are the fire hazards that I should really be worried about.

Other analyses on other plants I think can lead you to enough insights to say, "I understand what's really important about shutdown." And if you can show me that you're changing something that might have some implication for fire protection, but it's got nothing to do with these particular areas that we know are important, I think you can construct such an argument. And, you know, the more history you have of analysis --

MEMBER KRESS: The better off you are.

MR. HOLAHAN: -- the better off you are, yes.

And maybe it works out in the balance that where there's less analysis you get -- you know, we have to be, you know, quite sure that you are very remote from these issues. And where maybe hopefully the fire protection PRA analysis technology develops over the next few years, well, maybe you can make changes that are a little closer to the concerns at that point, but not now.

But, you know, there's always going to be a -- you know, in the absence of detailed analysis, there's got to be more judgment to fill in the gap.

MR. CUNNINGHAM: And there may have to be some more conservatism in that judgment --

MR. HOLAHAN: Absolutely.

MR. CUNNINGHAM: -- because of that.

CHAIRMAN APOSTOLAKIS: It seems to me if we go back to the goals itself, I mean, you remember this morning in the presentation by Mike Cheok we had the Surry case where we had 10^{-4} internal full power, five times 10_{-6} internal fire, and they shutdown 3 times 10^{-5}. So the total is 1.35 times 10^{-4}, which is already a little bit above the goal.

MR. HOLAHAN: Well, I wouldn't say it's a little bit above. I can't tell the difference.

CHAIRMAN APOSTOLAKIS: Okay.

MR. HOLAHAN: My eyesight isn't that good.

CHAIRMAN APOSTOLAKIS: But the problem with this is that seismic is not there.

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: And so presumably that would add something. And that's only from things that we have quantified.

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: Now, what do we do about the things that we cannot quantify? I mean, how does that affect this?

MR. HOLAHAN: Well, I mean, that's the same question that we were just addressing. It seems to me that either you ignore, you partition, or you address. At the moment, I am more inclined to say things that are not analyzed explicitly need to be addressed at least qualitatively. Why are the changes that you are suggesting, you know, independent of seismic or fire, or whatever it is that you didn't analyze? Does it really make sense to change your valve testing program if you haven't thought about seismic issues?

And I think that's a burden that ought to first be on the applicant to explain why that makes sense, and then on the staff to say why that judgment seems to be sensible in this case.

CHAIRMAN APOSTOLAKIS: Yes, but --

MR. HOLAHAN: But I think you have to sort of separate, because if you're changing something that really could, you know, involve seismic issues, then I don't think we're prepared to do a lot of that in the absence of understanding the seismic risk implications better.

CHAIRMAN APOSTOLAKIS: But let's take a case where in a particular plant we are in the neighborhood of 10^{-4} based on what we have quantified.

MR. HOLAHAN: Okay.

CHAIRMAN APOSTOLAKIS: And then your own group places that plant on the watch list. What do you do? You know that that part -- the deal is not quantified.

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: You have evidence that they are not doing very well. Should we use also some partitioning here perhaps? I mean, it's not again either/or, but should the goals allow for these things? Okay. I cannot quantify, but you are not doing very well, and I wouldn't want to see, at the same time, your -- everything you have quantified to be three times 10^{-4}. I mean, we can't raise walls because of those two, because the goals are supposed to be from all failure modes, right?

MR. HOLAHAN: Yes.

MR. CUNNINGHAM: And part of that is, as we were talking earlier, is the question of to what extent does the 10^{-4} subsidiary goal -- is it supposed to reflect that type of thing, in the sense that it purposely has some margin built into it. And do we need to take --

CHAIRMAN APOSTOLAKIS: Some of it is there, you're right. Some of it is there, but a lot of it is not.

MR. CUNNINGHAM: That's --

CHAIRMAN APOSTOLAKIS: You know --

MR. CUNNINGHAM: It's difficult when you reread the SECY reports and things like that on how they arrive at 10^{-4} to figure out what they really had in mind. Did they mean that to be total? And they say it is, but it's kind of murky, I must say.

CHAIRMAN APOSTOLAKIS: I thought it was total.

MR. HODGES: This is probably an excellent opportunity for the ACRS to provide us guidance on how we should do it here.

MEMBER CATTON: We'd rather just tell you we don't like what you're doing.

(Laughter.)

CHAIRMAN APOSTOLAKIS: No, no, no. I don't think anybody knows how to do it.

MR. HOLAHAN: I don't think anyone knows how to do it.

CHAIRMAN APOSTOLAKIS: No. It's just a question of addressing the issue and exploring options, and one of the options is to say, "Given that state of affairs, what we can quantify will have to meet a goal that is a little lower than the Commission's goal."

MR. HOLAHAN: I'm more inclined to treat the issues separately and to say, "You've done your analysis" -- I don't know how to quantify these things anyway -- and deal with operational performance issues on their own merits. If the agency has a problem with the way Plant X is being operated, we should go and directly deal with that issue, you know, express our concerns to that licensee and so we come to some, you know, suitable fix to those problems and not tie it to the risk analysis.

CHAIRMAN APOSTOLAKIS: But then you would have a strange situation because at the same time a different group in the agency is dealing with a core damage frequency that that plant has developed.

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: Which is comparable to, and handled the same way, as another plant that is very well run and has a similar core damage frequency, as if this other activity had nothing to do with managing risk here.

MR. HOLAHAN: But I can imagine those in the same sort of context that you do a tolerance on manufacturing products. And, in effect, what you're saying is it is -- this licensee may be drifting out of tolerance in the sense that you assumed a certain level of personnel performance or even, you know, maintenance performance, sort of personnel and operational sort of issues.

And then, at a certain point, qualitatively and judgmentally, the agency takes some corrective action, presumably to drive it back towards this median or whatever it is, this middle ground of where you assumed people were. So rather than try to analyze its drifting above and below, I think the agency is at least establishing some sort of subjective program that says, "We don't allow them to drift too far. We give them a letter. We say that they are -- they need to make some corrective action."

So yes, in a sense, for some period of time you might imagine them sort of becoming different, worse than other plants, and then undergoing a corrective action phase. But if you can't analyze it anyway, I mean, how do I know? You know, why am I trying to quantify things that I can't quantify?

MEMBER SEALE: Wouldn't we expect if we're talking about going into a more risk-oriented environment that there, in fact, would be -- the basis for any action like that would be deterioration in programs which have a direct implication on risk? I mean, it would be -- the maintenance program is not behaving itself, or there are difficulties with in-service testing, or whatever it may be. So it seems to me departures in the risk domain are very likely to be a part of the basis for any kind of regulatory action like that.

After all, we're talking about plant specific. I think we've already decided that site specific may be a little bit too much anyway, and plant specific is presumably the average of those that look like that.

CHAIRMAN APOSTOLAKIS: I understand that. But why are you reluctant to reduce the goal to allow for things that are not modeled? Or to come back to my earlier statement, maybe the Commission should explicitly say that these goals apply to what can be quantified at this time. Either one. Either one will do.

MR. CUNNINGHAM: Yes. I put the next slide up because this issue relates very much to that. It's an issue of if you have a plant that doesn't meet the goal you treat it differently than a plant that's better than the goal. So you, in a sense, how -- whether you leave the -- reinterpret the goal to be, as you said, that it's just what can be modeled today, or do you have them put some margin in, it has an impact in the sense -- and the other -- the policy question that we have to deal with is, should you be treating them differently? And, if so, how? And that type of thing.

CHAIRMAN APOSTOLAKIS: And one last issue before we come to this. I think the AEOD is collecting a lot of data that may have in them already the impact of some of these unquantified events and processes. We are collecting information on system unavailability. We are collecting information on common cause failures, actual incidents.

I wonder whether that kind of information can also play a role here, to say, "Look, we cannot quantify this, but we looked so many years back and it turns out that the system unavailability is what the PRA is predicting," or it's this or that. And that certainly includes at least part of what has not been quantified, and maybe that is another input to what you are doing.

Now, that cannot be applied to everything, but at least it will be -- give more realism I think to what we are trying to do here.

MR. HOLAHAN: It's kind of a performance-based approach to checking the validity of the PRA models. I think that makes a lot of sense.

CHAIRMAN APOSTOLAKIS: So shall we do it?

MR. HOLAHAN: I think we are already doing it.

CHAIRMAN APOSTOLAKIS: Okay.

MR. HOLAHAN: I mean, Mr. Baranowsky smiles proudly and says he is doing those things, and --

CHAIRMAN APOSTOLAKIS: Oh, he's doing it. I know he's doing it. But --

MR. HOLAHAN: -- he publishes those reports.

CHAIRMAN APOSTOLAKIS: -- it is not information being used in this context. That's --

MR. BARANOWSKY: This is Pat Baranowsky again. I just wanted to follow up a little bit on what you were saying, George.

You know, one thing we can do is on some things that don't appear in PRAs, when we've had sufficient experience that we should have seen some precursors to those issues, we can even on statistical grounds say that there are certain limits to how much they could even possibly contribute --

CHAIRMAN APOSTOLAKIS: Right.

MR. BARANOWSKY: -- even if we can't get a good sort of mean-type estimate from a good model with data.

CHAIRMAN APOSTOLAKIS: Yes, I think that would be a good idea.

MR. HOLAHAN: But I think we'll be much more successful in the hardware area than in the human factors area. It's much easier to collect data and, you know, reflect it in the future analyses.

CHAIRMAN APOSTOLAKIS: Well, it should be very clear what this information represents. For example, it may represent -- give you information regarding the routine human actions but not post-initiator human actions, you know, that kind of thing. But I'm sure you will get some useful information. But I still don't understand why you are reluctant to allow for things that are not quantified. I mean, I'm willing to be convinced.

MR. HOLAHAN: Since you haven't quantified it, how much allowance do you make?

CHAIRMAN APOSTOLAKIS: I don't know. But from the other -- and if I go with --

MEMBER SEALE: That's the problem.

MR. HOLAHAN: How much allowance do you make?

MEMBER SEALE: Sure. I mean, there are some cases where seismic is half.

MEMBER KRESS: That was a real ACRS question there.

MEMBER SEALE: And there are some cases where it's less than 10 percent.

CHAIRMAN APOSTOLAKIS: But the alternative is not to ignore it, and then why don't I become completely honest and say my goals apply to what I can quantify.

MEMBER SEALE: Then you burn all of the analyses you can, so you have a minimal number of things that --

(Laughter.)

-- the goal applies to.

MR. CUNNINGHAM: That's right.

CHAIRMAN APOSTOLAKIS: So we shouldn't do anything.

MEMBER CATTON: I don't think you can get away with doing nothing. You have to bound it or do something with it.

CHAIRMAN APOSTOLAKIS: Yes. I mean, we don't have to come up with the answer now, but I -- it seems that we are coming up with an answer, that we should not do anything about it.

MEMBER KRESS: No. I want to know what you think is wrong with Gary's approach to saying that you can't leave unquantified things alone; you have to deal with them some way. But use judgment and --

CHAIRMAN APOSTOLAKIS: Well, and I'm proposing -- I'm not proposing, I'm stating a way. I'm not really advocating it. And I'm saying all right -- well, I mean, people have addressed some of this stuff.

Again, the Sizewell B thing -- no sequence should contribute to a particular goal more than one-tenth of the frequency of that goal. Why? Because of the uncertainties. Because we do no want to be surprised. So people have b en creative. You may disagree with them, but at least they are proposing creative ideas.

Now, again, that is not always feasible because seismic turns out to represent the lion's share, and so on. But I'm not sure that we are ready, at this point, to just accept that we'll deal with it in another way and not really think about it.

MEMBER SEALE: But, George, isn't it true that when I made the comment earlier there are some places where we believe it's a half, and some places where we believe it's less than 10 percent? Let's just say those two extremes. That judgment is based on some kind of analysis. It may not be terribly quantitative, but it's a number which we can sincerely believe varies between the two extremes, those two cases.

They don't want, I don't think, to have to say they want to allocate any certain percentage for that uncertainty. But I do think what they're saying when they say they want -- it has to be dealt with in some way, that that's an allocation they are prepared to do on a case-by-case basis.

CHAIRMAN APOSTOLAKIS: So --

MEMBER SEALE: So it can't be in the rule.

CHAIRMAN APOSTOLAKIS: The message I'm getting, then, is that really the goal applies to what we can quantify.

MEMBER KRESS: No, I don't think that's true at all.

MEMBER SEALE: No.

CHAIRMAN APOSTOLAKIS: Why not?

MEMBER KRESS: Well, I think the goal should be for the overall full risk, excluding sabotage and things like that. But whether or not you deal with those things that you can't quantify at this time or not, what you were saying, one way to deal with it is to lower your goals a little bit.

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER KRESS: That's exactly the same thing he is talking about doing, and you're just doing it beforehand. He is doing it -- he is leaving the goals where it is and doing the quantification you had to do to lower it after the fact. And I see no difference in what you say and what he does. You have to do exactly the same things. In your case, you do it beforehand and do it to the total goal and try to apply it across the board, and you've got lots of -- you have to put more conservatisms in there. He does it on a plant-by-plant basis and deals with it specifically as it comes up, but he anchors the goal instead.

And I like his way better. You have to do the same thinking process, but in your way you'll have to put more conservatisms in, I think.

CHAIRMAN APOSTOLAKIS: But I will not lower the goals for everybody. I will do it on a case-by-case basis, too. Maybe I'm --

MEMBER KRESS: But that's what bothers me. That gives you floating goals that people are not -- don't know what to expect. The utility doesn't know what his goal is.

MEMBER FONTANA: No. Somebody sitting on a fault is going to have lower risk than someone who isn't.

MR. MARKLEY: One of the things -- I attended the Chairman's brief last week, and one of the things that was raised there which I thought was very important was consistency in how they're going to be able to accomplish that, recognizing that you have a spectrum of programs and inputs that are going to go into these things for whatever they might be trying to do. So the consistency is going to be a real big question there.

MR. HOLAHAN: In one way or another, it seems to me if we have two applications -- one from a licensee that has lots of quantitative analysis and another one has a lot of areas that aren't addressed -- we are ultimately going to make different decisions on those two cases. And whether it's done numerically by changing the goal or whether it's done in an integrated decisionmaking process later on, just say, "Well, I don't think we should be going quite so far with such an absence of analysis," it gets done one way or another.

MEMBER KRESS: And I think we've always said, "Don't put your margins in your regulations. Do your regulations as best you can. Put your margins in your decisionmaking process." That's why I like his approach better.

MEMBER FONTANA: There's a stumbling block in that if the goals are subsidiary goals, you can relate to those okay. But then when you try to relate those goals to the top level goals, seismic and stuff like that, then you've got a potential problem. So the margin has to be big enough to cover that comparison that somebody is going to make.

MEMBER KRESS: I don't he intended to leave those out in what I heard.

MEMBER SEALE: That's why you have to include those things in judging what it is you do versus a goal, because the goal has those things in it.

CHAIRMAN APOSTOLAKIS: So there will be a place, then, where there will be a discussion of the decisionmaking process, or you don't need that? That these are the factors --

MR. HOLAHAN: Yes. If I can sort of jump ahead, we are -- there is -- in the process of PRA and engineering, there is an integrated decisionmaking process, and we are writing -- the reg. guides and the SRPs have these, you know, elements to it.

CHAIRMAN APOSTOLAKIS: So there will be some guidance regarding --

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: -- what's left out.

MR. CUNNINGHAM: Do you have any observations on what you think is reasonable to say should be in in a quantified sense, or should be left out in a quantitative sense, or --

CHAIRMAN APOSTOLAKIS: I don't think anything should be left out. I think it's left out de facto. You just can't quantify it.

MR. CUNNINGHAM: Okay. Well, one question is, for example, low power and shutdown risk. You can quantify that.

CHAIRMAN APOSTOLAKIS: Yes.

MR. CUNNINGHAM: It's a big effort, and are we at the point with it -- or is the committee at the point that it would say, "Well, we think they ought to go ahead and do that. And because we can be quantitative about it, we should be," as part of this, or do we draw the line and say, "Well, we don't see the cost effectiveness of that, but for some other difficult but quantifiable area, like fire or something, it should be in"? Or -- I would be interested if the committee had any particular observations in that respect.

MR. HOLAHAN: I think the test is really whether the application, the analysis, is suitable to the decision that's being made. And there are some of these areas in which I don't think you can write general guidance to cover all of those cases, and you're just going to have to make an application-by-application decision about, you know, how important is it to have shutdown for this -- you know, for this top. I don't think we can identify all of those ahead of time. There's just too many possibilities.

MEMBER SEALE: But one of the things you have to have in your decisionmaking process, it seems to me, is the flexibility to make an allowance for the completeness or lack thereof of the human factors analysis that's in what you get, because if you don't include that then this is a very strong incentive for people to do nothing in the human factors area. And that's the last thing you want.

So you have to be prepared to make some judgment about --

MR. HOLAHAN: Yes.

MEMBER SEALE: -- what the cost is for the lack of consideration and lack of knowledge of human factors.

MR. HOLAHAN: If we do it wisely and --

MEMBER SEALE: Yes.

MR. HOLAHAN: -- and, in fact, send good signals, and do it in some sort of consistent pattern, although I'm not sure that we can write guidance on how to do it, I think the industry should get the message that says the better your analysis the more credit you get. Okay.

MEMBER SEALE: And you're correct. There are places where human factors probably means less than it might mean in other places. I don't want -- don't ask me where those are, but, you know, it -- the relative importance will vary.

CHAIRMAN APOSTOLAKIS: Well, I mean, I&C, software, we're not quantifying anything there. We're just hoping that if we control the process we'll get a good product.

(Laughter.)

MR. HOLAHAN: And monitor performance. And monitor performance?

(Laughter.)

CHAIRMAN APOSTOLAKIS: To the extent possible.

MR. HOLAHAN: To the extent possible.

CHAIRMAN APOSTOLAKIS: It's like post-initiator human error. Don't know. So there are things that are left out, and there are good reasons for it.

MR. HOLAHAN: Yes.

MEMBER KRESS: Because we don't know what to do with it.

MS. RAMEY-SMITH: I have a comment. Ann Ramey-Smith, Office of Research. In terms of, you know, eliciting some advice from you folks on, you know, are there certain PRA analyses that are required or not, maybe what it is is that if you do an adequate deterministic evaluation of your proposed change, and you're looking at the impact on defense in depth, and you really understand that, and you've looked at the impact on your safety margins, maybe that defines what risk assessment is necessary.

And so if you know that what you are proposing to do is going to change the safety margins that are assumed with your seismic supports, and so on, well, that tells you that, you know, maybe I need to look and see what -- okay, now, what is the risk significance of that?

So maybe we're making it a little harder than it needs to be in terms of figuring out a priori, you know, whether there are certain analyses that are required. Just a thought.

CHAIRMAN APOSTOLAKIS: I think, again, we are mixing a few things. As you were talking, it became clear to my mind, you have in mind, again, a specific obligation that would involve some change. On the other hand, that's not really what the Commission is asking, is it? And they are talking about plant-specific application of safety goals. They don't say in the context of they request changes, right?

So when you place an issue here, how are uncertainties to be accounted for? I have that big picture. I have safety goals, and I have uncertainties. What do I do, not necessarily in the context of a requested change?

Again, somebody, like Surry, here are the numbers. Well, you're not requesting anything. Thank you very much. Is that what we're talking about?

MEMBER KRESS: I think, Gary answered that a while ago. He was falling back on the licensing basis, which is the compliance with all the rules. And he's not going to do anything with the safety goals and uncertainties.

MR. HOLAHAN: Well, I'm not going to require --

MEMBER KRESS: Only if he gets a requested change that takes him outside the licensing basis.

MR. HOLAHAN: Let me say it a little differently.

MEMBER KRESS: Okay. I'm not going to require them to do anything because they calculated that number. The staff might initiate some study and use the backfit rule to address that concern.

And I think these issues about what constitutes a good analysis in terms of scope and treatment of uncertainties and all of that, I think this applies equally well to how good an analysis the staff does as to our expectations of the utilities.

So the reg guide we're writing is not instructions on how the staff should do backfit analysis, but all those topics are the same things that you really need to justify to yourself to make a good decision.

CHAIRMAN APOSTOLAKIS: So everything, then, the PRA implementation plan and all these things acquire a life only if the licensee requests a change.

MR. HOLAHAN: No, no, no. The specific reg guide and SRPs that we are writing are intended specifically to address licensee applications.

MR. CUNNINGHAM: But they're a subset of what's in the implementation plan.

MR. HOLAHAN: The implementation plan has more than 100 other issues, I think all of which, many of which, would be affected by the decisions that we're making here, not directly that you say, "I take that same reg guide, and I apply it directly to NRC inspection programs" or "staff training" or 100 other things, but it certainly has implications for those issues.

CHAIRMAN APOSTOLAKIS: Okay. I think we've discussed this enough, consideration of what's left out the next time you do this or you write something. I don't think we can come up with a definitive answer today. So the next issue is this?

MR. CUNNINGHAM: The next issue is: When a licensee requests the change, do we say that some increases in risk are allowable or permissible or do we say that they have to be purely neutral or only risk reductions are appropriate, that type of thing, and then a couple of subissues to that.

One is: Should the plant that doesn't meet whatever sort of goal that we have here be treated differently than a plant that's within that goal? In a sense if you look at the PSA applications Guide, you could say: If it's within the green region, do you treat it differently than if it's in the white region? is one way to think about it. And then there are some other subissues, too.

Just as an example to illustrate that point, I'm going to go back to Rick Sherry's discussion this morning.

CHAIRMAN APOSTOLAKIS: Did you prepare these after his presentation?

MR. CUNNINGHAM: No.

CHAIRMAN APOSTOLAKIS: Just curious.

MR. CUNNINGHAM: It's been talked about several times here that Rick did a calculation for the Surry plant that had a calculated core damage frequency of 1.4 times 10^{-4} per reactor year and assuming for the moment that was a complete analysis -- we know that left out the seismic analysis or fire or something -- and compared it, then, with the CDF goal of 1 times 10^{-4}.

The question is: How do you interpret that difference? One argument is if you use what's termed in other risk assessment businesses as bright lines, you could say that 1 times 10^{-4} is a bright line or a clip or something like that. Surry does not meet it. And, therefore, we have to treat it in a certain way, that it's above the goal and it has to be treated in a certain way.

Another viewpoint is, well, it's 1.4. Is that really any different than one? So do you, in effect, instead of saying that one acceptance guideline is a bright line, you say, "Well, that's a region where you have some sort of a discretion to say, 'Yes, that's acceptable' or 'It's unacceptable' or 'It will be treated differently' or not." So that's one of the questions that we're trying to deal with in terms of risk neutrality.

If Surry came in today and said, "I wanted a change" in their license, would I say, "Okay. That's acceptable only if you reduce the core damage frequency closer to one or is it okay to stay neutral or even allow some increases?" That's one of the questions that we were trying to answer and hoping to get some guidance from the Committee on.

CHAIRMAN APOSTOLAKIS: Well, do you have any problem with what NEI and EPRI presented earlier? They seem to be handling this.

MR. HOLAHAN: Yes, we have some reservations about their regions. And I think the two major items that the staff commented on in the earlier version of the guide was the specific decision criteria and the discussion or lack of discussion of uncertainties. There were about ten other, I would say, more minor issues.

I think the staff should write a letter to NEI, I would say, thanking them for the initiative and wishing them well on its applications but explicitly not endorsing the decision criteria in the document.

My reservations about those lines is personally I think they're too flat. I'm not very concerned about how big changes plants make if they really are down at a low level, 10^{-6}s or 10^{-7}s, whether they restrict themselves to another change of 10^{-6} I think is not very important. Likewise, I think that there is -- it's hard to tell.

The white region bothers me because it is so large. It is a very significant area. It goes all the way from 10^{-4} to 10^{-3}, which is an area that I think the staff and the Commission would be very concerned about whether that area is bright white or whether it's dark gray and is rarely or almost never used. We don't have a sense of that.

MEMBER CATTON: Is your concern where the lines are or the process?

MR. HOLAHAN: Well, I think it depends on what the lines mean.

MEMBER CATTON: They sort of gave meaning to them.

MR. HOLAHAN: Well, the meaning of the white region being additional management consideration needs to be made before you decide to move into that area I think is --

MEMBER CATTON: Flush out that statement a little bit.

MR. HOLAHAN: Well, for example, that white area goes all the way from 10^{-6} to 10^{-3}.

MEMBER CATTON: That's a concern about the numbers, now. The process was that in one region they were pretty liberal, another region that we tighten it up. And then there's an idea.

MR. HOLAHAN: I think the idea of having three broad regions, I think, is a good idea.

MEMBER CATTON: Okay.

MR. HOLAHAN: And we have thought about that some, the idea of having a center of a fuzzy region to me implies that, well, this is one fuzzy region. And that implies that there's something below it and something above it, which, in fact, turns out to be three, not so very different.

So conceptually I don't have a problem with it, the shape and the location of the lines. And what you really do in that intermediate region to me makes a lot of difference.

MEMBER CATTON: I think that's a good starting point.

MR. HOLAHAN: For a plant to go to 10^{-3}, I have a hard time thinking about what management decisions they're really making, that they think it's a good idea to go from 10^{-4} to 10^{-3}. I can't imagine such a thing.

That white region also allows them to go from 10^{-6} up to 10^{-5}. And I can imagine some of those pretty easily.

MEMBER CATTON: Maybe they ought to drag the red zone down to 2 times 10^{-4}.

MR. HOLAHAN: Or maybe the white zone ought to be partly pink and partly green because this is really -- one end of it is mostly red in my mind, and one end of it is mostly green in my mind. So it's just not all equally white.

CHAIRMAN APOSTOLAKIS: So it seems to me, then, judging from what you said, you said that an approach like EPRI's would make sense with three regions, but you would place them differently. And I have no problem with that.

MEMBER CATTON: I think it's a good idea.

CHAIRMAN APOSTOLAKIS: I think it makes sense.

MEMBER CATTON: So now the discussion can, then, focus --

CHAIRMAN APOSTOLAKIS: Yes, on the numbers. And I think you're right. I mean, to go from 10^{-4} to 10^{-3} and say this is right, I agree with you. I don't --

MEMBER POWERS: But isn't it reasonable that the regulator bears in mind, in the region that the applicant bears in mind, might well be two different things?

MR. HOLAHAN: Indeed, especially on the low end.

MEMBER POWERS: Yes, definitely on the low end.

MR. HOLAHAN: and I have no problem with -- we had some discussions at lunchtime about the licensees not wanting to make changes which were, in effect, a 100 percent change in risk.

If the plant said 10^{-6}, they don't want to double that. They think that that would be perceived badly. But I think from a regulatory point of view, they're free to make more conservative decisions.

But if that little 10^{-6} doesn't really matter much and certainly isn't contributing anything noticeable to health objectives, I don't see why we should be so concerned about it.

And if they want to be more conservative than such a line, that's fine.

MEMBER POWERS: And when they go into this white zone, if they only label it as "Additional analyses are required," they're not saying that you should accept those additional analyses. They're just saying, "We're going to have a much harder case to make."

And you saying, "You're right. It's going to be real tough to make."

MEMBER KRESS: Depending on where you end up on that.

MEMBER POWERS: Yes, where you started off with.

CHAIRMAN APOSTOLAKIS: I'm sure if you're saying 10^{-3} is out of the question.

MEMBER POWERS: Well, they pretty much say 10^{-3} is out of the question, too.

MR. HOLAHAN: Further evaluation.

CHAIRMAN APOSTOLAKIS: [illegible]'s still light, though.

MR. HOLAHAN: I was looking for their proper terminology. Further evaluation.

Well, I think that's only partially true because you remember they're talking about having two different types of decisions, some requiring regulatory review and approval.

But there are other management decisions made in the plant, many of them constantly, which influence risk, which don't require a submittal and approval for the NRC. And if a plant were already in the white region, they're probably making decisions on a daily basis, which could either push them up or push them down that the staff is not involved in.

MR. CUNNINGHAM: There was also a point made this morning that is worth coming back to. If you say, "We're going to have a fuzzy region," instead of a bright line, if you will, at some point you have to define where the edge of that fuzzy region is. To some degree you're just shifting --

MEMBER KRESS: It's another bright line.

MR. CUNNINGHAM: It's another bright line. That's right. And how you deal with that is --

MEMBER CATTON: Well, they define the upper bright line.

CHAIRMAN APOSTOLAKIS: That's where it is.

MEMBER KRESS: I know, but --

MR. CUNNINGHAM: But if we don't agree with that upper bright line --

MEMBER CATTON: It's down a little bit.

MR. HOLAHAN: That doesn't bother me so much in having a fuzzy central region with an edge to it which is a guideline and not a strict acceptance criteria. And so, you know --

MEMBER KRESS: In the regulatory world, you're almost stuck with guidelines and thresholds like that.

MR. HOLAHAN: I think there's nothing wrong with the guidelines.

MEMBER KRESS: Yes.

MR. HOLAHAN: I think it has the advantage of clarity.

MS. ROMEY-SMITH: I'd like to make a comment. There's a significant difference, a potential significant difference, I'll say, between the guidelines that are provided in the PSA applications guide and those that are more consistent with the way the staff is talking about it.

And this is what I mentioned earlier, the notion of total plant risk. The PSA guidelines and region are internal events, full power based on IPEs. And that has a significant cause for some indigestion perhaps with the regulator because you've got the combination of what Gary was talking about, the 10^{-4} to 10^{-3}. But, then, what those numbers mean is different perhaps.

MR. HOLAHAN: I see the opportunity for clarification.

MR. TRUE: Yes. There appears to be some misunderstanding about that. The way the applications guide screening criteria is intended to be used is that the baseline core damage frequency used in determining whether you're in the green or white or whatever region is based on the portion of the risk that's affected by the change that you're evaluating.

So if you are evaluating a change that only affects at-power risk, then you would use your total at-power risk value. If you deemed by evaluation that it only affected your internal events at-power risk, then you would use only that core damage frequency. So the baseline value you use is different depending upon the application.

What that means is that if you have an application that only affects internal events at power, for example, you would probably be limited to a smaller delta than if you used your total core damage frequency from all the events at all modes, again another risk management facet that the RTWG wanted to have built into the process.

CHAIRMAN APOSTOLAKIS: But wouldn't that create a problem, though, with the total risk? The goal applies to everything. So you're doing something to internal events if you're bringing it up close to 10^{-4} without regard of the fact that other contributors now would have to be added to that. So that it may take you to 6 times 10^{-4}.

MR. TRUE: Right. That's been a subject of some discussion between Gary and myself, at least, about whether that value should be the total core damage frequency or not.

CHAIRMAN APOSTOLAKIS: I think it should be.

MR. TRUE: We were trying to provide a means to use what you had available and what you used in your analysis as the basis for evaluation accepting the fact that we don't always have those full results available for all plants. No matter what you do, you're going to run into that problem because we don't have all modes, all event results for ever plant.

So we were trying to develop a criterion that would apply for what we have now and be consistent with the way I think the staff is heading in terms of dealing with some of the other non-quantified events.

MEMBER POWERS: Without the other analyses, how do you know that the change that you're proposing to make is assured not to affect the risk of those other modes of operation?

MR. TRUE: Without those, well, I think you have to do that by qualitative inspection and based on -- I mean, although many plants don't have, for examole, a seismic PRA or a fire PRA, they have done analyses of their plants using screen methods. They give them insights on where their dominant contributors are for those events.

I guess it was our belief that you could use those screen-type analyses to help you understand that those risks were small or large compared to your internal events at-power values.

MEMBER POWERS: It's been my experience that the thing that is most interesting about the PRA methodology is it usually reveals things to be important that I never anticipated being important.

MR. TRUE: Yes, but let's take fire, for example. At least my experience with utilities that have been doing fire studies is that they use some sort of a screening approach to limit themselves down to a small number of fire areas that they actually analyze.

Not surprisingly, those fire areas tend to be the control room, the cable-spreading room, and the switch gear rooms. Most other individual rooms are relatively insignificant in most plants and fire studies.

If you're making a change to IST, for example, does that really affect your fire risk if your dominant contributors to fire risk are the control room, the cable-spreading room, and the switch gear rooms? I guess I would contend it probably does not because your fire risks are things that are wiping out essentially the whole plant in one fell swoop anyway and not affecting individual component availabilities as we perceive IST might affect them.

MEMBER POWERS: Certainly there are incidences that are speculated about when fires cause smoke and smoke goes to instrument cabinets and at a very delayed time affects the availability of equipment.

MR. TRUE: I think that would be dependent upon the insights you got out of your plant-specific study. I mean, we can always postulate different sequences. But all the methodologies for fire, at least, involve some level of quantification. Whether it's a fire PRA or five, you have to screen areas out by some quantitative means.

And I guess there are some deterministic rules, too, but most of those are pretty well-based in giving you a low-probability event.

Seismic is a little bit more of a problem. And depending upon how you went about seismic and what seismic zone you're in, you may draw a different conclusion. Some utilities have taken a more bounding approach, those in low seismic zones at least, in trying to look at their seismic events.

So that was the philosophy of the criteria. The criteria, I guess what I wanted to say in response to Ann's question was that there's no reason you couldn't use them in that manner for the total core damage frequency if you have that available. That was not the way that we had interpreted to developed them and expected them to be used.

CHAIRMAN APOSTOLAKIS: So is it the consensus here that this issue can be addressed with a process similar to what was presented to us this morning but with different numbers in different regions?

Is that, first of all, something that you agree with? Are you proposing it as an option? I see that the options really are --

MR. CUNNINGHAM: Yes. The options that were --

CHAIRMAN APOSTOLAKIS: But they're not so specific, are they?

MR. CUNNINGHAM: Right. They're not very specific. That's true.

MR. HOLAHAN: Right. They do suggest possibly using three regions with different allowances depending upon whether the plant is in or above or near or below a region. So in a general sense I guess we do agree that this is --

CHAIRMAN APOSTOLAKIS: I think that would make sense. That would make sense.

MR. HOLAHAN: What the boundaries are and what's allowed in each region I think need more work.

I guess I'm prepared to cross one of the bullets off the options if it helps come to a conclusion. And that is for plants which are much better than the guideline, whatever that is, only risk-neutral changes would be allowed. That's the very first bullet. I'd say I think we've gone beyond that. I'm ready to cross that one out.

MEMBER KRESS: I would agree with that. And I think I would change Bullet Number 2.

MR. HOLAHAN: In what way?

CHAIRMAN APOSTOLAKIS: Well, you don't want to increase it all the way to the guidelines. Probably he doesn't --

MEMBER KRESS: Somehow I would work uncertainties into these guidelines as defining the fuzziness.

MR. CUNNINGHAM: Yes.

CHAIRMAN APOSTOLAKIS: That will be in the regions, in the --

MR. HOLAHAN: For example, one of the things we talked about the other day was, let's say the center of your region was 10^{-4}. The fuzziness, the width of the region might be related to how close you think you know 10^{-4}.

And if I use Rick Sherry's numbers from this morning, I'd say, "Well, on something like a factor of three." So you're within a factor of three, you're within some fuzzy central region. You're more or less near the guideline.

MEMBER KRESS: It seems to me like how far you're allowed to increase towards those guidelines --

MEMBER POWERS: Tom, you --

MEMBER KRESS: -- ought to incorporate the uncertainties in the delta change you got. You've got uncertainties in that. And they ought to be incorporated. If that's a highly uncertain number, you don't want to go as far up. So that ought to be factored into the decision.

MEMBER POWERS: Tom, if you interpret what are called up here the guidelines as the definition of safe, that's one thing. If you interpret them, on the other hand, as goals, where you would like to be, then that's quite a different thing.

I believe they are goals. In that case I'm not sure that you want to take your second bullet off.

MEMBER CATTON: Yes, but you ought to have an --

MEMBER KRESS: It depends on the cost-benefit or something?

MEMBER CATTON: -- adequate reason for

deciding not to meet your goals.

MR. HOLAHAN: If you really believe that the fuzziness of your region captured the amount of uncertainty, then I would say maybe you should just go to the edge of that region.

MEMBER CATTON: If you have a goal, the edge of the region ought not be beyond your goal or, else, you're deciding not to attempt to meet your goal. It doesn't sound very good to do that.

MEMBER KRESS: Well, I'm in a sense, Dana, trying to get out of this business of saying it's a goal; therefore, it doesn't need to be met. I'm developing criteria for acceptance of certain things. In this sense, it's more than a goal to me. It is an acceptance criteria.

I would like to get away from this fuzzy thinking about, "Well, it's just a goal. So who cares?" I'd like to get some firm guidelines on when it's acceptable and when it's not, incorporate the uncertainties, and really have a way to deal with those things without always having to fall back on judgment. Your judgment is going to be there anyway, but --

MEMBER POWERS: Well, then, in thinking about that, just to make life more difficult for you --

MEMBER CATTON: Me?

MEMBER POWERS: No. He's the one that's thinking about it. He's on the crusade here.

We talked about this multiple goal. You have to think about the situation of where indeed I drop CDF and I drop LERF but at the price of exceeding the goal on the conditional containment failure probability or any set of analogous things that when you've got more than one goal, then you can anticipate running into situations where you make great changes to the positive for two at the expense of making a negative change for the one.

MEMBER KRESS: Well, in Rick Sherry's world, you take the one that's controlling. You don't let that happen, then.

MEMBER POWERS: I'm on record to where I believe that world is.

MEMBER KRESS: Would you refresh my memory? Oh, yes. I know. Okay.

CHAIRMAN APOSTOLAKIS: Shall we go on?

MEMBER FONTANA: No. One more question. One the first bullet under 3, is that related to another criterion, such as risk benefit, cost-benefit, assessments? Would you allow an increase on a basis that it was just shown to be cost-effective or -- otherwise there are other things involved in 3.1.

MR. HOLAHAN: I would think there would have to be some. If a plant wasn't meeting your guidelines and, in fact, was proposing to drift further from a guideline, it seems to me there would have to be some good reason to do that. And whether it's cost or if you remember --

MEMBER FONTANA: I'm sorry. 3-A is what I said the same thing would apply to 1, Number 2. I guess I was really thinking of the second bullet under 1.

MEMBER KRESS: 1-B.

MR. HOLAHAN: Allowed to increase the guideline?

MEMBER FONTANA: The question applies to both of those. You're allowing increases. And the question is: Is there another criterion or another rule involved here where you do a cost-benefit analysis?

MR. HOLAHAN: If I go back to the objectives of all of these programs, to make better decisions, to be efficient in the use of the staff, and to reduce burden on the industry where it seems appropriate, those are the tests that I would apply to these cases.

Now, if you are much better than the goal, I'm not sure that you have to have a tremendous benefit in order to get that relaxation. Since you're not contributing much to overall risks, I would say, well, I mean, there should be some reason for it, I suppose.

Although the issue is the same, the first bullet under 3 seems to be the much tougher text. If you are outside the fuzzy region on the high side and you propose to drift further away from it, there ought to be an exceedingly good reason for that.

Maybe it should make some overall sense with respect to the efficient management of the plant or maybe even though it's increasing the risk a little bit, it's reducing occupational exposures to the staff of the plant or it seems to me there should be some good reasons for it.

MS. ROMEY-SMITH: And what Gary is referring to here, if you remember the six steps that were put up a little bit earlier, the fifth one is to conduct this integrated decision-making process. That includes not only this piece that we're talking about here, which is the probablistic input to that decision, but there's also the deterministic engineering, ALARA costs, regulatory effectiveness, and so on.

MEMBER CATTON: So, in essence, you would weaken the industry position with respect to the third zone because they say unacceptable.

MR. HOLAHAN: Well, I think it depends on where you draw the line. I wasn't imagining drawing the line quite so high. If I had drawn the line at 10^{-3}, I might say unacceptable, too.

MEMBER CATTON: So you would maybe even have another line in there?

MR. HOLAHAN: Well, it depends. I don't imagine our fuzzy region ending quite so high as 10^{-3}.

MEMBER MILLER: By the way, you were going to put a gradation on that white region.

CHAIRMAN APOSTOLAKIS: Who's going to do --

MR. HOLAHAN: In some way I think we should.

CHAIRMAN APOSTOLAKIS: Who's going to do Step 5?

MR. HOLAHAN: Both the applicant and the staff. The way the reg guide and the SRP would be written as parallel documents would be asked to think about why this decision makes sense in this way.

And we would expect the submittal to have an argument that we could review. So it would both be in the submittal and in the staff's review.

CHAIRMAN APOSTOLAKIS: Well, it's already 5:25. How many issues? There is one more in Mark's --

MR. HOLAHAN: One more.

CHAIRMAN APOSTOLAKIS: -- and Ann's set of viewgraphs. Then we have the Holahan here waiting. Are you going to cover all of this?

MR. HOLAHAN: There's only one issue on there that --

CHAIRMAN APOSTOLAKIS: Defining risk-informed regulation again. We agree.

MR. HOLAHAN: There's only one issue that needs to be covered in there. And I don't even know --

CHAIRMAN APOSTOLAKIS: Why wouldn't performance-based regulation be implemented?

MR. HOLAHAN: Right.

CHAIRMAN APOSTOLAKIS: Is that the issue?

MR. HOLAHAN: Right. Well, are we done with risk-neutral? I think it's covered.

CHAIRMAN APOSTOLAKIS: Yes, I thought so.

MEMBER FONTANA: Before you leave that, what would you rather do here, like allow packaging, for example, or what's your opinion?

MR. HOLAHAN: Well, offsetting risk by offering an improvement in some area to go along with a reduction in another area.

CHAIRMAN APOSTOLAKIS: Yes. I don't think we discussed this individually versus packaged.

MR. HOLAHAN: We didn't discuss the individually versus packaged, although I consider this more an implementation issue than a policy issue. And I don't see that the Committee really needs to address it at this stage, although --

CHAIRMAN APOSTOLAKIS: What do you mean by "packaged"?

MR. HOLAHAN: Combining more than one issue at the same time in order to show perhaps a net safety improvement, even though there would be a risk increase in one area and an offsetting reduction in another area.

MEMBER CATTON: It certainly would mean uncertainty in this arena.

MEMBER KRESS: You'll want an opinion there. That doesn't seem like it's any difference at all in doing them one at a time and the package ought to be perfectly acceptable.

MEMBER POWERS: It's a net change.

MEMBER CATTON: It might change how you do it depending on where you're at.

MEMBER POWERS: Isn't the packaging, the idea of packaging, kind of the heart and soul of going to risk-based regulation, where you --

MEMBER KRESS: I think it is, yes.

MEMBER POWERS: -- make a more optimal array of safety measures?

MEMBER KRESS: Yes. I think you'd find this Committee in favor of packaging being allowed.

MR. HOLAHAN: There are some complications associated with packaging that I think I'd like to put on the table before we all say it's a great idea.

MEMBER KRESS: Yes. Okay.

MR. HOLAHAN: If you remember the six-step process, one of the things you try to do is identify the deterministic engineering criteria of the current licensing basis of the plant and go back to the original thinking and intent on those issues to see whether you, in fact, are preserving those sorts of margins.

I know how to do that an issue at a time. I know how to go back to the IST program and the ISI program and figure out: What were these programs trying to achieve? And am I making sure that I preserve that original intent or reconsider the original intent? Does it really make sense with respect to current knowledge?

I think it's not so difficult to make a decision to say risk insights tell me something about pump and valve testing, engineering analysis, and the original intent, and the ASME code and all of that, and how to combine those two things in an integrated decision process.

Now, if I start to package things together, it seems to me to get a little more complicated if I'm combining the in-service testing program with changing testing on diesel generators and having a different fire protection requirement and changing my off-site emergency notifications. It's a little hard for me to say -- and what I do is package them in the sense that what I get is a net change in core damage frequency or large release.

How am I to deal with the original intent of those issues. Should I go back and really think about them individually or am I really thinking abouc them as an integral package if they're really not functionally related?

MEMBER KRESS: I would have dealt with that by treating them just here's a package of several individual things. And I would treat each individual just as I would have treated as an individual by itself.

MR. HOLAHAN: Okay.

MEMBER MILLER: That assumes they're independent, though.

MEMBER KRESS: That assumes they're independent, yes. Well, you could look at dependencies.

CHAIRMAN APOSTOLAKIS: I don't see why.

MEMBER MILLER: Why what?

CHAIRMAN APOSTOLAKIS: Doing them separately.

MEMBER MILLER: Well, Tom is saying if we consider them as independent issues, you put them in a package. And this certainly would apply. But there are many cases they will not be independent.

MEMBER KRESS: You don't have to worry about dependencies.

MR. HOLAHAN: The issue isn't how many submittals there are and whether it's a report with five dependencies. The issue is: For example, if there are two applications, one which increases risk by 10^{-5} and one which reduces it by 10^{-5}, if those are submitted to the staff at the same time, should we consider that a risk-neutral application?

MEMBER CATTON: And I guess you don't care if the CDF is 10^{-6}.

CHAIRMAN APOSTOLAKIS: He's neutral.

MEMBER CATTON: You're still well-aware from the 10^{-4}. On the other hand, if you were sitting right at 10^{-4} and somebody said, "Okay. I'm going to go up a factor of 10, but this is bringing me down a factor of 11."

MEMBER SEALE: You also have your concerns about how much of the risk is in one particular sequence.

MEMBER CATTON: I think, more importantly, it's the uncertainty associated with it because the uncertainty is high in one and low in the other. You may not get where you think you should be.

CHAIRMAN APOSTOLAKIS: Isn't though, the basic idea here to look at what happened to the plant? Whether they're proposing one or two or three, what really counts is the final impact.

MR. HOLAHAN: But are you making a decision that each of those changes individually makes sense because of its deterministic and risk implications or that all of those together make sense? Maybe an individual item that might not make sense on its own is only making sense because it is packaged with other things.

CHAIRMAN APOSTOLAKIS: Yes.

MR. HOLAHAN: Are you masking something that you would not have approved otherwise? Are you making --

CHAIRMAN APOSTOLAKIS: I would look at the total impact. And then I would look at the case by case. I said earlier I don't think you -- are we trying to develop prescriptive guidance to the decision-making in Step 5? Because I don't really think we should do that. But this particular case it seems to me should be left up to that group of people who will make the decision.

If you start with a premise that what really counts is what happens to the plant, I think that's where you start. If the applicant wants to give you three changes, you look at the total input because, after all, what does it mean, three?

MEMBER KRESS: That's what I'm saying, yes. In your case, say you had three of them that decreased risk and one that increased. I would have done something like, well, let's look at a new plant state where I took the three, the decreased risk, and see what his plant state is.

Now, I would have given this state, would I allow this fourth one based on my individual risk, whatever my individual was? If my answer was yes, I would say yes, it's a good package. If my answer was no, I would say no.

MR. HOLAHAN: Okay.

CHAIRMAN APOSTOLAKIS: Because, you see, one of those changes may be very costly to the utility.

MR. HOLAHAN: I'm a little confused because your description of it sounds to me like consider the changes only on their individual merits.

MEMBER MILLER: The way he's stating is it is all additive.

MEMBER CATTON: They need to present to you the one that reduces risk first.

CHAIRMAN APOSTOLAKIS: No. You look at the whole package.

MEMBER KRESS: I think it would be, but I wanted to make a change for some good reason that significantly increased risk and if I'm in a regime and my mounts won't allow it, then one way for me to do that is to change my regime and package something that gets me down to where it's allowed.

MR. HOLAHAN: Yes.

MEMBER KRESS: In that sense it's individual, and it is a package.

MR. HOLAHAN: But suppose the change, the improvement you are changing, doesn't get you out of the fuzzy region. And let's suppose that that fuzzy region, being in the fuzzy region, we wouldn't allow increases.

MEMBER KRESS: That's a good point there.

MR. HOLAHAN: The packaging would, in effect, allow you to do something which individually we wouldn't have approved.

MEMBER CATTON: I think you're going to have to decide separately when to package and not package.

MS. ROMEY-SMITH: Because you could do some very clever things with your packaging. Let's say that your RPA analysis didn't take credit for some specific equipment that is in the plant.

So now you come in, and you say, "I'm going to package that along with something else here that's an increase, and I'm going to reduce the risk." Well, the fact is that the plant as built and as operated got more risky, whether or not you packaged it or not. So you have to be clever.

MEMBER KRESS: You guys are smart enough to catch that.

MS. ROMEY-SMITH: If you have the intimate knowledge perhaps of what was in there.

CHAIRMAN APOSTOLAKIS: Yes, but, I mean, on the other hand: Where do you stop? What is a change? For example, this request for extended AOTs, does the -- I mean, they looked at shutdown risk and risk at power operations. Would it be possible to separate the two, then, and say, "Gee, you're increasing the risk of operations. So you shouldn't do it," even though the benefit from the shutdown part overcomes that?

MEMBER KRESS: I would be in favor of doing the overall.

MEMBER CATTON: Well, I think again --

CHAIRMAN APOSTOLAKIS: Let's not forget. I don't think we can have very prescriptive guidance in these things. Start with an overall package. And then you look at the individual merits. I mean, that's why I asked you earlier: Who is going to do five? You are giving that person significant authority, it seems to me.

MEMBER KRESS: But I do think Ivan's comment about that whole set of things you're changing, that you need to look at the uncertainties.

CHAIRMAN APOSTOLAKIS: Well, when we say "look," I take that for granted.

MEMBER KRESS: Yes. You need to account for it.

MEMBER CATTON: Well, I think you need to do something a little bit more substantive than to just look because maybe one of them has high uncertainty and the other one doesn't.

CHAIRMAN APOSTOLAKIS: That's part of looking. In my mind that's part of looking.

MEMBER CATTON: Okay.

CHAIRMAN APOSTOLAKIS: Let's not operate on the assumption that everything is point estimate and you do uncertainties when you say so explicitly. So I think we covered this.

MR. MARKLEY: Could I ask one quick question? Gary, just for calibration here, of the events that are screened by the Events Assessment Branch and stuff, how many of them jump into that area or that zone of decision of EPRI's? As I recall, there aren't that many 10^{-4} or 10^{-3} events.

MR. HOLAHAN: I don't think they're doing them on these units.

MR. CUNNINGHAM: Conditional probability there given an event.

CHAIRMAN APOSTOLAKIS: All right.

MR. HOLAHAN: The last issue we wanted to cover, -- and I'm not going to use all; I might only use one or two slides -- which is the issue of performance-based regulation, is one of the four policy issues that we're going to need to address by September.

(Slide.)

MEMBER KRESS: Do we have this slide?

CHAIRMAN APOSTOLAKIS: Yes, Number 4.

MR. HOLAHAN: Yes. I just skipped to Number 4, the question being: How should performance-based regulation be implemented in the context of risk-informed regulation?

There are two options, which are not mutually exclusive. You could choose to do both. The first one is something that I think is an integral part of what we have talked about.

When I put the blue slide back, you'll see it's one of the steps. And that is to include performance-based strategies as an implementation approach. And so that in this six-step process of addressing deterministic and PRA analyses, we would expect licensees and the staff to search out in the Step Number 4, to search out implementation strategies as a means of validation of the PRA assumptions or verification of compliance with the engineering requirements. And I think there would be a whole spectrum of possibilities.

If it were an IST program, well, that

inherently involves a valve testing. And so it's not hard to think about a monitoring approach. If it's the maintenance rule, clearly there's a data collection and analysis-type element to it. If it's graded quality assurance, then I think that's not quite so clear.

And I think we will ask the licensees and have to think about: For the things you're changing and the analysis you've done, what is it that you can do to convince yourself that in the future you're really maintaining the plant and running it in a way that's consistent with what you assumed in the analysis?

In some of these areas you can actually measure what it is that you'd like to measure, reliability of equipment. In other cases you can only have indirect measurements.

In the graded QA program, you might not be able to do much better than receipt inspection and measuring the tolerances of pieces of equipment as it arrives on the site. Maybe you can monitor reliability and failure rates, but there's some stuff that just doesn't fail very often, structural and passive-type equipment.

So this fourth step would involve searching out what is the highest level, the most performance-oriented element for the particular application of interest. And we would define that as being that makes this performance-based. That's as performance-based as you can get for this issue.

CHAIRMAN APOSTOLAKIS: Is the work that Pat Baranowsky's group about to start on risk-based performance indicators related to this?

MR. HOLAHAN: Not directly in the sense that for a given application, we would expect the licensee and the staff to choose things to measure, things to monitor that apply to that issue. I think what Pat's group is thinking about is more general plant-wide or system-level performance indicators.

Now, they may overlap. I mean, they may turn out to be the same things in some cases.

CHAIRMAN APOSTOLAKIS: Another issue here would be the consistency of these performance indicators with the bigger picture. I don't know how they did it in the maintenance rule, but you define a certain level of unavailability.

Is that consistent with your overall goal and the fact that you have all sorts of systems and so on? Where does that come from? Should we have a top-down approach, I mean, more or less what Rick described this morning but going down to performance measures if possible so at least you have the big picture in your mind and can see whether they're consistent or inconsistent?

In other words, can you do it on a case by case basis without looking at the big picture?

MR. HOLAHAN: I think you have to do it on a case by case basis because --

CHAIRMAN APOSTOLAKIS: How do you define the numbers?

MR. HOLAHAN: Well, you define the numbers by whatever was used here and here. That is, I mean, whatever was assumed in the analysis is what ought to be ... idated and operational.

CHAIRMAN APOSTOLAKIS: But shouldn't that be consistent also with whatever calculations you have done to produce a core damage frequency and have some sort of -- in other words, if you have a criterion of the core damage frequency, somehow that should be allocated, the things below it. so that if the change affects one system; right, you cannot just change the CDF completely just based on some change to that system. There should be allowance for the fact that this goal is the result of many contributors.

MEMBER CATTON: I guess I don't see why not. It's independent.

CHAIRMAN APOSTOLAKIS: But it's not. We have a goal here.

MEMBER CATTON: If it's not independent, then you need to redo it.

CHAIRMAN APOSTOLAKIS: There are 20 different things contributing to it. You propose a change that affects the first two.

MEMBER CATTON: Well, then you have to go through the pyramid again, I would think.

MR. HOLAHAN: It seems to me the difficulty is there are really two things involved in the decision process when you're taking deterministic and probablistic issues and you're making a final decision.

The easy part is to say the part of the plant that I'm changing, the process that I'm changing, I can search out ways of validating whether that change has made things a lot worse than I thought it was or whether it's really working well.

I think that's not so ha . The hard part is part of this decision is based not only on what you changed but what you didn't change, your judgments about how good the rest of the plant was. And whether at the fourth step we should really be thinking about performance measures to validate everything else in the PRA is a tough, tough problem.

MS. ROMEY-SMITH: Another way of thinking about that, I think, is from the perspective of defense-in-depth. And so maybe what you do is you've done an evaluation that you've convinced yourself that you have not reduced unduly defense-in-depth and reduced the safety margins and so on.

Now you want to make sure that you monitor those aspects of the plant that would give you indication that you were either right or wrong about that change in defense-in-depth. And from the PRA perspective, sometimes that will be other parts of the PRA because you relied on this other equipment to be available.

And that's why it was okay to reduce this a little bit. So it's kind of complicated.

MR. HOLAHAN: The scope of what's in Step 4 I think needs to be thought about on the given applications.

CHAIRMAN APOSTOLAKIS: I think in the context of a change, you're right. It's probably easier in the context of a change.

MR. HOLAHAN: In the context of a change.

CHAIRMAN APOSTOLAKIS: But in an absolute sense, if you want to monitor the performance of the plant to confirm that this is the risk level, then the issue of consistency is important.

MEMBER CATTON: I think they're forced to do that when they try to find out where they are on that diagram, which one of the regions they're in. They have to do it.

CHAIRMAN APOSTOLAKIS: That's why I'm saying that for a change it's easier. Your consistency does not arise because you start from a certain basis and you're .ying at some point --

MEMBER CATTON: Less frequently, but at some point you have to demonstrate that indeed that is your base. Now you --

CHAIRMAN APOSTOLAKIS: We keep evading that. Every time I raise it, people tell me, "No. We're only talking about changes."

MEMBER CATTON: It doesn't matter what you're talking about. If you want to figure out why --

CHAIRMAN APOSTOLAKIS: Well, we know.

MEMBER CATTON: I didn't mean it that way, George. If you want to find out what regime you're operating in, you've got to know the absolute value.

CHAIRMAN APOSTOLAKIS: It seems to me there are three. But I think the message is we worry about changes first. Then that comes later.

MEMBER CATTON: No. How can you do that? You can't.

CHAIRMAN APOSTOLAKIS: What do you mean?

MEMBER CATTON: How can they worry about changes by themselves if they're going to decide what criterion they're going to base this on on this diagram? The diagram is an absolute --

CHAIRMAN APOSTOLAKIS: Wasn't that the very first issue or, actually, the issue we were discussing just before lunch, when some of my colleagues got irritated? Where was it? I interpret the thing --

MEMBER KRESS: We were irritated because we were agreeing with you.

CHAIRMAN APOSTOLAKIS: Frustrated, frustrated. I interpret the issue, which I can't find now, as being much broader than it was interpreted by the staff. Do you remember?

What was it? I don't. The first issue was: How is acceptable risk defined for plants with partial scope PRAs? It was explained to me that it has a much more limited meaning than I thought. Now, at 5:40 we're deciding that --

MEMBER CATTON: Well, but everything we have been talking about is based on this diagram. And that diagram --

CHAIRMAN APOSTOLAKIS: It's only for changes, Ivan, only for changes. You assume you have a base.

MEMBER KRESS: No, they're not.

MEMBER CATTON: No. This is the absolute.

MEMBER KRESS: This line means CDF.

MR. CUNNINGHAM: Built into that is the idea that you're starting --

MEMBER CATTON: Baseline means CDF for a year.

CHAIRMAN APOSTOLAKIS: Right.

MEMBER CATTON: You can't even enter into the negotiation until you know what it is.

MR. HOLAHAN: Exactly, yes.

MEMBER CATTON: Beyond that point, it's all changed.

MR. HOLAHAN: Yes, yes. That's right.

MEMBER SHACK: No. We explained that that was only for the thing at issue. If it was internal events, then it was internal events.

MR. CUNNINGHAM: That's the NEI.

MR. HOLAHAN: But the staff's analogous curves I think would be total --

CHAIRMAN APOSTOLAKIS: But, Ivan, Gary just said very clearly that you will develop implementation and monitoring strategies for this change, --

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: -- not to confirm that your baseline risk is indeed what you think it is.

MEMBER CATTON: Yes. But then how do you know --

CHAIRMAN APOSTOLAKIS: It's a separate issue.

MEMBER CATTON: How do you know whether they're in the non-risk-significant, the unacceptable, or the further evaluation zone?

CHAIRMAN APOSTOLAKIS: That's a result of analysis presumably, but not of performance indicators.

MEMBER CATTON: How do you know where they're at?

MR. CUNNINGHAM: You know, separate from this, as NEI was talking about, there will be updates to their PRA. From their standpoint, you have to maintain that PRA in either refueling or whatever. And that's the process by which you would know where you are in terms of that baseline.

MEMBER CATTON: Now, what is this PRA that they're maintaining? I think that's where we're at. That's where we're going around in circles.

MR. CUNNINGHAM: We're going around in circles to some degree on what's the scope of --

MEMBER CATTON: No. But what is this PRA that they're going to maintain? Is it a full-scope PRA or what?

MR. CUNNINGHAM: You're right. That's where we're going around in circles.

CHAIRMAN APOSTOLAKIS: He's not talking performance indicators that will give you the warm feeling that my baseline PRA is realistic and I indeed have a core damage frequency of 10^{-5}. That's not what we're talking about, at least not yet.

MR. HOLAHAN: Not yet.

CHAIRMAN APOSTOLAKIS: What we're talking about here is --

MR. HOLAHAN: That's right.

CHAIRMAN APOSTOLAKIS: -- performance indicators that will tell me yes, --

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: -- the proposed change and the analysis which is based on it, --

MR. HOLAHAN: Right, right.

CHAIRMAN APOSTOLAKIS: -- indeed just confirm my experience.

MEMBER KRESS: That's because we don't have good performance indicators for the other thing.

MR. HOLAHAN: Well, it's not that we have no programs to address that.

MEMBER KRESS: There are.

MR. HOLAHAN: There's a maintenance rule. And hopefully someday we'll have a reliability data rule. There are performance indicators. And maybe there will be better performance indicators. So it's not entirely --

MEMBER KRESS: You're working in that

direction, yes.

CHAIRMAN APOSTOLAKIS: So the issue of consistency in my opinion is not significant when you talk about changes. It's significant when you talk about the big picture, but for changes I don't think that it is significant because all you're saying is, look, if I change this, I expect my failure rate to go down. And to prove it to you, I will monitor the number of failures in the next three years.

MR. HOLAHAN: Yes, yes. That makes sense because, in effect, the plant is proposing to do something different from what's been done before. Presumably what's been done before has some history to it.

CHAIRMAN APOSTOLAKIS: That's right.

MR. HOLAHAN: And it's producing failure rates and all consistent with what history has shown. If you want to be different, you should justify the differences.

CHAIRMAN APOSTOLAKIS: Exactly.

MR. HOLAHAN: Now, whether we should tackle this larger task of performance-based validation of all PRAs is I think a more difficult issue.

MEMBER CATTON: That makes a lot of sense when you're doing something that reduces the numbers, like you improve a particular system. But what about when you put a different pump in that's a little less reliable because it's a hell of a lot cheaper and easier to maintain? Now what do you do?

That fits into I think what George was talking about. That's part of the system.

MR. HOLAHAN: The first part is easy. And that is as an integral part of the --

MEMBER CATTON: If it's a better pump, I think it's clear that --

MR. HOLAHAN: If it's either a better or worse pump, I think Step 4 would say you do something to monitor the reliability of that pump. And whether it's mean time between failures or shaft vibration or whatever --

MEMBER CATTON: Yes, it is worse.

MR. HOLAHAN: Or that it's not even worse than you thought. I don't care if it's perfect.

MEMBER CATTON: If it's the same or better, there's no problem. But if it's a little bit worse, --

MR. HOLAHAN: Right.

MEMBER CATTON: -- what does that do to your CDF?

MR. HOLAHAN: But you have to have --

MEMBER CATTON: How do you know without the PRA?

MEMBER SEALE: You included that in the analysis.

MR. HOLAHAN: You included it in the analysis. And whatever you included in the analysis should be validated in the plant within the scope of that change. That's the easy part.

The hard part is part of your decision was this plant is pretty good or not so good based on the other tens of thousands of decisions that were made in the PRA. Should I insist on performance validation of every one of those before we allow them to change a pump? Okay?

CHAIRMAN APOSTOLAKIS: Some of it will have to be to considered, Ivan, you're right, because if somebody tells you, "Yes, my pump will perform better," compared to what? So you need to have that, but you don't need consistency criteria. It's not an easy job.

MEMBER CATTON: It's not all that difficult to deal with that. I mean, there are measures for the quality of a mechanical device. But if you go the other way, where it's not going to be as good and it fits into this system of trees and branches or whatever you do in the PRA world, where does the bottom line come out? How do you transfer that decrease in performance?

CHAIRMAN APOSTOLAKIS: That's for the applicant to worry about. That's basically what I'm saying. There's a Step 2, a Step 3, a Step 4. We can't predict every possibly --

MEMBER CATTON: Okay. I --

MEMBER SEALE: He has train reliability calculations as well as plant reliability calculations.

MEMBER CATTON: Crane?

MEMBER SEALE: Train.

MEMBER CATTON: Train. Okay.

CHAIRMAN APOSTOLAKIS: Back to your Viewgraph 4, what is the second option, Gary? Commission explicitly address the scope and role?

MR. HOLAHAN: I think, in effect, what we're doing is we're recommending Option 1. It's an integral part of the six-step process because that really is, I think, a bit narrower than most people would say for performance-based regulation because it only addresses those things in the context of PRA and it probably only addresses those in the context of changes based on PRA.

The Commission could establish some additional guidance, policy statement or something, to explicitly address the scope and role of a performance-based regulation and regulatory process, maybe a new policy statement, maybe a performance implementation plan or something.

The Commission hasn't expressed that. As a matter of fact, if I go to the fifth slide, it gets a little closer to the current situation.

CHAIRMAN APOSTOLAKIS: Before you go to that, --

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: -- could the Commission statement be your first bullet, your first option?

MR. HOLAHAN: It could, but if that's the limit of it, it isn't needed because we were going to do that anyway.

CHAIRMAN APOSTOLAKIS: So you think it could be more than that?

MR. HOLAHAN: NEI has proposed a risk-based, performance-based approach to regulation. I don't remember exactly the title of their document, which I think goes further than what we're talking about here.

CHAIRMAN APOSTOLAKIS: Okay.

(Slide.)

MR. HOLAHAN: In effect, what the current state is, the first bullet is basically to limit implementation to performance elements as part of the Step 4 of the process.

The third bullet relates to NEI's proposal. And the staff has written back saying, "We're willing to work with the industry in searching out additional pilot applications where they make sense, not necessarily limited to those in the PRA implementation plan," but where objective criteria, where monitoring programs make sense, and where failures are could be tolerable; for example, like the maintenance rule, where individual component failures are not such a big problem, that we would be willing to work with the industry to search out examples.

I think the Commission needs to decide whether it wants to take on a broader initiative in this area. In the absence of a broader initiative from the Commission, the staff would include performance elements in its risk-based, risk-informed decisions, and would search out some suitable examples with the industry, but not initiate any new broad regulatory program.

MEMBER SEALE: We can use it.

CHAIRMAN APOSTOLAKIS: I just found out you have two and a half hours tomorrow.

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: Now, the only member who's not here is Bill Lindblad. I don't think we need two and a half hours tomorrow.

MR. HOLAHAN: Okay.

CHAIRMAN APOSTOLAKIS: Given how late it is now, maybe some of the discussion on this particular topic can take place tomorrow. And I think that's something that Mr. Lindblad is particularly interested in.

MEMBER SEALE: Yes.

CHAIRMAN APOSTOLAKIS: I would suggest that, instead of going through your presentations here, summarize where we have agreed. It seems to me we have agreed on just about everything; right?

MR. HOLAHAN: I agree to that.

MR. CUNNINGHAM: Of course.

CHAIRMAN APOSTOLAKIS: What you proposed, we agree; right, which is a glorious performance-based conformation of the finding from the risk communication researcher that you have to bring the stakeholders into the process at the early stages? So one stakeholder group, you brought it into the process early, and you got agreement.

So maybe you can list those tomorrow. Mr. Lindblad probably will have some questions, especially when it comes to the restatement of the goals. And then we will spend a little extra time on the performance part because I think it's too late now to --

MEMBER SEALE: Are you going to ask the industry people to say anything tomorrow?

CHAIRMAN APOSTOLAKIS: I don't know if they want to.

MR. MARKLEY: They didn't ask to.

CHAIRMAN APOSTOLAKIS: They didn't ask.

MR. MARKLEY: They said they didn't want to when I asked them.

MEMBER SEALE: Okay.

MR. MARKLEY: Nevertheless, I would like to point one thing out here, that what agreements have been reached this evening are those with the individual views of the members and not of the Committee because that is a process in and of itself which is the official view.

MEMBER SEALE: They know that.

CHAIRMAN APOSTOLAKIS: They know that and --

MR. MARKLEY: I know. But the public record has to state that.

CHAIRMAN APOSTOLAKIS: If you have the agreement of all of the members, you have the agreement of the Committee. The other way doesn't work. Anyway, I'm speaking as G. A.

Another thing you may want to do tomorrow is address the specific questions from the SRM, how you plan to respond, unless it's the same thing. It's the same thing? So we can go down that all the performance-based regulation is a PRA implementation plan?

That's much bigger than the change. So maybe you want to say a few words about that. Are you seeing only changes first?

MR. HOLAHAN: I think it's not much bigger.

CHAIRMAN APOSTOLAKIS: Okay. But that's the kind of thing we -- because you expect us to write a letter as well?

MR. HOLAHAN: Yes.

CHAIRMAN APOSTOLAKIS: And we will do that by when?

MEMBER SEALE: Friday night.

CHAIRMAN APOSTOLAKIS: What Friday? We don't meet Saturday?

MEMBER SEALE: Saturday, but not on --

MEMBER KRESS: I won't be here Saturday, and I want to be part of this letter.

CHAIRMAN APOSTOLAKIS: Okay. So you will come up with a draft.

(Laughter.)

MEMBER KRESS: If you are willing to let me write the draft, I will write it.

CHAIRMAN APOSTOLAKIS: I would rather talk about specifics tomorrow. The only issue that needs to be discussed a little further is the performance-based part. Go down the list here of the SRM. Tell us what you plan to say more or less. And then we have to write our own letter.

And make it shorter. Maybe we can finish in an hour and a half tomorrow, instead of two hours and a half. Try to shoot for that. And the extra time we can spend --

MEMBER SEALE: On the letter.

CHAIRMAN APOSTOLAKIS: -- writing our letter.

MEMBER WYLIE: Does that address all of the issues, though?

CHAIRMAN APOSTOLAKIS: Yes. That's another question because we --

MEMBER WYLIE: I don't think so.

CHAIRMAN APOSTOLAKIS: No?

MEMBER WYLIE: If you look at the SRMs, you've got the one where the Commission has told us to advise the staff on the appropriate methods for judging the acceptability and unacceptability of assumptions and models used in PRA.

CHAIRMAN APOSTOLAKIS: Which one is this, now? I'm sorry.

MR. MARKLEY: The June 11th SRM.

MEMBER WYLIE: Eleventh.

MEMBER SEALE: Now, which SRM do you specifically require?

CHAIRMAN APOSTOLAKIS: June 11th is addressed to us.

MEMBER SEALE: Yes. I think we're talking about the staff's SRM.

MEMBER WYLIE: That's the May 15.

MR. MARKLEY: The ACRS SRM, June 11th, has no suspense date. So you have some flexibility or wiggle time in addressing it. But the staff in order for them to have meaningful use of whatever feedback you give them, they really need it because their suspense date is September 20th.

MR. CUNNINGHAM: Right.

CHAIRMAN APOSTOLAKIS: Now, this statement about the use of expert judgment is just a statement. You really don't do anything; right?

MR. CUNNINGHAM: Yes.

CHAIRMAN APOSTOLAKIS: There's no question there.

MR. CUNNINGHAM: Yes, that's correct.

CHAIRMAN APOSTOLAKIS: Right. Okay. So I will finish on a cultural note. I handed out this morning the quotation from Pericles.

MEMBER KRESS: Was he a Greek or a Turk?

MEMBER FONTANA: Don't start a --

CHAIRMAN APOSTOLAKIS: I want it on the record.

MEMBER FONTANA: Did Pericles give the oration or he was the dead guy.

CHAIRMAN APOSTOLAKIS: He gave the oration.

He was the leader of a state. And he was honoring the dead.

MEMBER FONTANA: All right.

CHAIRMAN APOSTOLAKIS: Okay? And he said, "We are capable at the same time of taking risks and of estimating them beforehand." Now we're 25 centuries later.

MEMBER FONTANA: Haven't learned much, have we?

CHAIRMAN APOSTOLAKIS: And now we're beginning to actually do it; right? And there is still an unquantified part. But I just wanted to bring it to your attention. And he was not a Turk.

Thank you very much, gentlemen.

MEMBER KRESS: By the way, Mario and I have rewritten that so it conforms to the standards of ACRS.

MEMBER FONTANA: It's not politically correct either.

CHAIRMAN APOSTOLAKIS: You really want me to regret that I brought it up.

(Whereupon, the foregoing matter was concluded at 6:06 p.m.)

C E R T I F I C A T E

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: ACRS SUBCOMMITTEE ON PROBABALISTIC RISK ASSESSMENT

Docket Number: N/A

Place of Proceeding: ROCKVILLE, MARYLAND

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Corbett Riner

CORBETT RINER
Official Reporter
Neal R. Gross and Co., Inc.

#1

INTRODUCTORY STATEMENT BY THE CHAIRMAN OF THE
PROBABILISTIC RISK ASSESSMENT SUBCOMMITTEE
11545 ROCKVILLE PIKE, ROOM T-2B3
ROCKVILLE, MARYLAND
AUGUST 7, 1996

The meeting will now come to order. This is a meeting of the ACRS Subcommittee on Probabilistic Risk Assessment. I am George Apostolakis, Chairman of the Subcommittee.

ACRS Members in attendance are: Ivan Catton, Mario Fontana, Thomas Kress, William Lindblad, Don Miller, Dana Powers, Robert Seale, William Shack, and Charlie Wylie.

We also will have a presentation by ACRS Senior Fellow: Rick Sherry

The purpose of this meeting is to discuss risk-based inservice testing and inservice inspection requirements, pilot applications for risk-informed and performance-based regulations and related matters. The Subcommittee will also continue its discussion of issues identified in the Staff Requirements Memoranda (SRMs) dated May 15 and June 11, 1996, including: the role of performance-based regulation in the PRA Implementation Plan; plant-specific application of safety goals; and requirements for risk neutrality versus the allowance for acceptable increase in risk. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate, for deliberation by the full Committee.

Michael T. Markley is the Cognizant ACRS Staff Engineer for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the *Federal Register* on July 24, 1996.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register Notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have received no written comments or requests for time to make oral statements from members of the public.

(Chairman's Comments-if any)

We will proceed with the meeting and I call upon Mr. Gary Holahan of the Office of Nuclear Reactor Regulation to begin.

#2.

High Level Goal Definition and Risk Allocation

Rick Sherry
ACRS Senior Fellow

Meeting of the ACRS Subcommittee on Probabilistic Risk Assessment

August 7, 1996

Top Level Safety Goal Objectives for Offsite Consequences, Containment Performance (Large Ra[illegible]nuclide Release) and Core Damage

Controlling SG QHO

- SG IEFF QHO goal ≤ 3.5 E-7/ry

Subsidiary Goals

- LERF goal of ≤ 1E-6/ry
- CDF goal of ≤ 1E-4/ry
- CCFP goal of ≤ 0.1

Relationship of Various Safety Goal Objective to PRA Analyses

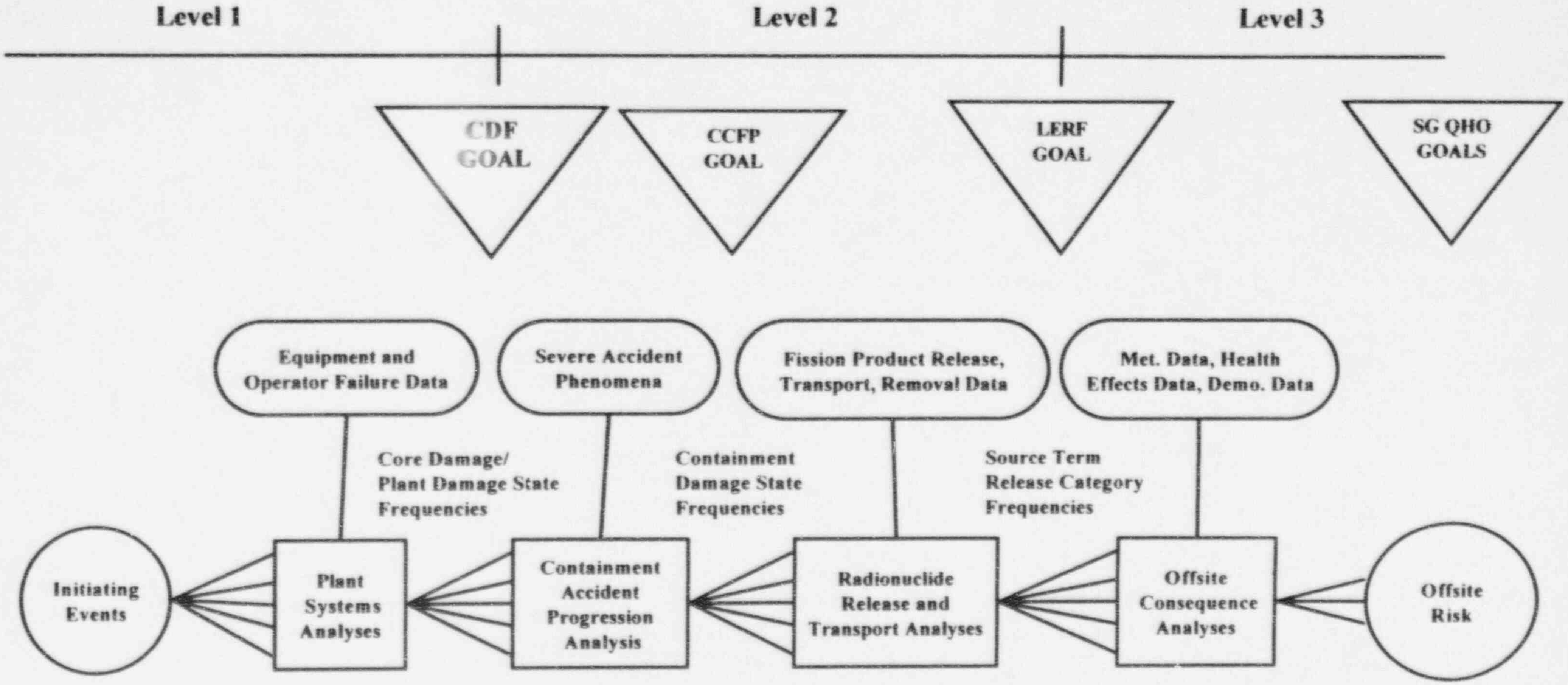


Figure 1 - Top Down Single Objective Approach for Determining Subsidiary SGs and Performance Crit

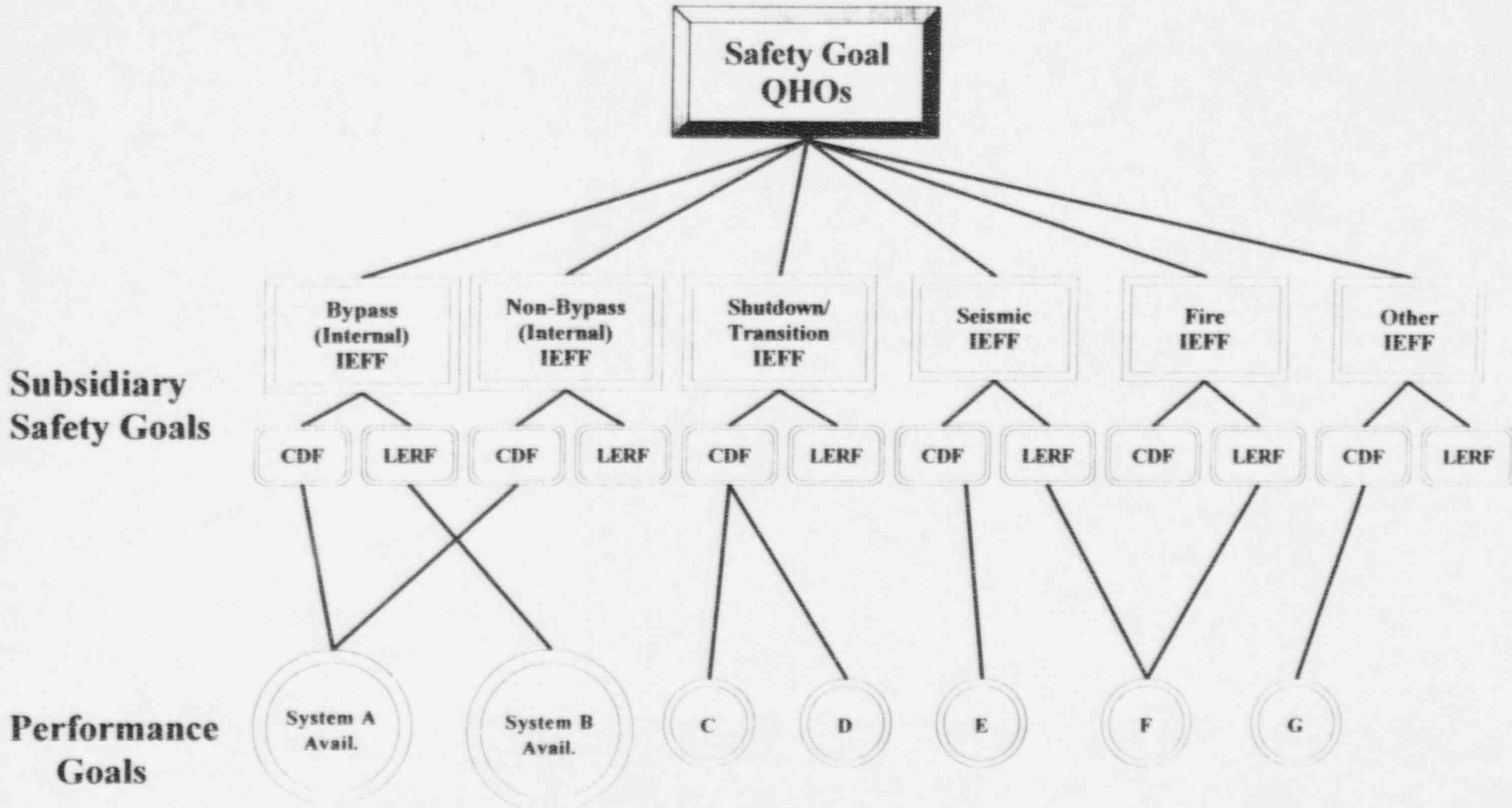


Table A - Surry - Summary of Major Risk Parameters by Core Damage Sequence Class						
Sequence Class	CDF	% Total CDF	LERF	% Total LERF	IEFF	% Total IEFF
Internal w/o Bypass	4E-5	27	6E-7	12	3E-9	3
Bypass-ISLOCA	2E-6	1	2E-7	4	1E-8	12
Bypass-SGTR	2E-6	1	---[a]	---	7E-10	0.6
Seismic[d]	6E-5	43	4E-6	83	9E-8	82
Fire	1E-5	8	6E-8	1	6E-10	1
Shutdown/Low Power	3E-5	19	---[b]	---	2E-8[c]	2
Totals	1.4E-4	99	4.8E-6	100	1.1E-7	101

a) No SGTR sequence release categories resulted in volatile fission product source terms that met the criteria for LERF.

b) Definition of LERF not meaningful for shutdown and low power sequences as a result of long decay times and the decay of short lived iodine and tellurium isotopes which are significant contributors to early health effects for accidents initiated at full power.

c) Estimated based on the conditional probability of Individual Early Fatality Risk calculated for internal event initiators.

d) Seismic results have been adjusted to account for the revised Lawrence Livermore Laboratories seismic hazard curves (Ref YY)

Definition of Large Early Release (LER)

(Sherry/Kaiser)

- Average release fraction of volatile radionuclides (I, Cs, Te) > 10%

and

- Release begins prior to implementation of emergency protective actions (evacuation)

BNL

- I, Cs release fraction > 5% or Te release fraction > 3%

Table B - Surry - Conditional Probabilities of a Large Early Release (LER) and Individual Early Fatalities (IEF)			
Sequence Class	LER Conditioned on CD	IEF Conditioned on LER	IEF Conditioned on CD
Internal w/o Bypass	.015	.005	.00008
Bypass-ISLOCA[a]	.13	.06	.0075
Bypass-SGTR[a]	---[b]	---[b]	.0004
Seismic	.07	.02	.0015
Fire	.005	.01	.00005
Shutdown/Low Power	---[c]	---[c]	.00006
All Sequences	.04[d]	.02[d]	.0008

a) Interfacing systems LOCA (ISLOCA) bypass sequences have been separated from SGTR bypass sequences due to large differences in conditional consequences

b) No radio nuclide release categories containing SGTR sequences met requirements for assignment to LER

c) Definition of LER not meaningful fo. shutdown and low power sequences as a result of long decay times and the decay of short lived iodine and tellurium isotopes which are significant contributors to early health effects for accidents initiated at full power

d) Does not include SGTR and Shutdown/Low Power sequences

Table C - Surry - High Level Goal Allocation---Single ObjectiveTop-Down Approach						
Sequence Class	Current IEFF NUREG-1150	IEFF Goal	LERF Goal	Percent LERF Goal	CDF Goal	Percent CDF Goal
Internal w/o Bypass	3E-9	5E-8	1E-5	26	6E-4	16
Bypass-ISLOCA	1E-8	2.5E-8	2E-7	0.5	3E-6	0.08
Bypass-SGTR	7E-10	2.5E-8	---	---	7E-5	2
Seismic	9E-8	5E-8	3E-6	8	3E-5	0.8
Fire	6E-10	5E-8	5E-6	13	1E-3	27
Internal Flooding	---	5E-8	1E-5[a]	26	6E-4[a]	16
Other External	---	5E-8	1E-5[a]	26	6E-4[a]	16
Shutdown/Low Power	2E-9	5E-8	---	---	8E-4	22
Totals	1.1E-7	3.5E-7	3.8E-5	100	3.7E-3	100

(a) LERF and CDF Goals Calculated Using Same Conditional Consequences as for Internal Events without Bypass

Figure 2 - Multi-Objective Approach for Determining Safety Goals and Performance Criteria

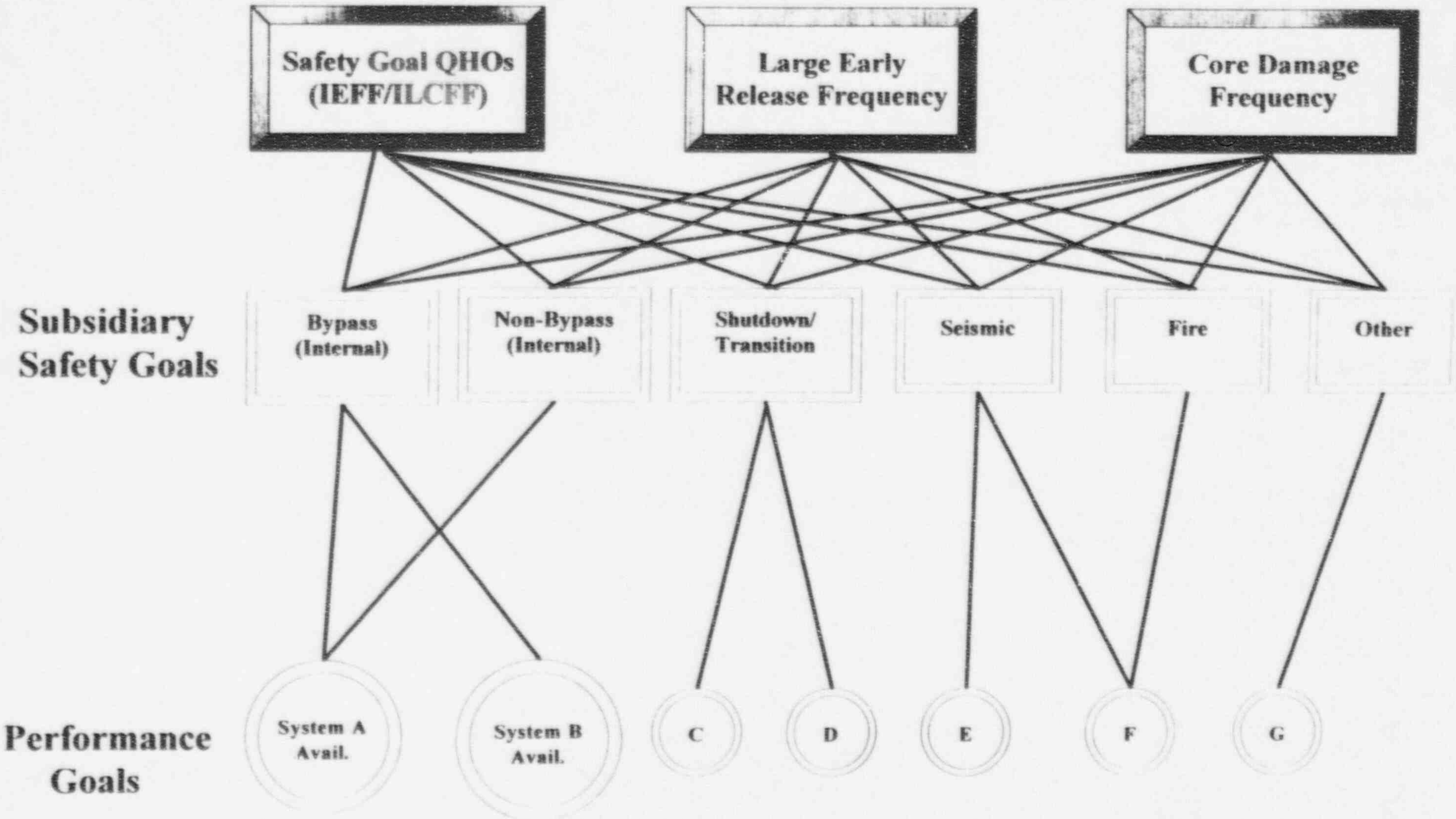


Table D - Surry - CDF Goal Allocation-Combined Multi-Objective Approach					
Sequence Class	CDF Goal Based on SG QHOs	CDF Goal Based on LERF SG	CDF Goal Based on CDF SG	Composite Multi-Objective CDF Goal	Calculated CDF NUREG-1150
Internal w/o Bypass	6E-4	1E-5	1.5E-5	1E-5	4E-5
Bypass-ISLOCA	3E-6	6E-7	7.5E-6	6E-7	2E-6
Bypass-SGTR	7E-5	---	7.5E-6	7.5E-6	2E-6
Seismic	3E-5	2E-6	1.5E-5	2E-6	6E-5
Fire	1E-3	3E-5	1.5E-5	1.5E-5	1E-5
Internal Flooding	6E-4	---	1.5E-5	1.5E-5	---
Other External	6E-4	---	1.5E-5	1.5E-5	---
Shutdown/Low Power	8E-4	---	1.5E-5	1.5E-5	3E-5
Totals	3.7E-3	---	1E-4	8.3E-5	1.4E-4

Observations and Conclusions

- Multi-objective top down approach appears to be most appropriate for definition of lower level goals and criteria
  - Reflects defense-in-depth philosophy
  - Specific objectives for core damage prevention, containment performance and offsite risk
  - A strict top-down approach using the SG QHOs as the only top objective can allow high CDFs (> 1E-3)
- CDF goal of 1E-4/ry will control the CDF (and risk) for all sequences other than those with high conditional consequences which will be controlled by the IEFF QHO or by the LERF goal
  - IEFF QHO goal and LERF goals are somewhat redundant. Both control high consequence sequences. May not need both
- Large Early Release (or Containment Failure Goal) difficult to formulate <u>for existing plants</u>
  - CCF goal does not recognize differences among designs in fission product mitigation in containment and is sensitive to "mix" of CD sequences
  - "Large early release" difficult to define and does not generalize well to shutdown sequences (important short half-life I and Te species have decayed) or seismic sequences (offsite emergency actions/sheltering factors much different than for non-seismic sequences)
- Seismic sequences are often dominant contributors to the IEF risk

Surry	82%
Peach Bottom	99+%

  - Top-down approach focuses on those structures, equipment and human actions important to seismic events. Is this appropriate given the large epistemic uncertainties in seismic hazard?
  - What standards or criteria related to seismic risk can be influenced by performance and monitored?

#3

INDUSTRY PERSPECTIVES ON SCREENING CRITERIA

Presented To:
ACRS

Presented By:
Tony Pietrangelo, NEI
Jack Haugh, EPRI
Doug True, ERIN Engineering & Research, Inc.

August 7, 1996

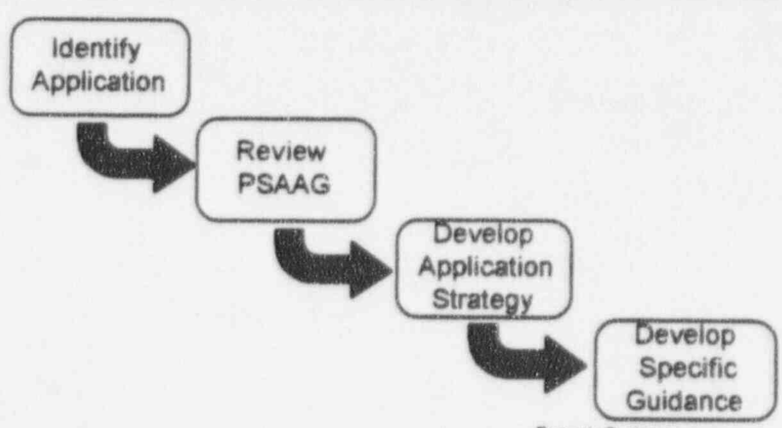
OVERVIEW

- PSA Applications Guide
- Considerations In Defining Screening Criteria
- Figures of Merit
- PSA Applications Guide Screening Criteria
- Maintaining Defense-In-Depth
- Dealing With Uncertainties

PSA APPLICATIONS GUIDE (PSAAG)

- Issued In Mid-1995 To Support Pilot Projects and Individual Utility Applications
- Provides General Overall Framework For PSA Applications, Not An Application-Specific Methodology
- Suitable Starting Point For Staff Efforts In Developing SRP/Reg. Guides
- Industry Would Welcome NRC Endorsement of PSAAG Screening Criteria

USE OF PSAAG FOR SPECIFIC APPLICATIONS



Example Guidance
- EPRI Risk-Based Tech Spec Guidelines
- NEI Risk-Based IST Guideline
- NEI Risk-Based ISI Guideline

CONSIDERATIONS IN DEFINING SCREENING CRITERIA

- Relationship To Safety Goal and Subsidiary Safety Objectives
- Figures of Merit
- Approaches To Defining Screening Criteria
- Current PSA Results

RELATIONSHIP TO SAFETY GOAL AND SUBSIDIARY SAFETY OBJECTIVES

- The Safety Goal's QHOs Relate To
  - Prompt Fatality Risk (<0.1% of other accidents)
  - Cancer Fatality Risk (<0.1% of other cancers)
- Several Interim Subsidiary Safety Goals Have Been Discussed
  - CDF < 1E-4/yr
  - CCFP < 0.1
  - Large Release Frequency < 1E-6/yr
- The Subsidiary Goals Are Not Derived From The QHOs, Nor Are They Commission Policy

MARGIN BETWEEN NUREG-1150 MEAN VALUES & SAFETY GOAL QHOs

PLANT	INDIVIDUAL EARLY FATALITY	INDIVIDUAL LATENT FATALITY
SURRY	28	1,000
PEACH BOTTOM	10,000	4,000
SEQUOYAH	50	182
GRAND GULF	12,500	4,444
ZION	50	182

NUREG-1150 PLANTS RELATIVE TO SUBSIDIARY GOALS

PLANT	CDF	CCFP	LRF
ZION	3.4E-4	.27	5E-7
SEQUOYAH	5.7E-5	.36	6E-7
SURRY	4.0E-5	.19	2E-7
PEACH BOTTOM	4.5E-6	.73	1E-9
GRAND GULF	4.0E-6	.77	3E-10
SUBSIDIARY GOAL	1E-4	.1	1E-6

SAFETY GOAL IMPACT ON SELECTION OF CRITERIA

- Criteria Should Reflect Both Prompt and Cancer Fatality Risk
- Subsidiary Goals Should Be Accommodated To The Degree They Support The QHOs
- No Single Subsidiary Measure Is Likely To Be Adequate

PSAAG FIGURES OF MERIT

- Two Quantitative Figures of Merit:
  - Core Damage Frequency (CDF)
  - Large, Early Release Frequency (LERF)
- Applications Address Both Prevention (CDF) & Mitigation (LERF) While Minimizing Need For Full Level 2 Analyses

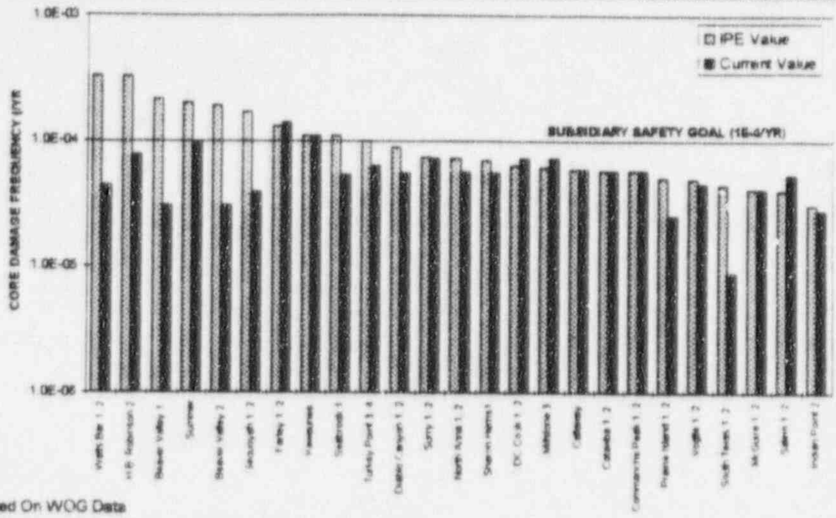
CONDITIONAL CONTAINMENT FAILURE PROBABILITY (CCFP)

- CCFP Is A Strong Function Of Plant Design & Mix of Core Damage Contributors
- High CCFP Does Not Translate To High Risk
- Frequency of Serious Release Provides Better Correlation To Plant Risk
- NUREG-1150 and Numerous IPEs Show That CCFP Is Not A Good Indicator Of Plant Safety And Can Lead To Illogical Conclusions

APPROACHES TO DEFINING SCREENING CRITERIA

- Absolute Criteria - Set limit on absolute value of change (e.g., 1E-6)
- Relative Criteria - Set limit on relative change (e.g., 1% or 10%)
- Ceiling Approach - Set upper limit on figure of merit & allow flexibility below limit (e.g., CDF < 1E-4/yr)
- Graded Approach - Variable limit based on baseline value of figure of merit

WOG COMPARISON OF PSA DATA

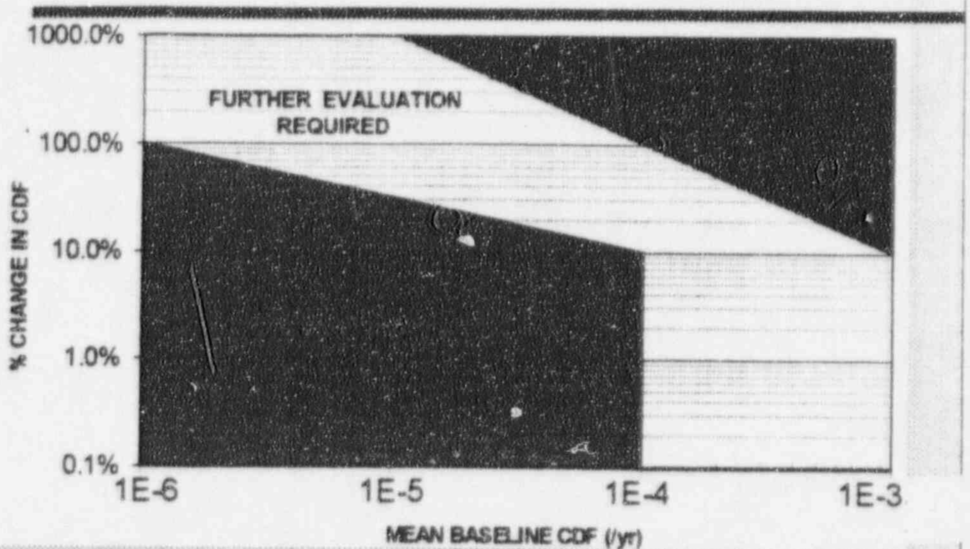


*Based On WOG Data

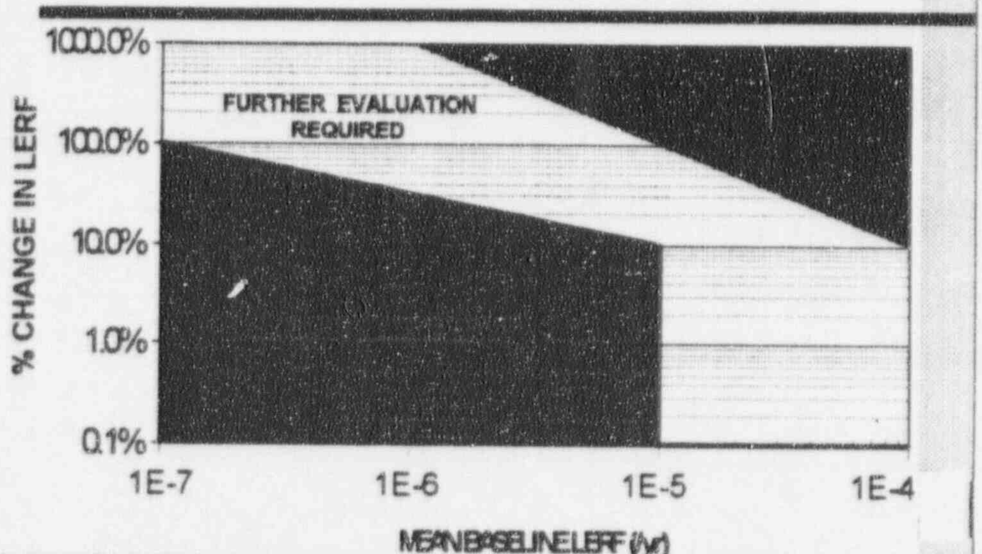
RELEVANT INSIGHTS FROM CURRENT PSAs

- CDFs Span Two Orders of Magnitude
- CCFPs Span Several Orders of Magnitude
- LERFs Span Over One Order of Magnitude
- Risk Awareness Has Resulted In Downward Trend For High CDFs
- Should Acknowledge These Variations

QUANTITATIVE SCREENING CRITERIA FOR PERMANENT CHANGES IMPACTING CDF



QUANTITATIVE SCREENING CRITERIA FOR PERMANENT CHANGES IMPACTING LERF

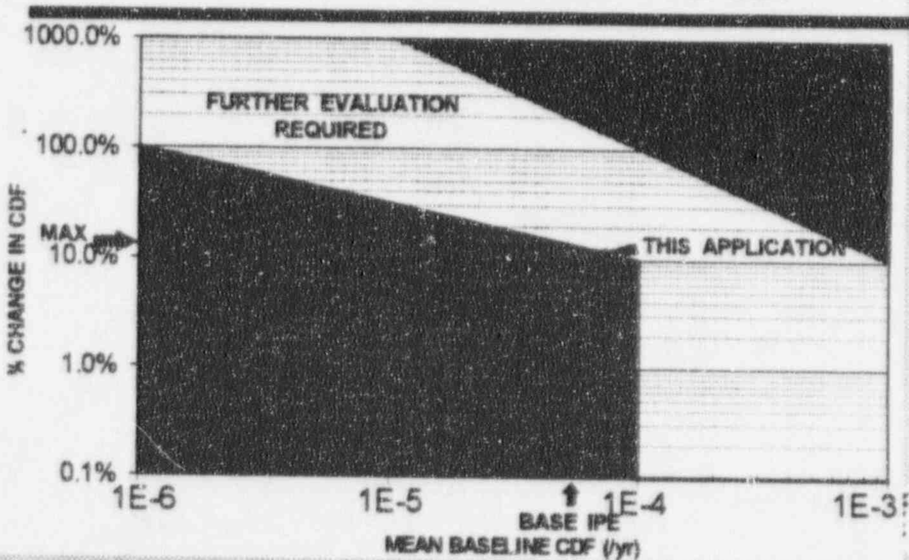


PERMANENT CHANGE - EXAMPLE

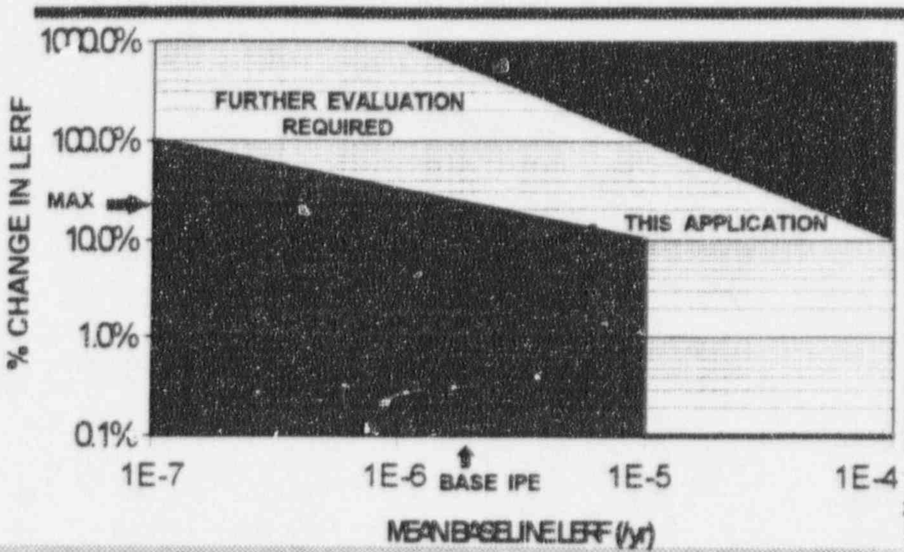
- A Proposed Design Change To Improve Operational Flexibility Involves The Addition of A New Motor Operated Valve To A Risk Sensitive System
- The Introduction of A New Component To The System Introduces New Failure Modes & Has A Small Impact on System Reliability During Power Operations Only
- A Sensitivity Study Yielded The Following Results:

CASE	CDF	LERF
Base Case (PSA)	5.3E-5/yr	1.8E-6/yr
With New MOV	5.8E-5/yr	1.9E-6/yr
Percent Change	9.4%	5.6%

QUANTITATIVE SCREENING CRITERIA FOR PERMANENT CHANGES IMPACTING CDF



QUANTITATIVE SCREENING CRITERIA FOR PERMANENT CHANGES IMPACTING LERF



PERMANENT CHANGE - EXAMPLE (Cont.)

- Qualitative Considerations Which May Apply:
  - What Accident Scenarios Are Most Impacted?
    - Are They New, Previously Unconsidered?
    - Were They Previously Negligible?
  - Are There Other Considerations That May Mitigate The Calculated Change In Risk?
  - Are There Unquantified Risks (or Benefits) Associated With The Change?
  - Are New Issues Raised?
    - New Common Cause Failures?
    - New Human Errors of Commission/Omission?
    - New Spatial or Equipment Interactions?

MAINTAINING DEFENSE IN DEPTH

- Objectives:
  - Defense In Depth of Fission Product Barriers Not Compromised
  - Frequency of Challenges Considered In Assessing Redundancy Impacts
  - Minimize Common Cause Potential
  - Consider Impacts Re: Deterministic Margins
- Operational Impacts Versus Configuration/ Design Impacts
- Expert Panels Play A Key Role

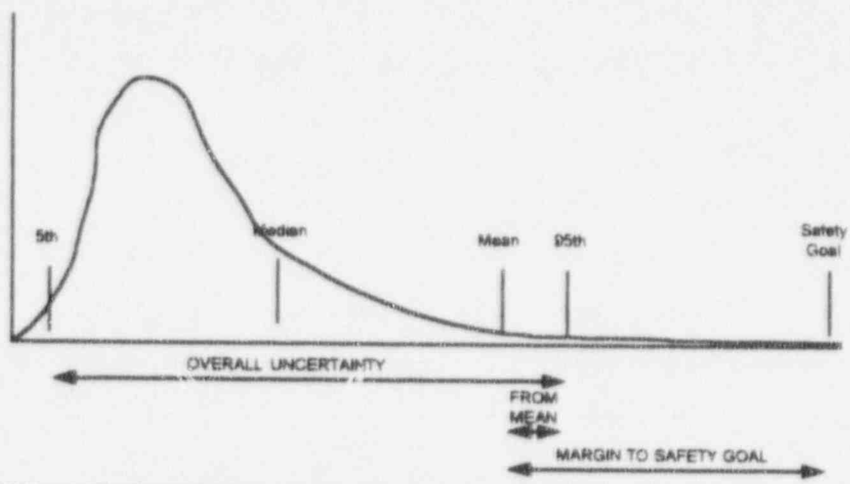
PSAAG HANDLING OF MULTIPLE CHANGES

- PSA Maintenance & Update Process Involves Update Every Two Refueling Cycles
- Updated Results, Including Applications, Are Compared To Permanent Change Criteria
- If Change Is Risk Significant, Risk Reduction Measures Investigated and Justification Developed

DEALING WITH UNCERTAINTIES

- PSA Is Not The Cause Of Uncertainty; It Allows Presentation of Uncertainty
- Overall Uncertainty Bands Associated With The Calculated Absolute Values Can Be Large
- Uncertainties In Relative Results Are Much Smaller
- However, Upper Bound Uncertainties Are Not That Large With Respect To Mean Values

TYPICAL UNCERTAINTY DISTRIBUTION



UNCERTAINTY BANDS IDENTIFIED IN NUREG-1150 PRESENTED AS A RATIO OF 95TH PERCENTILE TO 5TH PERCENTILE

RISK MEASURE	SURRY	PEACH BOTTOM	SEQUOYAH	GRAND GULF	ZION
INTERNAL EVENTS CDF	19	37	15	71	8
FIRE CDF	70	58	N/A	N/A	N/A
SEISMIC CDF (LLNL)	1,128	5,094	N/A	N/A	N/A
SEISMIC CDF (EPRI)	333	565	N/A	N/A	N/A
EARLY FATALITY RISK	23,810	21,667	4,000	27,273	300
LATENT FATALITY RISK	167	146	248	311	47
50 MI POPULATION DOSE	120	83	83	327	51
TOTAL POPULATION DOSE	129	122	174	360	44
INDIVIDUAL EARLY FATALITY	500	250	2,180	130	157
INDIVIDUAL LATENT FATALITY	183	66	217	214	67

UNCERTAINTY BANDS IDENTIFIED IN NUREG-1150 PRESENTED AS A RATIO OF 95TH PERCENTILE TO MEAN VALUE

RISK MEASURE	SURRY	PEACH BOTTOM	SEQUOYAH	GRAND GULF	ZION
CORE DAMAGE FREQ (INT)	3	3	3	3	2
FIRE CDF	3	3	N/A	N/A	N/A
SEISMIC CDE (LLNL)	4	4	N/A	N/A	N/A
SEISMIC CDE (EPRI)	4	4	N/A	N/A	N/A
EARLY FATALITY RISK	3	5	4	3	2
LATENT FATALITY RISK	5	4	6	3	3
50 MI POPULATION DOSE	6	3	5	3	3
TOTAL POPULATION DOSE	6	4	4	3	3
INDIVIDUAL EARLY FATALITY	3	5	5	3	1
INDIVIDUAL LATENT FATALITY	5	3	5	3	2

MARGIN BETWEEN NUREG-1150 MEAN VALUES AND NRC SAFETY GOALS

PLANT	INDIVIDUAL EARLY FATALITY	INDIVIDUAL LATENT FATALITY
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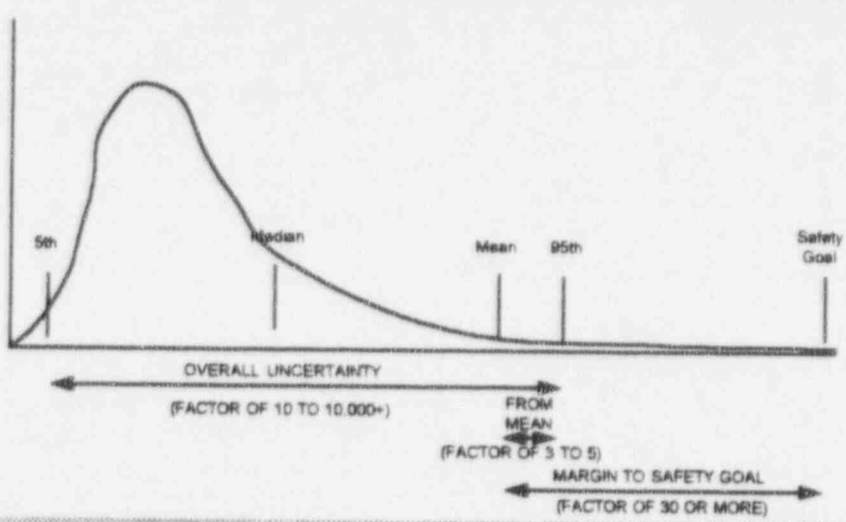
ZION	50	182

TYPICAL UNCERTAINTY DISTRIBUTION - NUREG-1150



CONCLUSIONS

- PSAAG Screening Criteria Are Adequate and Appropriate
- CDF and LERF Are Appropriate Figures of Merit That Already Address Subsidiary Goals
- Uncertainties Reflected In PSA Results Do Not Threaten Safety Goal And Are Less Significant For Relative Results
- Mean Values Acceptable For Screening Criteria
- Impacts On Defense In Depth Must Be Considered
- PSAAG Screening Criteria Provide Long Term Assurance of Meeting Safety Goals

; #4

CEOG Probabilistic Safety Assessment Applications

A. Hackerott (OPPD)
Chairman
CEOG Probabilistic Safety Assessment Working Group

Presentation to the ACRS
August 7, 1996

Overview of CEOG PSA Applications

- Background
- Current PSA Activities
- Joint Application Process
- CEOG Blended Approach
- Specific Applications Currently Under NRC Review
- Summary
- Conclusions

CEOG PSA Applications

Background

- Improvements based upon existing IPE insights have been performed to enhance safety at all CEOG utilities
- CEOG supports PSA risk informed operation as a means to simultaneously:
  - » Enhance plant safety
  - » Focus attention of plant resources
  - » Increase operating flexibility
- CEOG Management recognized the importance of risk informed decisions; PSAWG involved in PRA/IPE process for greater than nine years
- Pilot activities emerged as part of a PSAWG plan to establish PSA based licensing approaches

Current PSA Applications

- Technical Specification Changes
  - » AOT Extensions, Action Statements
  - » Mode 4 versus Mode 5 safe end states
- Risk Based ISI/ IST
- PSA Methodology Development
  - » Transition risk methods
  - » Global PSA model comparisons (phase 3)
- Inter-Relationship Between the Maintenance Rule, PSA, and AOT Extensions
- Standardized Guidelines
- Risk Informed Operation Program Plan

CEOG Joint Application Process

- New Process for "Group" Submittals
  - » Plant specific analyses across an industry group in a single report
  - » Group results provide an inherent technical credibility check
    - – Provides for a formal cross comparison
    - – Provides spectrum of results so that regulatory decisions not biased by a single "point"

CEOG "Blended" Approach

- **Approach Similar to That Used in Resolving Advanced Reactor Licensing Issues**
- **"Blended" Approach Integrates Full Scope of Issues In Supporting Technical Justification Including:**
  - » Justification of Need
  - » Consideration of Deterministic Issues
  - » PSA Assessment
    - – At Power Risk
    - – Transition and Lower Mode Risks
  - » Identification of Contingency/Compensatory Measures

PSA Applications

- Advantages of Joint Comparisons
  - » Focuses review resources on risk significant:
    - Modeling assumptions
    - Plant specific data
    - Unique plant design features
  - » Highlights commonalities as well as differences among plants
  - » Identifies risk significant insights
  - » Consistency and understanding provide confidence in application

Joint Comparisons for PSA Applications

- Steps for Cross Comparisons
  - » Identify an appropriate set of parameters and metrics for the application
  - » Compile plant specific PRA inputs and results
  - » Use PRA panel to resolve differences
  - » Determine importance of plant features or modeling assumptions
  - » Depth and scope of cross comparisons commensurate with application
  - » Focus on parameters important to the conclusion

CEOG PSA Applications

Pilot Technical Specification Modifications (Submitted 5/95)

- Applications Include Allowable Outage Times (AOTs) Modifications for:
  - » One Safety Injection Tank (SIT) Inoperable
  - » One Low Pressure Safety Injection (LPSI) SubTrain Inoperable
  - » One Emergency Diesel Generator Inoperable
- AOTs Chosen Based Upon Need and Low Risk
- Establish an Efficient Process for Integrating PSA in Regulation
- Initiated NRC Discussions on April 5, 1994

AOT Extensions

- **Control, Planning and Implementation of Maintenance Activities is More Important Than Duration**
- **AOT Extensions**
  - » Allow integration of risk into maintenance planning
  - » Allow sufficient time to perform most PM and CM tasks at power
  - » Allow flexibility in allocating plant resources
  - » Allow planning work for restoration times if required
  - » Allow increased availability of component at shutdown
  - » Reduces potential for exigent NOEDs
- **Maintenance Rule Governs Total Unavailability of Systems and Configuration Risk**

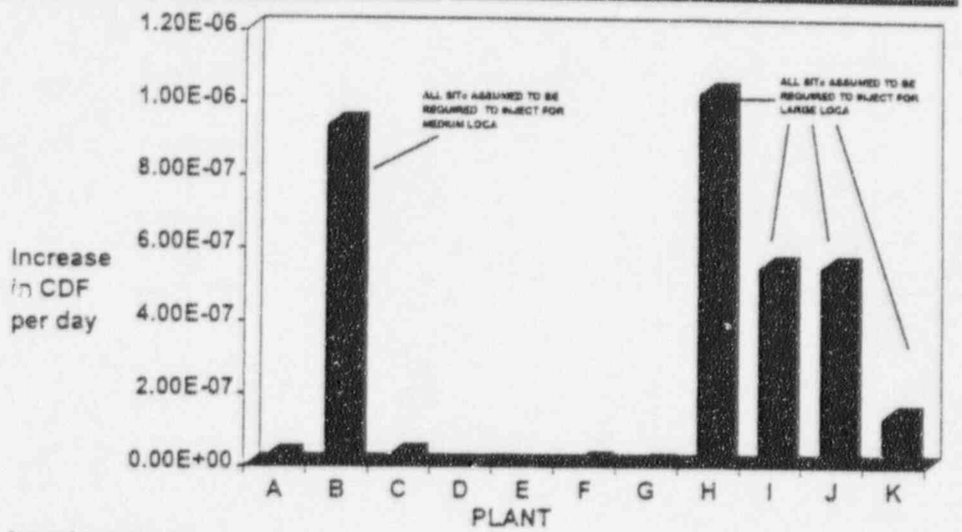
PSA Considerations

- "At Power" Calculations:
  - » Preventive
  - » Corrective
- Transition and Shutdown Risk Approximately Quantified
- Risk Comparisons for Different Modes Provide Insight Into Plant Operation and Decision Making

SIT AOT Change

- Extend AOT from 1 to 24 Hours
- Deterministic Considerations:
  - » SIT function limited to response to the large break LOCA
  - » Realistically, unavailability of 1 SIT will not impact ability of plant to respond to large LOCA
  - » Radiological releases bounded by existing source term
- PSA Evaluations Showed A Negligible to Small Risk Impact SIT Unavailability

Increase in CDF Due to Anticipated Corrective Maintenance (CM) for 1 SIT Unavailable (per day)



SIT AOT Change

- Insights from PSA Cross Comparisons:
  - SIT function and application is the same at all CE plants
  - PSA differences are PRA modeling factors not plant uniqueness
  - Most CEOG PSAs predict the impact of 1 SIT inoperable to result in a negligible impact on plant risk
  - A few utilities have very conservatively modeled the large LOCA and SIT criteria:
    - Large LOCA + 1 SIT Unavailable = Core Damage
  - Variation in PSA predictions are due to modeling and do not reflect real differences in risk
  - Variability in risk increase predominately related to IE frequency for large LOCA and selection of success criteria
  - Results could be approximately confirmed by simple order of magnitude PSA assessments
  - Low risk sequences frequently employ time saving conservative assumptions

SIT AOT Change

- Cross Comparison Provided:
  - » Understanding of how design basis assumptions (Appendix K) impact PRA
  - » Confidence that important plant behavior and relevant phenomena are adequately addressed

LPSI AOT Change

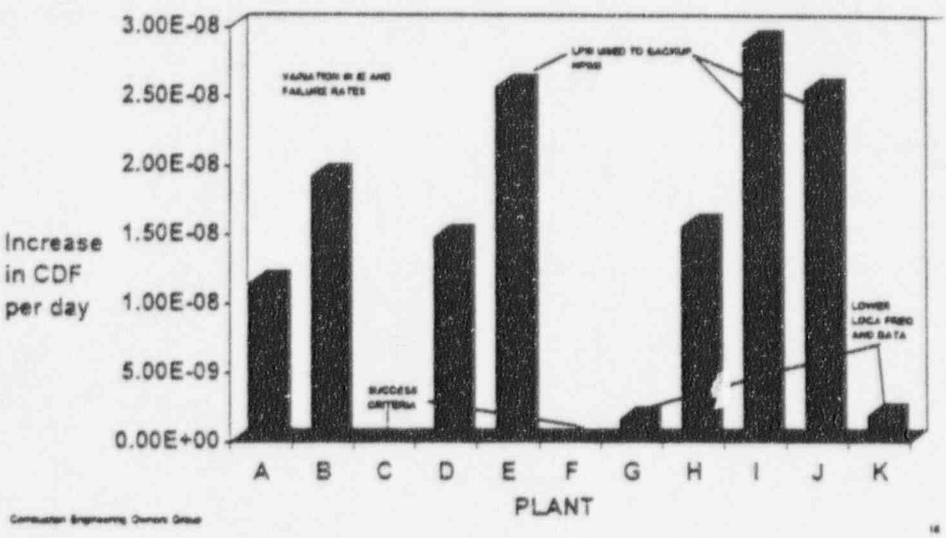
- Extend AOT to 7 Days
- Deterministic Considerations:
  - » At power the LPSI subsystem provides short term inventory control following a large break LOCA
    - Operation of one LPSI subsystem is adequate for the design basis accident
    - Radiological release bounded by existing source term
    - LPSI subsystem provides a backup means of core heat removal during events requiring lower mode transition
  - » At shutdown the components of the LPSI subsystem provide the primary means for core heat removal

LPSI AOT Change

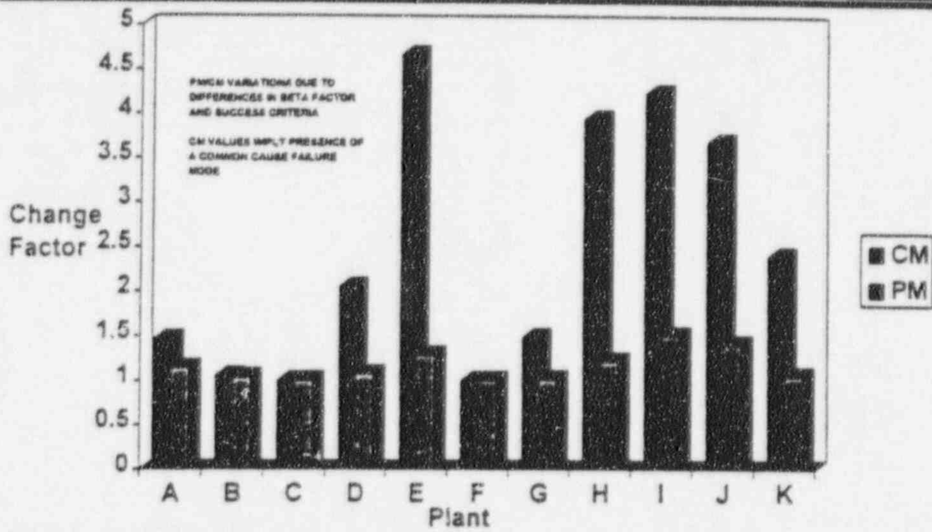
LPSI AOT Change

- Contingency/Compensatory Measures:
  - » Minimize maintenance associated risks
    - – PM on LPSI subsystem MOVs should b : performed individually
    - – If possible, valve maintenance should b· performed with the valve in the emergency position
  - » Small risk reduction will occur if concurrent maintenance on HPSI and LPSI in the same subtrain can be avoided

Increase in CDF Due to Anticipated Preventive Maintenance (PM) for 1 LPSI Train Unavailable (per day)



Comparative PM/CM Change Factors for 1 LPSI Train Unavailable



LPSI AOT Change

- **Cross Comparison Provided**
  - » Understanding of how design basis analysis modeled in PRA
  - » Confidence that the at power risk of LPSI unavailability is small compared to shutdown alternative
  - » Differences attributable to modeling assumptions particularly by IE LOCA frequencies and success criteria
  - » Insight that crediting use of LPSI as backup to HPSI (recovery action) impacts worth of LPSI. Larger benefits for plants with two HPSI pumps.
  - » Insight into relationship between PM and CM

LPSI AOT Change

- Insights from PSA CEOG Cross Comparison:
  - » LPSI function and application are the same at all CE PWRs
  - » All CEOG PSAs predict the impact of one LPSI inoperable to result in negligible to small impact on plant at power risk
  - » PSA differences are attributed to:
    - – Assumed large LOCA initiating event frequency
    - – Assumptions in common cause modeling
    - – Large LOCA success criteria
    - – Credits use of LPSI as backup to HPSI

EDG AOT Change

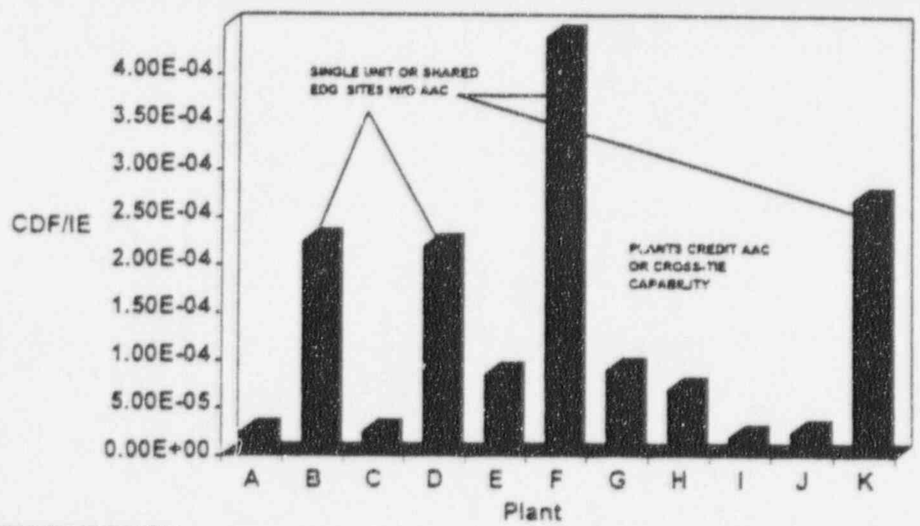
- **Existing AOTs Vary from 3 Days to 7 Days**
- **Present Task to Extend Emergency Diesel Generator (EDG) AOT**
- **Design Considerations:**
  - » EDG provides emergency plant power following events involving loss of power. Applies to both power and lower mode operations
  - » Most CEOG plants include provisions for independently powered alternate decay heat removal capability:
    - – Swing diesels
    - – Combustion turbines
    - – Diesel driven AFW pumps
    - – Unit cross tie capability

EDG AOT Change

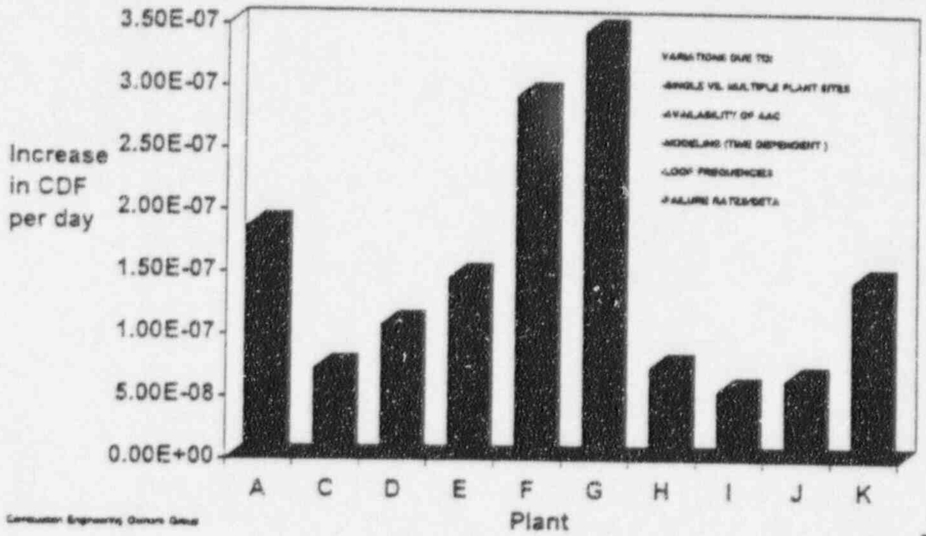
- PSA Results Show Small Potential Risk Increases Associated With Increased "At Power" Maintenance of EDGs

- Risks Controlled/Offset By Contingency Action/Planning

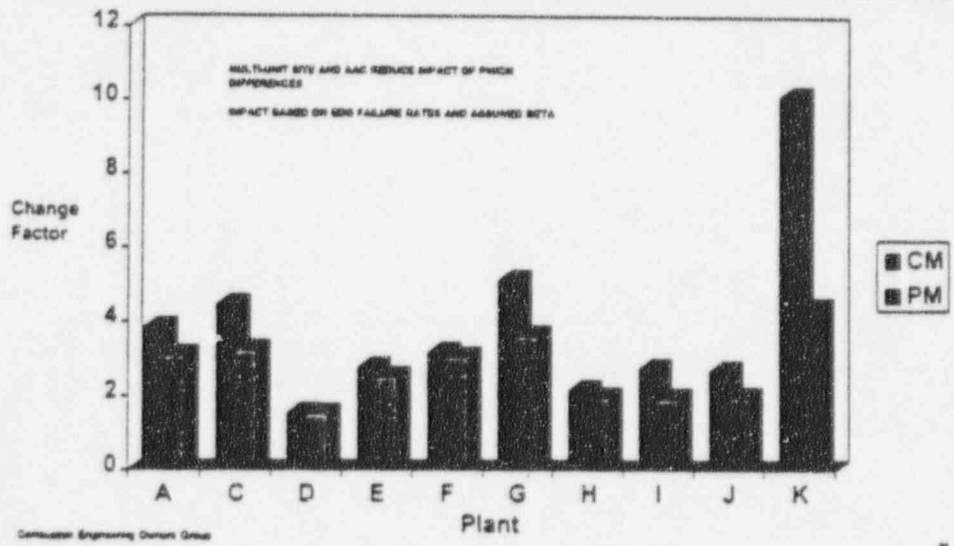
Plant Response to Loss of Offsite Power (LOOP) with EDGs Available



Increase in CDF Due to Anticipated PM for 1 EDG Unavailable (per day)



Comparative PM/CM Change Factors for 1 EDG Unavailable



EDG AOT Change

- **Insights from PSA Cross Comparison:**
  - » EDG function and application is the same at all CE PWRs. However, backup power and decay heat removal capabilities vary
  - » Differences among PSA predictions are attributed to:
    - – Site layout (single vs. multiple unit)
    - – Availability of alternate power sources or alternate decay heat removal systems
    - – Loop frequency
  - » Plants with single units and no independent backup equipment for decay heat removal predict the higher conditional risks given the loss of site power
  - » PSA modeling
    - – Treatment of run failure; consideration of recovery actions

EDG AOT Change

- **Cross Comparison Provided:**
  - » Understanding of importance of plant design features and modeling assumptions on PSA calculations
    - – Modeling sophistication impacts results
  - » Risk impact of PM vs. CM maintenance activities
  - » Uncertainties in IE frequency and modeling assumptions do not challenge validity of overall conclusion to extend AOT

CEOG PSA Applications

Emergency Diesel Generator (EDG) AOT Change

- Contingency/Compensatory Measures:
  - » Control of maintenance and development of contingency actions can be effective in minimizing risk
  - » Actions typical of those to be implemented in response to item A3 of the Maintenance Rule* include:
    - Initiating event hazards leading to loss of power (i.e., switch yard work) and weather conditions are minimized.
    - Maintenance to be performed without significant simultaneous maintenance activities
    - Compensatory measures to restore the EDG to service are developed
    - Confirmation of EDG inoperability is not due to a common cause failure
    - Assure independent backup power or heat removal capability is available prior to entry into the 10 day AOT due to a planned maintenance

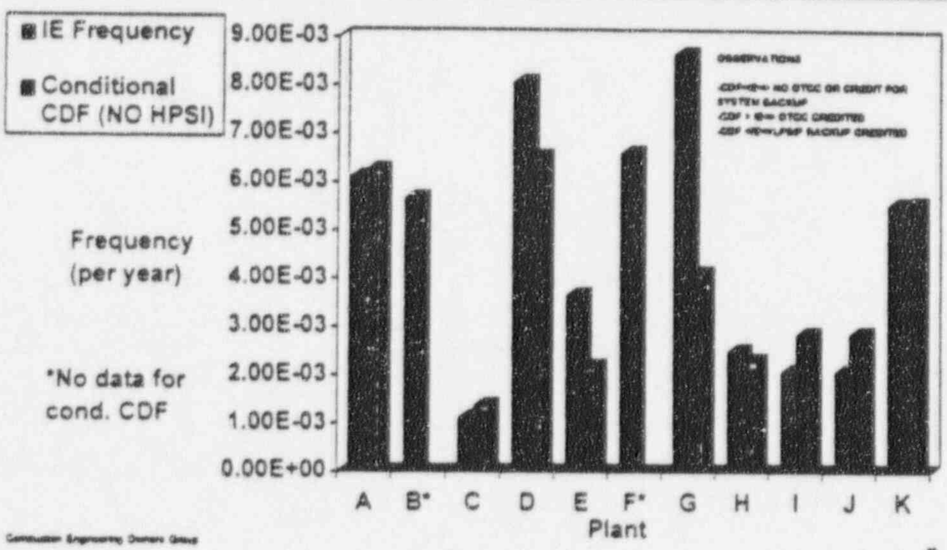
Insights of Comparison Process

- **Cross-Comparisons**:
  - » Cross-Check results/find errors
  - » Clarifies impact of modeling assumptions
  - » Clarifies impact of plant design differences
  - » Inherently considers "first order" uncertainties

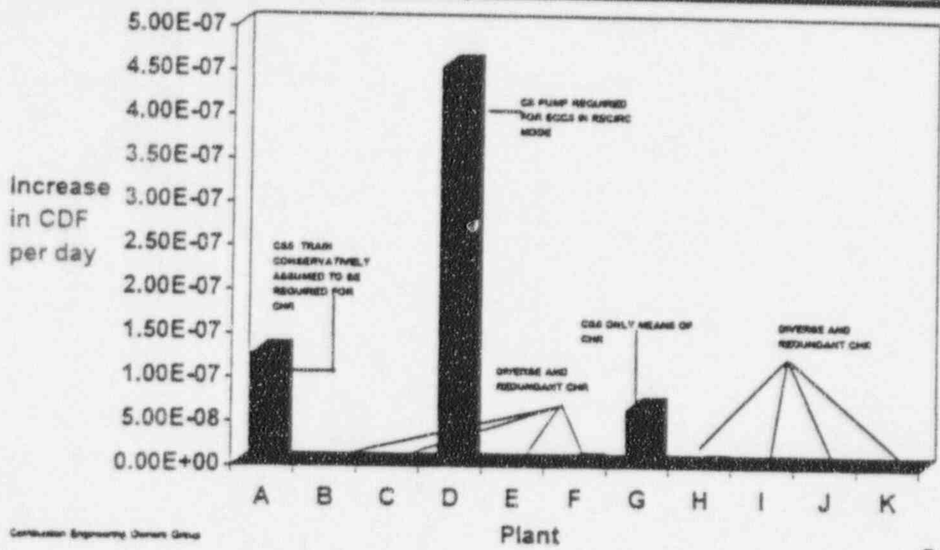
Joint Comparison Efforts

- Joint Comparison Process is being extended to other common systems and applications
  - » HPSI system
    - – Focuses attention to small/medium LOCA modeling and Once Through Core Cooling (OTCC)
  - » CSS system
    - – Focuses attention to sumpwater cooling and containment integrity
  - » AFW system
    - – Focuses attention to OTCC and SG heat removal functions
- Goal is to assure group results are scrutable

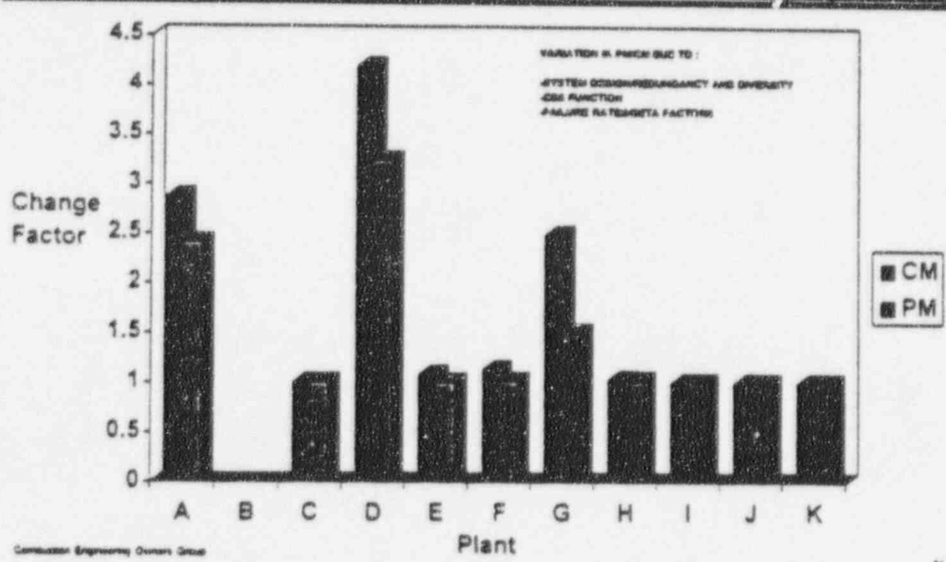
Comparison of LOCA Initiating Event Frequencies to LOCA CDF (HPSI System Unavailable)



Increase in CDF Due to Anticipated PM for 1 CS Train Unavailable (per day)



Comparative PM/CM Change Factors for 1 CS Train Unavailable



Summary

- **PSA Evaluations Indicate Requested AOT Changes Typically Range from Risk Beneficial to Risk Neutral**
  - » CM "at power" may be partially or totally offset by risks associated with mode transition and repair of the equipment at shutdown
  - » Small increments in the "at power" risk can be well managed in using Maintenance Rule
- **Requested AOT Extensions Provide Both Safety, Economic and Operational Benefits to the Utility**

Conclusion

- Results of Both Global and Application Specific Cross Comparisons Used to Update Plant Specific Living PSAs
  - » Application specific comparisons result in a deeper and more thorough understanding of all PSA models
  - » *Cross comparisons* (global and application specific) are the best way to certify plant specific models
  - » *Joint Applications* provide the best method for performing and validating PRA applications

Conclusion (cont.)

- Joint Applications Provide an Effective and Efficient Means of Integrating Risk Insights Into Regulation
  - » Current joint applications, with cross comparisons, provide quality commensurate with the applications
  - » Applications and their associated cross comparisons provide insights that improve:
    - – Plant specific PRA models
    - – PRA techniques
    - – Understanding of PRA technology by industry and staff

Pilot Applications

Edward J. Butcher
Michael C. Cheok

Presentation to ACRS
Subcommittee on PRA

August 7, 1996

TECHNICAL ISSUES IN RISK-INFORMED APPLICATIONS (LESSONS LEARNED FROM THE PILOT APPLICATIONS)

This presentation will discuss technical issues in risk-informed performance-based applications, and lessons learned from the pilot submittals

SCOPE OF THE PRA

Description of Issue:

How is acceptable risk defined for plants with partial-scope PRAs?

General Observations from Pilots:

- **From the IPE program, most plants have a basic level I PRA with level I/II interface. In addition, models and insights on external events developed for the IPEEE programs are also available.**
- **For determination of absolute risk, risk partitioning could be used for partial scope PRAs. For risk categorization, other evaluations are needed to support partial scope PRAs.**

SCOPE OF THE PRA (continued)

- Most pilots have CDFs that approach that of the safety goal subsidiary objective, especially when partition factors are taken into account:

		CP	PV	Surry	Fitz.	ANO	STP	GG
Full Power	Internal	6E-5	5E-5	1E-4	2E-6	4E-5	4E-5	2E-5
	Fire	2E-5		~5E-6				
	Seismic							
	Other	6E-6						
Shutdown				3E-5				

SCOPE OF THE PRA (continued)

- In the pilot IST risk ranking, CP added a total of 32 valves to the HSSC list as a result of Level II considerations. Of these, 17 were based on ISLOCA considerations, 8 were based on CIV considerations and the other 7 based on other LER considerations. PV added a total of 24 valves (16 from CIV and 8 from LER). In the GQA pilot, GG identified 2 new safety significant systems by performing sensitivity studies on the containment event trees.

- CP added 20 valves to the HSSC list based on its fire PRA. PV used an expert panel process for fires, and did not add any components to the HSSC list. In GQA, a review of the GG IPEEE fire analysis added 3 new systems to the safety significant list.

SCOPE OF THE PRA (continued)

- For shutdown, PV added 22 components to the HSSC list using insights from a yet to be completed PRA. CP added 15 components based on a comprehensive set of rules. Using the ORAM code and database to develop shutdown importance measures, GG identified 1 new safety significant sub-system.
- In the pilots, there were no additions to the HSSC list as a result of external events other than fires.

SCOPE OF THE PRA (continued)

Preliminary Conclusions:

- **If Level I/II interface trees are available, Level II PRAs are generally not necessary. However, the Level II plant damage state logic and the Containment Event Trees will provide useful insights on release timing and magnitude.**

- **For component categorization, shutdown PRAs would be useful but the lack of a PRA can generally be compensated for. PRA analysts and engineers familiar with all the shutdown modes and operations, and also with the internal events full power PRA can do a reasonable qualitative assessment of risk as long as success paths are clearly identified.**

SCOPE OF THE PRA (continued)

- **For risk ranking, external events PRAs should be required if these events contribute to 10% or more of the total CDF. PRAs are needed because:**

  1) external events could result in a mix of plant initiators that could result in relative importances of SSCs being changed;

  2) plant configurations can be altered by these initiators;

  3) spatially dependent CCFs which are unique to these initiators can be taken into account; and

  4) SSCs lost as a result of external events are usually non-recoverable.

QUALITY OF PRA

Description of Issue:

What is the required PRA quality for an application, and what is the process to review this quality?

General Observations from Pilots:

- PRAs used in pilot submittals are of varying quality with varying degrees of review. However, in general, the "quality" of pilot plant PRAs are better than the "quality" of the average IPE PRA.

Preliminary Conclusions:

- A well defined and documented peer review can help insure that PRA results and conclusions are sufficiently robust to be used to support decision making.

QUALITY OF PRA (continued)

- In addition to licensee demonstration of an independent review, a general overall focussed-scope review of the PRA and a review of the pertinent results (i.e. results and conclusions that affects the application in question) to see if there is consistency of results with PRA models and with general engineering judgement should also be carried out during the staff review process.

- Sensitivity studies on modeling and data issues with high uncertainty will bound the results and conclusions and will reduce the dependency of the results and conclusions on models and data used

- Expert panel deliberations on PRA results with feedback to resolve divergent views is also useful.

QUALITY OF PRA
SUB-ISSUE: TRUNCATION LIMITS

- **Preliminary results from the configuration risk profile studies show that as much as 82% of the total cutsets are eliminated when the truncation level is increased by a factor of ten (e.g., 1E-9 to 1E-8 or 1E-10 to 1E-9). These results also show that truncation levels lower than 1E-12 might be needed to obtain "stable" results in terms of ranking order.**

- **At STP the following was obtained:**

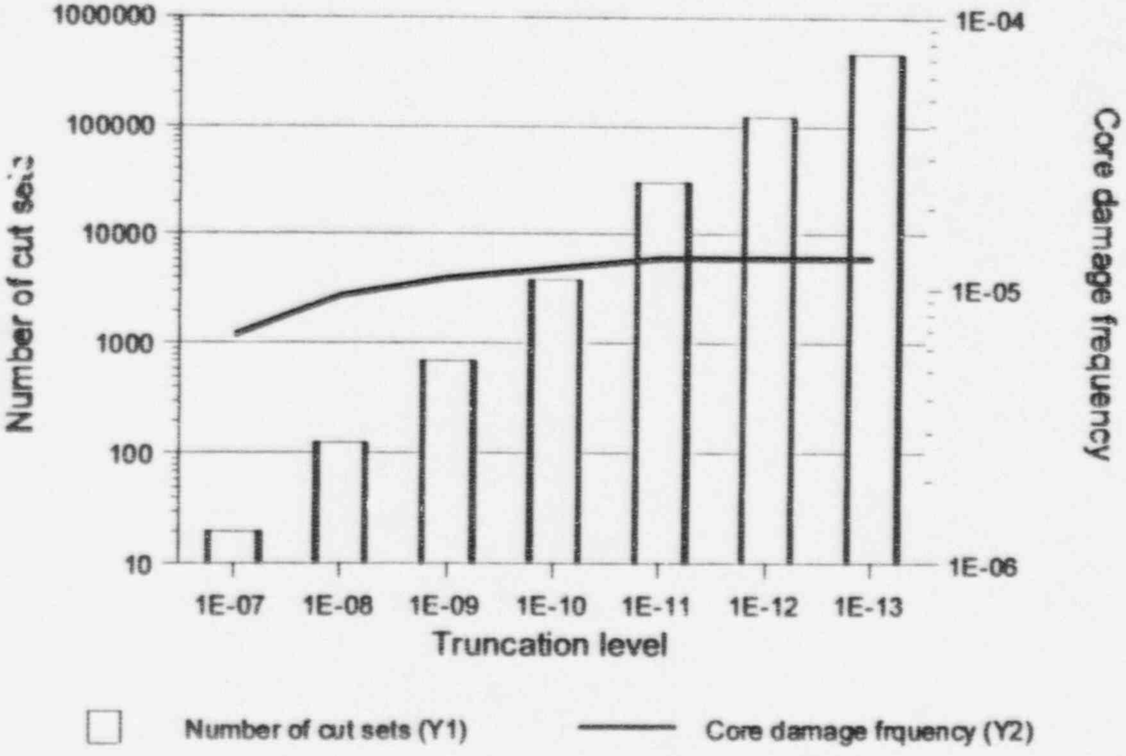
Truncation Limit	# of Sequences	% CDF
1E-8	241	67
1E-10	7,782	92
1E-12	115,314	97

QUALITY OF PRA
SUB-ISSUE: TRUNCATION LIMITS (continued)

- **The effects on STP SSC ranking are as follows:**

	1E-08	1E-10	1E-12
FV ≥ 0.01	61	69	74
FV ≥ 0.001	117	134	139
FV ≥ 0.0001	138	195	217
FV < 0.0001	232	526	548
RAW ≥ 10	264	303	331
RAW ≥ 2	54	139	113
RAW < 2	230	482	534

Core Damage Frequency and Number of Cutsets Sensitive to Truncation Limits



QUALITY OF PRA
SUB-ISSUE: MODELING AND QUANTIFICATION OF PROPOSED CHANGES

Description of Issue:

For many pilot applications (e.g., GQA and ISI), proven models do not currently exist for quantification of proposed changes.

General Observation from Pilots:

- **In GQA, there is little information and no models on the impact of reduced QA on SSC failure rates**
- **In ISI, models to quantify statistical fracture mechanics are relatively new and need thorough review**

QUALITY OF PRA
SUB-ISSUE: MODELING AND QUANTIFICATION OF PROPOSED CHANGES (continued)

Preliminary Conclusions:

- Analyses can be performed to determine a bounding impact on SSCs from the application. This will help determine bounding risk from the application.

- System and component level importance categorization should also be carried out to determine SSCs where contribution to plant risk is insignificant. This analysis will have to be performed together with identified sensitivity studies to ensure that identified LSSCs will remain as LSSC for the expected range of PRA assumptions, data and modeling techniques.

- Deterministic considerations (e.g., defense in depth) should also play a major role in risk categorization.

UNCERTAINTY/VARIABILITY IN PRA DATA AND ASSUMPTIONS

Description of Issue:

How do we account for PRA uncertainties in modeling and data?

General Observations from Pilots:

- **In many pilot submittals, uncertainties are not quantified. Instead, results are usually shown to be insensitive to various parameters by a set of sensitivity studies.**

- **In the limited pilot evaluations that included uncertainty analyses, it was shown that uncertainties do not alter the overall results.**

UNCERTAINTY/VARIABILITY IN PRA DATA AND ASSUMPTIONS (continued)

- **Studies on risk ranking show that, while an uncertainty analysis can provide valuable perspective to the results and can cause some changes in the relative ranking of some components, the overall risk categorization of components into a small number of groups is not affected.**

- **In a study involving modifications to LPSI/SIT AOT, a comparison of the CDFs using the current AOTs to extended AOTs showed a difference of less than 2% in the mean and median values and in the distributional moments greater than 2, confirming that in this case, the extended AOT has no impact on the shape of the CDF probability density function.**

UNCERTAINTY/VARIABILITY IN PRA DATA AND ASSUMPTIONS (continued)

Preliminary Conclusions:

Pilot approaches to addressing uncertainty are still being evaluated. More studies are being carried out to determine application cases where a full uncertainty analysis will be required.

DETERMINISTIC EVALUATIONS
SUB-ISSUE: DEFENSE IN DEPTH

Description of Issue:

How do we ensure that the appropriate levels of defense in depth are maintained?

General Observation from Pilots:

- **Most pilot submittals do not explicitly treat this issue except to state that since PRA implicitly treats defense in depth, PRA based conclusions would preserve defense in depth.**

- **However, it is the staff view that when components are picked for reduced regulation without consideration of defense in depth, there is a potential for erosion of multiple success paths. Continuing discussions are necessary to resolve this issue.**

DETERMINISTIC EVALUATIONS
SUB-ISSUE: DEFENSE IN DEPTH (continued)

Preliminary Thoughts:

The following are potential methods for ensuring the maintenance of defense in depth:

- **Assurance of at least one success path in the accident sequences that is not degraded by the change.**

- **Defining the elements and requirements for the redundant and diverse protection in each of the areas below:**

  - **Accident prevention**
  - **Accident mitigation**
  - **Accident containment**
  - **Emergency planning**

DETERMINISTIC EVALUATIONS
SUB-ISSUE: DEFENSE IN DEPTH (continued)

- **For example,**

CDF: Single active failure for DBAs
Better than single active failure for AOOs

LERF: Better than single active failure for initiators modeled

Shutdown Management: Redundancy required for success paths

CCF has be accounted for in each of the above criteria

ACCEPTANCE CRITERIA

Acceptance criteria is a sub-issue related to the issues of "use of safety goals" and "risk neutral vs. risk increase"

Description of Issue:

> **What acceptance criteria should risk-informed applications be evaluated against?**

General Observations from Pilots:

> **Current criteria used by pilots is based mostly on the EPRI PSA Applications Guide. This includes criteria for CDF and LERF and for classification of SSCs as HSSC or LSSC.**

ACCEPTANCE CRITERIA (continued)

Preliminary Conclusions:

The acceptance of risk-informed changes in regulatory requirements should depend on six elements:

- **risk significance of the change (CDF and LERF);**
- **maintenance of defense in depth;**
- **assurance that change will not result in outliers which might increase risk (importance categorization);**
- **consideration of cumulative effects of all changes;**
- **consideration of deterministic factors; and**
- **implementation of a performance-based feedback loop.**

INTEGRATION OF PROBABILISTIC AND DETERMINISTIC ISSUES

Description of Issue:

How should probabilistic and deterministic considerations be integrated?

General Observations from Pilots:

All pilot applications rely on expert panels for the integration of PRA and deterministic criteria. However, the process used by the pilots has to be better defined.

INTEGRATION OF PROBABILISTIC AND DETERMINISTIC ISSUES (continued)

Preliminary Conclusions:

- **A guideline detailing a well-defined, systematic, and scrutable decision process is needed.**

- **The panel members must have the appropriate qualifications and be provided with the appropriate information.**

- **Both probabilistic and deterministic considerations have to be taken into account. Potential limitations of the risk model have to be identified, discussed and resolved. SSCs that are affected by the proposed application but that are not modeled in the PRA have to be considered individually and evaluated based on a pre-defined and structured set of rules or criteria.**

ACRS PRA SUBCOMMITTEE

AUGUST 7, 1996

CHANGES IN IST AND ISI REQUIREMENTS

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CHANGES IN IST AND ISI REQUIREMENTS

- CURRENTLY, *10 CFR 50.55a* STIPULATES THAT ASME CODE CLASS 1, 2 AND 3 COMPONENTS MEET THE REQUIREMENTS OF ASME XI FOR IST AND ISI.

- CURRENT METHOD IS PURELY DETERMINISTIC AND FOLLOWS THE PRESCRIPTIVE CRITERIA OF SECTION XI OF THE ASME CODE AND APPLIES ONLY TO ASME CODE CLASS COMPONENTS.

- STAFF PLANS TO INVOKE *10 CFR 50.55a (a)(3)(i)* FOR THE REVIEW AND APPROVAL OF RI-IST AND RI-ISI PILOT PROGRAMS FOR PLANTS WHICH HAVE REQUESTED OR ARE IN THE PROCESS OF SUBMITTING REQUESTS TO USE RISK INFORMED METHODS.

- *10 CFR 50.55a (a)(3)(i)* PROVIDES FOR PROPOSED ALTERNATIVES TO THE REQUIREMENTS FOR IST AND ISI WHEN AUTHORIZED BY THE DIRECTOR OF THE OFFICE OF NUCLEAR REACTOR REGULATION PROVIDED THE LICENSEE DEMONSTRATES THAT THE PROPOSED ALTERNATIVE WOULD PROVIDE AN ACCEPTABLE LEVEL OF QUALITY AND SAFETY.

- PILOT PLANTS' PROPOSED METHOD IS BASED ON RISK SIGNIFICANCE AND DETERMINISTIC CONSIDERATIONS. SCOPE IS EXPANDED TO INCLUDE ASME COMPONENTS AND OTHER COMPONENTS THAT MAY BE RISK SIGNIFICANT.

- PILOTS WILL PROVIDE STEP-WISE AND PRE-PLANNED METHOD TO "CONVERT" FROM EXISTING ISI/IST PROGRAM TO RISK-INFORMED PROGRAM.

- INTERACTION WITH PILOT PLANTS EXPECTED TO CONTRIBUTE TO DEVELOPMENT OF REGULATORY GUIDES (RGs) AND STANDARD REVIEW PLANS (SRPs)

- STAFF WILL INFORM COMMISSION OF APPROACH PRIOR TO APPROVAL OF PILOT PROGRAMS - COMMISSION SRM

- PILOT PLANTS WILL BE EXPECTED TO MODIFY PROGRAMS TO CONFORM WITH FINAL RGs AND SRPs.

- NRC WOULD ENDORSE (WITH LIMITATIONS, IF NECESSARY) RISK-INFORMED CODE CASES BEING DEVELOPED BY ASME.

- STAFF WOULD BE WILLING TO CONSIDER RISK-INFORMED ALTERNATIVES FOR OTHER PLANTS AFTER FINAL RGs AND SRPs ISSUED, BUT SUCH REVIEWS AND APPROVALS WOULD BE PROCESSED CONSISTENT WITH NRR'S REVIEW RESOURCES.

United States
Nuclear Regulatory Commission

Issues Related to the Risk-Informed Regulatory Process

Mark A. Cunningham
Ann Ramey-Smith
Office of Nuclear Regulatory Research

Presentation to ACRS Subcommittee on PRA
August 7, 1996

#7.

Overview

- **Revisit and elaborate on key issues discussed at July 18 meeting of the Subcommittee:**
  - **Risk evaluation issues**
    - **Can the Commission's Safety Goals and subsidiary objectives be referenced or used to derive guidelines for plant-specific applications?**
    - **Should requested changes be risk-neutral or should risk increases be permitted?**

Risk Evaluation Issues - Use of Safety Goals

- **Issue: Can the Commission's Safety Goals and subsidiary objectives be referenced or used to derive guidelines for plant-specific applications and, if so, how?**

- **Options:**

  1) **Yes, utilize existing subsidiary safety goal objectives to derive acceptance guidelines for plant-specific applications**

  2) **No, establish relationship between plant-specific risk changes and industry population goals and subsidiary objectives**

  3) **Yes, utilize existing Regulatory Analysis Guideline process for applying safety goals and subsidiary objectives on a plant-specific basis**

  4) **No, define plant-specific safety goals considering societal risk and site characteristics**

- **Initial Staff Opinion: Option 1**

Risk Evaluations Issues - Use of Safety Goals (cont.)

- **Observations from presentation by Dr. Sherry:**
  - **Strict top-down approach using the SG QHOs as the only top objective can allow high core damage frequencies**
  - **Subsidiary CDF objective (1E-4) will control the CDF (and risk) for sequences other than those with high conditional consequences which will be controlled by the individual prompt fatality QHO or by a LERF goal**
  - **Multi-objective top down approach appears to be most appropriate for definition of lower level goals and criteria**

Risk Evaluations Issues - Use of Safety Goals (cont.)

- Issue: How are uncertainties to be accounted for?

- Options:

  1) Establish margin in guidelines sufficient to allow use of point estimate

  2) Define how to use uncertainty analysis in assessing against guidelines (e.g., utilize mean values)

  3) Utilize sensitivity analysis

- Initial staff opinion - Option 2 for detailed analysis

Excerpts from Safety Goal Policy Statement - Treatment of Uncertainties

To the extent possible, the Commission intends to ensure that the quantitative techniques used for regulatory decisionmaking take into account the potential uncertainties that exist so that an estimate can be made on the confidence level to be ascribed to the quantitative results.

The Commission has adopted the use of mean estimates for purposes of implementing the quantitative objectives of this safety goal policy ...

... sensitivity studies should be performed to determine those uncertainties most important to the probabilistic estimates.

Risk Evaluations Issues - Risk Neutrality

- **Issue:** Should requested changes be risk-neutral or should risk increases be permitted?

- **Sub-issue (a):** Should the acceptance criteria be different for plants that do not meet the guidelines?

- **Options (Sub-issue a):**

1) Plants much better than guidelines
   - Only neutral changes permitted
   - Allowed to increase to guidelines
   - Allowed to increase to some fraction of guidelines

2) Plants near guidelines
   - only neutral or risk reduction
   - small increase allowed

3) Plants not meeting guidelines
   - Small increases permitted
   - Only neutral changes permitted
   - Only risk reduction permitted

Risk Evaluations Issues - Risk Neutrality (cont.)

- Results from Dr. Sherry's presentation (Table D)
  - CDF goal: 1 E-4 per reactor year
  - Calculated CDF for Surry (NUREG-1150): 1.4 E-4 per reactor year
- Alternative interpretations of goal
  - "bright line"
  - Center of fuzzy region
- Comparisons for other plants
  - CDF < < goal
  - CDF > > goal

Risk Evaluation Issues - Risk Neutrality (cont.)

- **Issue:** Should requested changes be risk-neutral or should risk increases be permitted?

- **Sub-issue (b):** Should requested changes be considered individually or "packaged" when assessing risk?

- **Options (Sub-issue b):**

  1) Changes within one application area (e.g., IST) only

  2) Packaging across application areas permitted

  3) Packaging across application areas permitted, with certain limitations.

United States
Nuclear Regulatory Commission

Performance-Based Regulation and Risk-Informed Pilot Applications

Gary M. Holahan

Presentation to ACRS Subcommittee on PRA

August 7, 1996

RISK-INFORMED REGULATION

Insights Derived From Probabilistic Risk Assessments Are Used In Combination With Deterministic System And Engineering Analyses To Focus Licensee And Regulatory Attention On Issues Commensurate With Their Importance To Safety

PERFORMANCE-BASED REGULATION

A Performance-Based Regulatory Approach Consists Of At Least Four Key Elements:

- There Are Measurable Parameters To Monitor Plant And Licensee Performance
- Objective Criteria Are Established To Assess Performance Based On A Combination Of Risk Insights, Deterministic Analysis And Performance History
- There Is Licensee Flexibility To Determine How To Meet Established Performance Criteria
- Failure To Meet A Performance Criterion Must Not Result In Unacceptable Consequences

PERFORMANCE-BASED REGULATION

- Issue: How should performance-based regulation be implemented in the context of risk-informed regulation?

- Options:

  1) Where practical, include performance-based strategies in implementation and monitoring step of risk-informed regulation decision process

  2) Commission explicitly address scope and role of performance-based regulation in regulatory process

PERFORMANCE-BASED REGULATION

Current staff proposal:

- Only limited implementation of performance-based element is practicable in near term risk-informed activities
- Include a feedback mechanism in the pilot applications where the results from implementing the risk-informed regulation are evaluated for its safety impact, resource benefit, and effectiveness
- Consider pilot application of industry performance-based initiatives where objective criteria can be established for performance monitoring and where failure to meet the performance criteria results in tolerable conditions

OBJECTIVES OF PILOT APPLICATIONS

- To evaluate the different PRA methodologies, gain additional experience using PRA in regulatory activities, and develop decision criteria for use in RG/SRP development
- Identify PRA issues and deterministic issues related to pilot applications, determine safety significance of each issue and its resolution
- Test implementation of pilot programs through feedback mechanism and licensee corrective action

WHY THESE PILOT APPLICATIONS?

- Issues associated with pilot applications are representative of wide-range of issues associated with risk-informed regulation

- Interactions sufficiently focused to identify and resolve many policy and technical issues

- Pilot Applications are responsive to industry initiatives for reducing burden using risk-informed approaches

- Pilot applications are helping staff improve safety decision-making in the context of current industry applications -- for example Graded QA

HOW PILOTS HELP IN DEALING WITH THE TECHNICAL ISSUES

		IST	ISI	GQA	T.S.
PRA Quality	Scope	✓	✓	✓	✓
	Level of Detail	✓	✓	✓	✓
	Result Truncation	✓	✓	✓	✓
	Uncertainty	?	?	?	✓
	Lack of Models / SSCs not Modeled	✓	✓	✓	
PRA Acceptance Guidelines	Probabilistic Criteria	✓	✓	✓	✓
	Defense in Depth	?	?	?	✓
	Role of Importance Analysis	✓	✓	✓	✓
Integration of Probabilistic and Deterministic	Deterministic	?	?	?	✓
	Expert Panel	✓	✓	✓	
Monitoring Strategies	Performance Monitoring	✓	✓	?	✓

✓ = Pilot was helpful in addressing technical issues; ? = Need to be pursued further

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We Athenians, in our own persons, take our decisions on policy and submit them to proper discussion. The worst thing is to rush into action before the consequences have been properly debated. And this is another point where we differ from other people. We are capable at the same time of taking risks and of estimating them beforehand. Others are brave out of ignorance; and when they stop to think, they begin to fear. But the man who can most truly be accounted brave is he who best knows the meaning of what is sweet in life and what is terrible, and he then goes out undeterred to meet what is to come.

Pericles' Funeral Oration in Thucydides'
"History of the Peloponnesian War"
(started 431 BC)

#10

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SAFETY GOALS AND RELATED QUESTIONS

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ABSTRACT

A discussion is given of the question of safety goals and the related questions 'How much risk is acceptable?' and 'How safe is safe enough?'. Taken at face value, these questions are misleading and illogical in that, in isolation, no risk is acceptable and nothing is ever safe enough. Thus, the old regulatory concept of pass-fail criteria based on risk alone is unworkable and should be replaced by one based on the best cost-benefit-risk mix of all available options.

1. INTRODUCTION

The question of what safety goals should be established for nuclear power plant has been receiving a great deal of urgent attention and debate recently, both by those responsible for reactor licensing[1,2] and by others interested in establishing a quantitative measure of reactor safety.[3] The same question, phrased alternatively in the forms: 'What is acceptable risk?' and 'How safe is safe enough?', has been debated extensively for quite a long time.

Whichever form is used, this question is obviously one of much importance and many difficulties. The purpose of the present paper is to suggest that part of the difficulty may originate in the particular way the question is being phrased. Indeed, when a question has been debated as long and as unsuccessfully as this one, that is often a clue that there is something amiss about the question itself.

What seems to be amiss is that, taken at face value, the way the question is phrased above would seem to suggest that decisions and regulations can be based on consideration of safety and risk alone. Actually, as Starr,[3] Okrent[1] and many others

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have emphasized, risks must be considered together with the costs and benefits of all available alternatives. This emphasis, however, is not present in the above phrasing. This phrasing is thus used among insiders to the debate as a kind of shorthand or code phrasing for the more complete and meaningful questions underlying. The problem with this is that non-insiders, who don't fully understand the code, tend to misinterpret the meaning of the questions, thus contributing further to an already confused and emotional public debate of energy alternatives and societal risk in general.

As a contribution to making these debates more productive, we should like in the present paper to shed some light on the nature of this misinterpretation problem. For this purpose we adopt the device of taking the above questions totally at face value, interpreting them as meaning exactly what they say. We then show that, so taken and interpreted, the questions are unanswerable, other than trivially, and are therefore incapable of satisfactory resolution.

We shall argue in fact that, so phrased and taken at face value, the questions are logically absurd and in this sense bear a resemblance to other well-known questions of the same ilk, such as: 'How many angels can stand on a pin?', 'Have you stopped beating your wife?', 'What is the sound of one hand clapping?', 'Does the barber who shaves those men who do not shave themselves, shave himself?' and 'Is the statement, "This statement is false" true or false?'

Now, to say that a question is a logical absurdity does not mean that it is valueless. Quite the contrary is true, in fact; for all questions are asked with respect to a specific context. Thus, when a logically absurd question can be asked within a given context, that is a signal to us that the context itself is no longer workable and needs to be enlarged. When we succeed in enlarging the context, we thereby expand our understanding, and do what we call 'moving closer to the truth'. Indeed, this process of paradox identification followed by context expansion is well known, the theories of relativity and quantum mechanics being two notable examples.

The purpose of the present paper, therefore, is to show that the above questions, taken at face value, exist within an unworkable context, which we shall call the 'old regulatory context' (ORC), and that within this context lead to several absurdities. We shall argue that this context needs to be replaced by another context, which we call the 'decision theory context' (DTC), and which we hope will also become the 'new regulatory context (NRC), not only for nuclear plant issues but for all public issues.

Accordingly, we begin in the next section with a concise review of the decision theory context. We then see the ORC as only a limited part of the DTC and show the logical problems that follow from this incompleteness. We then acknowledge that the full DTC is difficult to use in practice but argue that this is no reason to discard it, since discarding it amounts to replacing difficulty with absurdity which is worse. We suggest instead another approach which retains the DTC in principle but makes approximations to it so that it can be applied in practice.

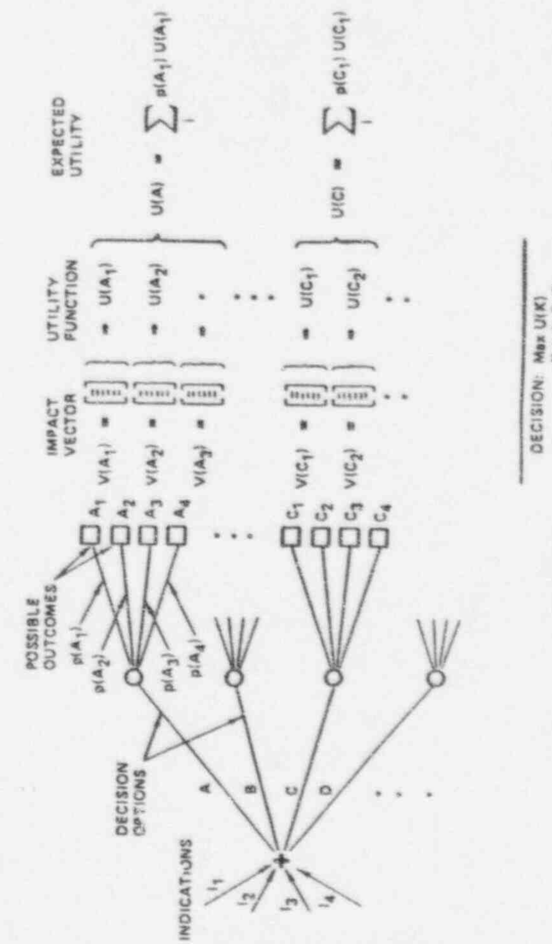


Fig 1. Model of a decision made in the decision theory context.

2. DECISION THEORY

Figure 1 is a version of the well-known decision theory diagram[4] or model of a decision situation. At the left is represented the point of decision with various items of information feeding into it. On the basis of this information, we need to choose between options A, B, ... N.

If we knew for certain what would be the outcome of each option the decision, of course, would be easy. What makes the situation interesting is uncertainty. The uncertainty is represented in Fig. 1 by showing a set of possible outcomes, e.g. $A_1, A_2, \ldots$, for each option. The best we can do, standing at the decision point, is to look ahead and assign a probability to each of the possible outcomes, assuming we choose the corresponding option. These probability values represent our state of knowledge at the point of decision, based upon all the information available there.

Associated with each outcome is a set of 'impacts' which we regard as listed in a linear array called the impact 'vector' to denote the fact that in general there are many different impacts or categories of impact associated with a given outcome.

Next we must feed into the decision process the notion of 'preference', that is we must say which sets of impacts we prefer to which others, and by how much. Analytically, this is done by establishing a 'utility' function which maps each impact vector into a single scalar, an ordinary number which expresses our preference value for that set of impacts.

This being done we may now calculate the 'expected utility' associated with each option as the sum, over the possible outcomes of that option, of the product of the probability of that outcome multiplied by its utility.

According to this model of the decision process, the optimum decision is that option having the largest expected utility.

This is the fundamental model of a decision situation. It is necessary to remark that in order for the model to represent a real life decision situation, it must include all the options present in that situation, including, for example, the option of not deciding—which is itself a decision, though rarely the optimum one. Similarly, it should include the option of delaying the decision while we gather further information. Both these options have probabilities, outcomes, impacts and utilities like any other option and should be included explicitly in the decision diagram.

3. AN ALTERNATIVE FORMULATION

We now give an alternative formulation of the decision diagram which is better suited to our needs here. For this purpose we so define impacts such that there are only three components in our impact vectors, namely, 'cost' c, 'benefit' b and 'damage' x. We consider moreover the simplest case in which our uncertainties about the

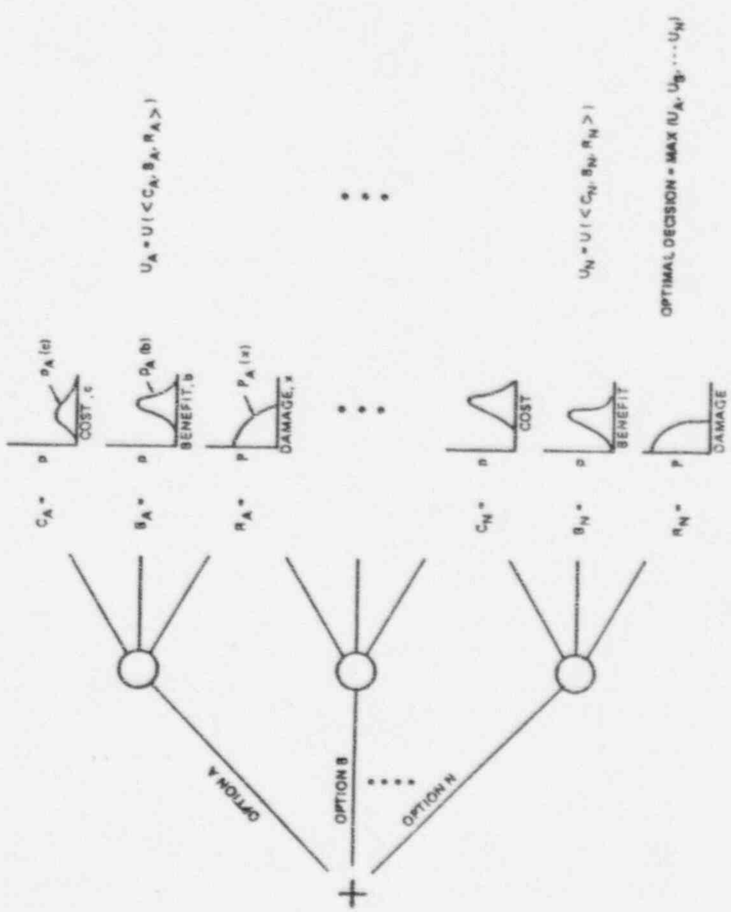


Fig. 2. Model of a typical decision situation.

magnitudes of cost, benefit and damage are independent of each other. We may then draw the decision diagram in the form of Fig. 2.

In this figure we allow C_A, the cost of option A, to stand for the entire probability density function $P_A(c)$. Similarly B_A, the benefit of A, to stand for the pdf $P_A(b)$. In the case of damage, in keeping with current convention, we show the probability curve drawn in complementary cumulative form, and we denote this curve by $R_A(x)$, the risk of A.†

We now think of the triplet $\langle C_A, B_A, R_A\rangle$ as characterizing option A. Similarly, $\langle C_N, B_N, R_N\rangle$ characterizes N, etc. The utility function now becomes a mapping from such triplets to scalars.

Thus

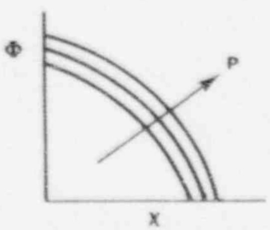
$$U_A = U(\langle C_A, B_A, R_A\rangle) \ldots U_N = U(\langle C_N, B_N, R_N\rangle)$$

where the scalar U_A now expresses our degree of preference for the triplet $\langle C_A, B_A, R_A\rangle$, etc. The optimum decision is then that option having the largest utility value.

4. ENERGY RELATED DECISIONS

Suppose we are proposing to build a nuclear power plant. Then the set of options A, B, ... N could represent various design features: vented containment, core ladle, etc. Or they might represent different choices of site location. At a broader level they could represent different types of power plant: conventional nuclear, breeder, coal, oil, wind, none at all, etc. 'Costs' in this case represent labour and materials expended, land allocated, etc. Benefits include, of course, the quantity and reliability of electric power. Damage includes whatever we think of as damage—damage to people, damage to property, environmental damage, etc.

† For simplicity we use here the Level One definition of risk.[5] For the Level Two definition, we would simply replace the diagram shown with:



In this diagram the single risk curve of Fig. 2 has been replaced by a family of curves, with probability being the parameter of the family. In this way we express our uncertainty in the original curve.

5. THE DTC AND THE ORC

We shall say that an energy related decision is made according to the decision theory context when the process of Fig. 2 is applied, i.e. the options laid out, the costs, benefits and risks quantified, and the optimum triplet selected. 'Optimum' here means whatever we the decision makers consider it to mean; that is, whichever triplet we consider preferable to all the others.

Different people, of course, will have different notions of what constitutes optimum. In collective decision making, this is a very important aspect and needs to be dealt with; however, this is not the aspect we wish to focus on in the present paper. The point here is that in the decision theory context all three elements of the triplet are given due consideration.

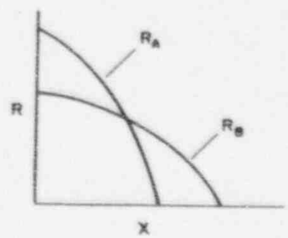
By contrast, what we call the ORC point of view considers only the third element of the triplet—the risk. This point of view thus seeks to establish as a decision criterion that the risk shall be less than some designated level, say $\mathscr{R}$. Thus, in this view, only those options are admissible which satisfy:

$$R < \mathscr{R} \tag{1}$$

$\mathscr{R}$ thus becomes the 'acceptable' risk level, the 'safe enough' level or the 'safety goal'.

6. PROBLEMS AND ABSURDITIES

There is a minor problem in applying criterion (1) in that, since we have defined risk, R, as a probability curve, it is not clear what the inequality symbol < should mean between two curves. Thus, for example, in the following figure:



it is not clear which risk curve, R_A or R_B, should be considered 'bigger'. The situation is even worse when the Level Two definition of risk is used. However, this problem, again, is not the point of focus in this paper, and we shall assume that by some means or other, like that described in ref. 5, the inequality (1) is given meaning.

The major problem, which we do focus on here, is the idea of establishing a risk criterion of the form of criterion (1) in the first place. The problem is in the idea, suggested by the acceptable risk type of language, that decisions can be based upon risk alone, considered in isolation from the cost and benefit elements of the triplet. Clearly this idea is absurd, for none of us would accept any risk at all, except when there are concomitant benefits that make it worthwhile. We thus now see the linguistic problem. For, considered in isolation, no risk is acceptable. The only risk that is acceptable is zero risk. The only amount of safety that is safe enough is infinite safety. Total safety is the only valid safety goal.

Now the proponents of the ORC are, of course, aware of this point, and when pressed on it say something like: 'Yes, of course, but the cost and benefit elements are well known, and therefore need not be brought explicitly into the discussion. They may be regarded as "understood" in the background'.

This would not be too bad a position if it were true. Unfortunately, it is not clear that it is 'understood' by certain vocal elements of the public and the media. It may not even be understood by certain segments of the regulatory establishment, for one sometimes hears coming from these segments such statements as: safety goals must be met 'regardless of cost', and 'It's not our job to consider costs, our job is just to protect the public safety'. Well, if you don't consider costs, the only acceptable risk is zero risk.

To see the illogic of the ORC in another way, suppose we did establish an acceptable risk curve $\mathscr{R}$ as in Fig. 3. We would then pronounce that curves lying entirely to the left of $\mathscr{R}$, such as R_A and R_K below, are acceptable risks, while those not so placed, such as R_B are unacceptable.

The practical consequences of this pronouncement would be, first, that design B would have to be changed to pull the little protrusion back under $\mathscr{R}$, and this would have to be done 'regardless of cost' or regardless of loss of benefit. Secondly, if it were true that design A could be changed to design K for a very small extra cost this would not need to be done, since by regulatory definition R_A is acceptable and safe enough.

Clearly both these consequences are absurd. On the other hand within the decision theory context, the conclusions would be that if design K costs little more

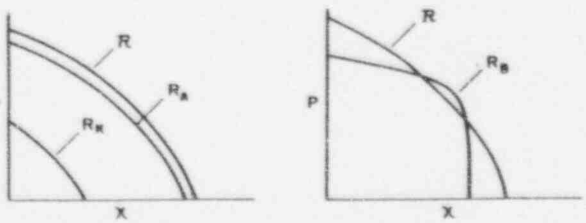


Fig. 3. Acceptable and unacceptable risk curves.

than design A, and the benefits are the same, then we must choose design K. The risk R_A is no longer acceptable, regardless of the fact that it is less than $\mathscr{R}$, since a better option exists.

Similarly, if it costs a great deal to move R_B slightly to the left, we may decide it's not worth it. We will accept R_B and spend our money more productively elsewhere.

This last point also helps bring into focus the inherent illogic of the position: 'It's not our job to consider costs, our job is just to protect public safety'. The author remembers well a story told by his professor of hydraulics. This professor had been a famous engineer in the Soviet Union responsible for the design of major dams and canals. He said that he had had to flee the country because he was under attack for having made the concrete walls too thick in a canal. He was thus accused of the crime of sabotage—wasting the people's resources. The point is, being over conservative is not conservative. Being too safe is not safe. Pouring talents and resources into reducing an already miniscule risk, *when there are other major problems requiring attention*, is not protecting the public safety. On the contrary, it is an extremely dangerous and irresponsible thing to do. In some parts of the world, as we have seen, it is considered a criminal action.

Another type of absurdity that flows from the 'acceptable risk' concept is as follows: Let us suppose that we have a set of existing power plants that were built according to standards of the past and thus have risk level, say, R_e. Now when we contemplate building new plants, we note that technology has improved so that we can now reduce the risk at reasonable cost. We, therefore, require that the new plants have risk level less than $\mathscr{R}_n$, where

$$\mathscr{R}_n < R_e$$

This is a perfectly desirable and reasonable thing to do. However, somebody gets up at this point and says, 'You have established an acceptable risk level $\mathscr{R}_n$. Your existing plants have risk greater than $\mathscr{R}_n$. Therefore, they are unacceptable—you have to shut them down'.

Within the ORC this sounds like a logical conclusion, though it is obviously ridiculous. The problem, as in the 'angels on a pin' type question, is the choice of an erroneous context, in this case the ORC. From the standpoint of the DTC, the situation is perfectly simple. With respect to new plant, we have a certain set of design options, and we choose that one having the best cost/benefit/risk triplet. Because of technology improvement, this best triplet contains a smaller risk than that of existing plant.

With respect to an existing plant, the decision tree has three branches: shut it down, leave it alone, or modify it. Each branch has its own cost/benefit/risk triplet. The best of these three options should then be the one chosen and this should be done without regard to what is being done with new plant. That is, the decision on existing plant is a decision problem all by itself and should be treated as such irrespective of the new plant problem.

7. PRACTICAL IMPLEMENTATION OF THE DTC

Granting then that the logical way to make a decision is the DTC, we must now acknowledge that in principle this could be difficult to carry out. To do a full-blown analytical treatment of a power plant decision would require consideration of all possible types of plant, including no plant, all possible site locations, designs, etc. It would require calculation of the environmental consequences of fossil fuel wastes, the socio-economic/political consequences of insufficient electric power and so on. Clearly this is an overwhelming task. The same could be said about the full-blown analysis of any public, or private, decision. Indeed the decision of how much analysis to do must itself be subject to a decision tree analysis. In this latter tree one of the branches is labelled 'paralysis by analysis'. This branch has its own costs, benefits and risks.

In order to avoid the paralysis option, we must acknowledge that all decisions, public and private, must be made as a combination of a reasonable amount of analysis, along with a large amount of good judgement, common sense, intuition and tradition.

In the case of nuclear power plant, the task is made easier by the fact that risk analyses of existing plant are now beginning to be published. We will thus soon have a set of risk curves, in Level Two form, for existing plant (Fig. 4).

These curves will give us a good understanding of what level of risk presently exists. Since these plant have already been built, we know this level can be achieved at reasonable cost. This level then becomes, in effect, our reference point. Since all decisions are choices between alternatives, we can begin by comparing any new reactor design, modifications to existing plant, alternative energy sources or alternative sites against the cost, benefit and risk of our existing reactors.

We can then begin to identify optimal options in a rational way. We cannot, of course, examine all options and thus theoretically speaking will never do a complete analysis of a decision tree. In practical terms, however, a reasonably moderate set of options will be found to be a sufficiently good approximation, together with an honest attempt to quantify the impact vector of each option including the

Fig. 4 Risk curves for existing plant.

uncertainties in that quantification. When this set of options has been calculated, our understanding will have improved to the point where we can confidently give definite guidance as to when, how and where to build plant, make changes, etc. The reasoning behind this guidance will also then be clear. And, as a result of this clarity, we may hope to replace current adversarial and antagonistic attitudes by understanding, by recognition of joint interests and by cooperative actions for the common good.

ACKNOWLEDGEMENT

This paper grew out of thoughts and ideas developed during a conversation with Robert Breen of NSAC. I wish to acknowledge the contribution of Mr Breen to these ideas and to the form of their expression used here.

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