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U.S. NUCLEAR REGULATORY COMMISSION

BRIEFING ON SEVERE ACCIDENTS AND OPTIONS FOR PROCEEDING WITH LEVEL 3 PROBABILISTIC RISK ASSESSMENT ACTIVITIES

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TRANSCRIPT OF PROCEEDINGS

Public Meeting

Before the U.S. Nuclear Regulatory Commission:

Gregory B. Jaczko, Chairman

Kristine L. Svinicki, Commissioner

George Apostolakis, Commissioner

William D. Magwood, IV, Commissioner

William C. Ostendorff, Commissioner

APPEARANCES

Stakeholder Panel:

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Program Manager for Risk and Safety Management,
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P R O C E E D I N G S

CHAIRMAN JACZKO: Good morning, everyone, the Commission meets today to receive a brief overview of the agency's approach to severe accidents and to discuss the potential uses for Level 3 probabilistic risk assessments. Since the 1995 PRA policy statement, the Commission has endorsed and encouraged the use of PRAs and other risk tools to strengthen our regulatory framework. Today, they are widely used by the NRC and in number of important safety areas, including fire protection and new reactor design reviews. Although not all of our activities necessarily lend themselves to this type of risk analysis, it is no exaggeration to say that the NRC today is a leader in the state of the art use of PRA technology, and I want to thank the staff for developing a paper that lays out several options on how we can build on a strong foundation and move forward with the future use of Level 3 PRAs. And I recall, as we had the RIC, which now seems like years ago, given the things that happened in between the RIC, I suggested that we look to having Level 3 PRAs within five years, or at least have a standard, a consensus standard, on Level 3 PRAs in the next five years. I think the paper laid out some options that are even more aggressive and potentially more significant than that. I think that there's no question that the state of the art has improved significantly over the last two decades and that there are new issues that perhaps should be examined through the completion of Level 3 PRAs. As the staff notes in their paper, those include issues raised by the Fukushima accident, specifically the challenges posed by multi-unit events in the risks of radiological releases from spent fuel pools.

It is credit to everyone who has worked on these issues, especially my colleague Commissioner Apostolakis, and all the work he's done for a long

time on these issues. I remember years ago, I was trying to learn about what PRA was all about and I started pulling all these papers from the beginnings of this stuff, and there was this guy, name was all over them. It was George Apostolakis, and, but --

COMMISSIONER APOSTOLAKIS: Somebody actually read those papers?

CHAIRMAN JACZKO: I did, I will tell you. I tried to find the journals, but they didn't have them, so I had to call around, eventually got it on eBay, so [laughs]. No, so today, we are considering the development of a full scope Level 3 PRA. Before we begin today's meeting, would any of my colleagues like to make any remarks?

COMMISSIONER APOSTOLAKIS: Yeah, I would. Well, as an agency, we pride ourselves on being a risk informed agency, and of course the Level 3 PRA is the most complete representation of planned risk. It's been about 36 years since the Reactor Safety Study was published, the first Level 3 PRA, and about 20 years since NUREG-1150. And the Chairman mentioned Fukushima, I mean the near term task force says that the dose assessment is the primary means for assessing the potential consequences of radiological emergency, and it seems to me a Level 3 PRA addresses the issue of those, and it would be very useful in that context. So I think this meeting is very timely, and I'm looking forward to listening to our guests and the staff, looking forward to disagreeing with the staff, in fact.

CHAIRMAN JACZKO: [laughs]. I'm sure they're looking forward to their presentation now. Well, if you want to begin, we'll begin with Biff Bradley, who is the Director of Risk Assessment at the Nuclear Energy Institute.

BIFF BRADLEY: Thank you, Mr. Chairman, and thank you to the Commission for inviting us today. Industry is and has been a strong supporter of risk informed regulation, and we believe this has been a successful technique for improving plant safety as well as improving our plant operations, and we're always interested in enabling and keeping these activities moving forward, so I appreciate the opportunity to discuss this today. Slide, please.

Let me get to our punch line. Industry does support the concept of an updated Level 3 study, and we believe that there could be significant value to this. NUREG-1150, even though it is 20 years old, is still held in high esteem by the risk community, and has proven to be an excellent foundation for everything we've done, and the concept of updating it to reflect everything that's happened in 20 years is a good idea. We know that there have been significant changes to plant design, operation, we have the maintenance rule, we're using risk in the operation of plants now. There have also been improvements in the analytical techniques that underpin PRA, and as well as in the state of knowledge; we have a lot more operational experience now -- excuse me -- both in the U.S. and worldwide.

We do believe that the Level 3 effort is not needed to replace the current regulatory approach. For most risked informed decision making now, we're using the concept of Reg Guide 1174, which is Core Damage Frequency and Large Early Release Frequency. This lends itself very well to most of the types of decisions we make in the plant, and we do use Level 3 in some places, SAMA for license renewal, and going forward with emergency planning considerations, there might be a purpose for Level 3 in a risk informed emergency planning approach, but we do believe that for the majority of the uses

of PRA that the current approach is appropriate. Next slide.

This is just a quote from the 90 day Task Force report. I won't read it to you, but it's essentially making the same comment I just made, that the existing system has served us well. There wasn't enough room on the slide, but there was another paragraph that followed this that said that it would be a good idea to perform some selected Level 3s to confirm the existing approach, and I think we agree with that. Next slide.

I wanted to talk about some industry considerations that we believe would be beneficial for this study, and they're a little different from some of the things that may be in the SECY. We've -- we're moving toward an era where we're really using PRAs in decision-making, and it's a different era than we were in 20 years ago. 1150 was done primarily to look at primary contributors, insights, potential safety enhancements, but now we're in a different era where we're making regulatory decisions on numerical thresholds. These are small thresholds, these are thresholds that can be affected by assumptions in the PRA, any number of things in the PRA can affect these decisions. Because of that, there's much more scrutiny of the PRA than there was in that era, and we now have a whole regime of standards, which has been an effective tool to help us achieve better PRA, but even underlying standards, there are methods. The standards tell you what to do, the methods tell you how to do it, and as we've moved into -- for instance, NFPA 805 implementation, we've seen tremendous scrutiny of the underlying methods in PRA. And that, I guess, you know, would be expected, given that we're using it in a much more rigorous regulatory application.

There are also larger uncertainties. We've done a pretty good job

to develop really, I think, robust internal events models, but as we move into fire and seismic, where you're starting to get into spatial considerations as well as external hazards that have their own uncertainties, even before you build the model, you're also dealing with larger uncertainties than we typically had in the past, so that's another challenge.

So we've sent some letters to NRC with respect to the need to have better understanding, clarity on the underlying methods, and we believe this study could actually do that because in order to build a Level 3, you have to have a really good Level 1, Level 2 that looks at all modes, all initiators, and that's where we believe the real benefit of this comes, from the underlying methods development that would do that. We also believe that a pilot plant is essential; I agree with the ACRS letter on this subject. Developing these methods or filling gaps, what you have, in the absence of a real plant application, doesn't really get us to where we need to be. We have experience from NUREG-6850, which was a joint project, also with EPRI-1011989, and some good methods developed, but we didn't fully pilot at them, and we found out later that it would have been a great benefit to have a full pilot of those methods, so we really believe we don't want to replicate that experience.

We believe Level 1 for all modes and all initiators is a logical first step. ACRS sort of recommended sequencing this in terms of developing full Level 3s for groups of initiators and modes, but I think our view is more try to get the Level 1 stuff done first and then move on to Level 2, Level 3. There's also the issue of the Fukushima insights, and what will be learned from that accident going forward, and how that can be folded in. ACRS letter spoke to that to some degree. Next slide.

So, our perception of benefits from this is one, a practical benefit, is this provides and documents acceptable methods of Level 1 as well as LERF for an expanded scope of modes and hazards. That's our, probably our compelling need right now in, in terms of applications. Also, this would inform and pilot the standards. We have a lot of standards development going on, and we've learned in standards development that having a pilot and an actual application integrated into that process is extremely beneficial. This could also provide a reference study that documents methods and standards compliance going forward. Right now, we have some ongoing struggles with the peer review process and the standards and issues of interpretation, so more clarity going forward would be helpful in that regard, and help us to have more efficient applications. Also, NRC has the SOARCA project, which wasn't a PRA but looked at some selected sequences, and we believe that some of the technology developed for SOARCA, which included some improved computer codes and other improvements can be folded into this effort and would be, can be used to support the Level 3 study. Next slide.

So, we know what the three options were that were proposed in the SECY. Status quo, that's where we are now and, as I mentioned, we're struggling to get better understanding of methods just to underlie our PRAs, so we would like to move away from that and get into a more -- an effort that gets us to where we need to be. I mentioned already that the Option 2 doesn't include, or is not proposed to include a pilot plant and we believe that does not get us to where we need to be.

Relative to Option 3, I think we're in general agreement with the ACRS observations that a sequenced Option 3 approach makes sense. Not

sure, you know, ACRS recommended doing a PWR. I think we believe there's value to doing both a P and a B. We do recognize the challenges presented here, that there are competing resource priorities, and that -- I think that is the essential challenge for this effort. I'm not sure anyone doesn't think this isn't the right thing to do, it's just a matter of how do we, how does this fit in the other activities that are going on. Next slide.

We, you know, we recognize this is a resource intensive effort, for both NRC and the pilot plant. We've had experience with this with the original 1150 as well as SOARCA, where even just doing a couple of sequences, that was a major undertaking for NRC as well as the pilot plants. I observed the, you know, the original NUREG-1150 was a lengthy effort, and a, you know, I wouldn't expect this to be much easier. It's not -- we shouldn't underestimate the challenge. So as I mentioned, we need to factor in the other priorities. I do believe that the timeline proposed is optimistic. Our experience has been that these are multi-year efforts, so just make that observation. Next slide.

We have discussed this with industry, and I do have several possible pilot plants that are willing to engage in discussion with NRC staff, relative to supporting this effort. I don't have formal agreements from those plants, but they are willing to engage in discussion. Not clear that we have a single plant that can meet all the expectations that were delineated in the SECY relative to multi-unit external hazards, et cetera, but we're ready to sit down and talk with you about that. So we're ready to engage in those discussions should the decision be made to proceed. Final slide.

Again, we believe that the new Level 3 study could provide important insights to complement and confirm NRC's risk informed approach.

You know, we do believe there's a significant practical additional benefit in the development of Level 1 methods and demonstration of standards. That's the world we live in now, and doing the study without that part really isn't going to give us maximum benefit. Finally, as I've mentioned, the timing schedule are challenging, and so we'll have to deal with that. So, I know my time is up, so thank you.

CHAIRMAN JACZKO: Thank you. We'll now turn to Stuart Lewis, who is the Project Manager for Risk and Safety Management at the Electric Power Research Institute.

STUART LEWIS: Thank you, and thank you for this opportunity to speak to you about this effort. As you may know, EPRI has been engaged in advancing PRA tools and methods for many, many years, and --

As I was saying, EPRI has been involved in developing and advancing PRA tools and methods for a very long time now, and over that period, from time to time, we've worked pretty effectively with the staff to do that, going back to at least the development of common cause failure analysis methods back in the mid 1980s. So I'd like to talk to you now -- if we could go to the first slide after the introduction. I'd like to talk to you very briefly from a technical perspective about some of the programmatic aspects of this project, and then give you some thoughts on where we might consider working together, if you were to engage in doing a Level 3 PRA. Next slide, please.

I have just a few comments about some of the objectives that might come into play in undertaking a Level 3 PRA. Of course, I think we've all recognized updating NUREG-1150 would be a valuable thing to do. We talked already about some of the reasons for doing that. Biff also mentioned SOARCA

and providing a Level 3 PRA would add context to what was done in SOARCA, and draw on technical elements of SOARCA. Certainly, there are specific areas in which we think that the technology needs to be improved for PRA, and doing that in the context of PRA in some cases can be a valuable way to go about doing business. In other cases, it makes sense to do those developments before you get into a PRA, but, again, the PRA provides context and helps you understand whether you've gone far enough in the methods development in some cases.

One thing that may not be as high on NRC's radar screen as it is for the industry, is to try out new standards that are being developed. We have new standards, for example, that are pretty close to being available in both Level 2 and Level 3 space. We have a new standard coming out in low power shutdown, and we have other standards that haven't been fully tested yet in seismic and other external hazards. The more we can test those standards before we start to use the results in risk-informed applications, then the better off we will all be, think, NRC and industry both.

Another think that I think would be valuable and it's hard to put a -- to assess that value, is to provide real hands on experience among staff members in performing PRAs. A lot of us, like me, are getting a lot more gray hair; that's true in the industry and the staff, I think. In developing new expertise, people who have actually been involved in doing PRAs as opposed to reviewing methods or handling specific cases adds real value. I recognize that's a challenge in terms of having the resources within the staff to do that, but I think it's one that's worth considering very carefully. Next slide, please.

With regard to the overall scope again, I think that most of us

believe that Option 1 is --that we can do better than Option 1, that we need to do more development than really is reflected in Option 1. I recognize that Option 2 may seem to fit best with the current resources that the staff has available or even maybe that would be a stretch to some extent. At the same time, I think, as Biff said, there is merit to, first of all, doing this development work in the context of a real plant, and also, I think there are other reasons for engaging in something more like your Option 3 that's been proposed. In particular, I think that when you look at a lot of these risks, looking at them in isolation is much less valuable than having an integrated, comprehensive framework, understanding the interaction between external hazards and other aspects in plant operation, for example, would be very important, and you don't necessarily get that tackling one issue at a time. I think that we still have a ways to go. We've been working with the staff on the treatment of uncertainties in PRA and risk-informed applications, and a comprehensive Level 3 PRA would help to provide more of a context for that development as well. And I think there is a real benefit you need to recognize in terms of actually doing a full PRA, and that is that much for the real work comes when you think you're finished and you're trying to understand the results, putting everything together and figuring out what the PRA is telling you, and you end up doing a lot of iteration and a lot of refinement of the models, further investigation of things you didn't think were important, and you simply don't have that aspect of it present if you tackle the PRA on an issue by issue basis. You're not forced to achieve the same level of closure that you are when you do a full PRA. I think that's a benefit that shouldn't be overlooked in pursuing your options there. Next slide, please.

Certainly the schedule is a challenge. I think depending on what

the scope chosen would be for a Level 2 -- or of an Option 2 PRA, even two years might be optimistic given that it's likely that you're going to be engaged longer than two years in this work. I think it's worthwhile thinking about it and more in context of Option 3. Again, I recognize that you have, like everyone else, have limitation on your staff and the financial resources you can bring to bear. Nevertheless, I think it's certainly worth thinking about further. I also think that Fukushima certainly plays a role in the way we schedule the tasks for any kind of Level 3 development that's done. I think that there are issues associated with responding to Fukushima that could be informed by pursuing the Level 3 PRA. At the same time, all of us are stretched trying to do the best we can in light of our new challenges. And so I hope that we can move forward on a Level 3 PRA in a way that enhances response to Fukushima without diverting resources from other things that need to be done. I think that's going to be a real challenge for everyone going forward in this work. Next slide, please.

I think there are a number of areas in which we would be pleased to talk to the staff about engaging in cooperative work. We've done that most recently in areas including human reliability analysis, uncertainty analysis, of course, Biff would mention NUREG/CR-6850, the fire work. There are several other areas where we've worked together usually in an effective manner, sometimes in a -- not quite as effectively, but there are often good reasons for. And I think this Level 3 PRA offers an opportunity for us to bring to bear some of the research we already planned to do and augment your resources and your ability to engage in some of the technical activities.

Now, I've just listed a few areas here where we might talk about doing that. Again, these are all areas in which we already have work underway

or planned. I'm on slide six. That includes, again, further development of the treatment of uncertainty. We're working right now on a project to evolve methods for human reliability analysis and that work will go on for some time yet, but would seem to play an important role in a Level 3 PRA. We're engaged in quite a bit of work related to assessment of external hazards: external flooding, high winds from tornados, that sort of thing. We've long had work going on in the severe accident research area. As you may well be aware, we have our own severe accident suite of codes under the MAAP umbrella, and it would be an opportunity to further benchmark MAAP against MELCOR, again, with real problems to solve. But I think that would be valuable for both you and the industry. We're engaged in work to further our understanding of the risks associated with spent fuel pools. And we have our – have other programs at EPRI engaged in that work as well in the fuels area, and materials and so forth. And we're also beginning to do more work in the areas of low power and shutdown operation and transition risk. And again, all of those things would bear directly on the Level 3 PRA that might be conceived by the NRC and are areas where we'd like to talk about cooperative efforts.

To summarize, my last slide, I think that the -- we all agree that Level 3 PRA development would be a valuable thing to do. It's primarily a matter of deciding the best way to go about it to make use of everyone's available resources. I think that the -- a staged approach certainly makes sense, and any venue would tend to start with a Level 1 PRA. The only qualification I might add to what Biff had to say is that there's a difference between deciding to do a Level 1 PRA and deciding to do a Level 3 PRA where you start with a Level 1 PRA. You look at different things with respect to the types of core damage accidents

you might have to consider when you want to carry all the way through to evaluating consequences, as opposed to stopping when you've evaluated what kinds of core damage sequences you could have and their frequencies. So that's a fairly subtle qualification I think that it's important to keep in mind.

So I -- again, I think that Option 3 in some form is still worth pursuing if we can do that. And I'd be very pleased to talk further with the research staff at NRC about how we might help to work on that project. And I think I'm giving back some of Biff's time.

CHAIRMAN JACZKO: Thank you, Mr. Lewis. We'll now turn to Karl Fleming who is the president of KNF Consulting Services.

KARL FLEMING: Thank you very much, and I want to thank the Commission for inviting me to provide a PRA practitioner's input and views on the topics under consideration, severe accidents and Level 3 PRA. First slide, please.

What I'd like to do is offer some insights from some work that we did about more than 20 years ago on Seabrook station that looked into some of these multi-unit risk issues, offer a couple of insights from the Fukushima accident, identify some modular reactor licensing considerations that might play into the decision-making process, and just offer my PRA practitioner's input on these options that you're talking about. Next slide, please.

I want to talk a little bit about work that was done more than 20 years ago on Seabrook station and it was a project that I was deeply involved with and many of my colleagues, including George Apostolakis, and Dennis Bley, and John Stetkar, and Nathan Siu, and many others worked on these projects. But we did this project while Seabrook was still under construction. The plant

was still planning to be a two unit station and there were already identified some very serious emergency planning issues that needed to be resolved to get the plant licensed. So they went out for bids for a comprehensive PRA and there was a lot of emphasis being placed on it being a very comprehensive study. And there was a contractual requirement put in the bid spec that I had to worry about as a project manager, that we had to include the integrated risk of the two reactor station. I'm not exactly why that was in there and what they meant by that, but we did our best to try to address it in that particular accident.

The PRA that we did was full scope Level 3 PRA to the extent that we knew how to do it at the time. The initial work in the mid-'80s was focused on full power operating conditions, but by the time we got through the emergency planning applications of this, we extended it to low power shutdown, including seismic, fire, flood, and Level 3 at low power shutdown. Also because the plant was -- the owner was struggling to get the plant in the rate base, we did extensive sensitivity studies looking at the plant operating at 25 percent power, 40 percent power, and running through the Level 3 applications. Of course, the strategy there was to try to get the plant in the rate base. But from that, we got insights as to the impact of the power level and the inventory of radionuclides and how that would play into the overall situation. Next slide, please.

As we first finished a full scope PRA on Unit One and then we set off to the task to do the integrated site PRA for Unit One and Unit Two. Now, Seabrook as originally planned was two separated -- what's called slide along units with very few shared systems, more or less identical units sitting side by side on the same site. But still we had to consider the multi-unit effects on the PRA. We went back through the initiating events as shown in this slide, and we

had to look at different categories of initiating events: those that would affect each reactor independently, those that would obviously affect both reactors, and then of course there was a gray area where the event -- you had to sort of tease it apart to find out, well, in some cases it might involve multiple challenges to the plant. We then completed a Level 1 PRA for the integrated site -- and if we could go to the next slide, please.

We were surprised to find out that even though these were not highly integrated sites, the core damage frequencies that we were calculating for the dual unit accidents were a sizable fraction -- more than 10 percent -- of the frequency for a single reactor accident. That was due primarily as we see on the next slide, it was due to seismic events, external flooding, events of that source that would challenge both plants. As you see the numbers, I wanted to make an obvious comment there. These numbers for core damage frequencies that we obtained for Seabrook were considered realistic in its day. It was a plant that had no operating experience, and the generic database we had on initiating event frequencies, component failure rates and so forth, did not show the improved performance that exist today. So it was typical to see core damage frequencies in excess of 10 to the minus 4. And today, if you look at the Seabrook results, their core damage frequencies are more than an order of magnitude less. Even though Seabrook didn't complete Unit Two, had they carried through the integrated risk assessment with the upgrades that they've done in their PRAs, my personal view is that the relative contributions of the multi-unit events would have been comparable to what they were in the past.

If we can go on to the next slide, please, that shows some results on consequences. Well, we did the Level 3 analysis and we looked at scenarios

involving one or two reactor worth of source terms. There's a pair of -- two pairs of curves on this slide. These are the conditional results for consequences for health effects. The slides on the upper right are latent cancer fatalities and the lower left are early fatalities. And what we found was that in the case of early fatalities, there was a non-linear effect for certain conditions. These -- those results you're looking at happen to be for what we call small unscrubbed bypasses. That included things like containment isolation failures and small penetrations with no sprays which were borderline in producing early health effects. They had high enough doses that were -- under certain meteorological conditions, would produce early effects. And what we found in those cases is that you can have much more than linear increases in consequences under certain conditions which, combined with the results on the core damage frequency, led us to conclude that there really isn't any reasonable way to manipulate single reactor risk metrics to produce a perspective for an integrated plant.

If we go on to the next slide, there's a total risk profile for latent cancer fatalities --

CHAIRMAN JACZKO: I'm sorry. Can you just go -- can you -- what are the different curves on that graph?

KARL FLEMING: Okay, in the previous curve if we can back up --

CHAIRMAN JACZKO: On the -- for the small unscrubbed bypasses.

KARL FLEMING: Yeah, okay. This is for a certain class of scenarios. The two curves on the right, the curve with the subscript one --

CHAIRMAN JACZKO: Yeah.

KARL FLEMING: -- is a single reactor accident. And the ones with the subscript two are the double -- or the dual source term accident. So the upper curves are latent cancer fatalities and the lower curves on the lower left are early fatalities.

CHAIRMAN JACZKO: Oh, okay. Okay.

KARL FLEMING: So there are two sets of risk metrics all put in one; it's kind of confusing, but the twos versus the ones show the effect of doubling the source term, basically, on the consequences.

CHAIRMAN JACZKO: That was using a -- that was using a Seabrook population -- I mean, that was using actual --

KARL FLEMING: Yeah, the actual site, evacuation plans, site characteristics at Seabrook station.

CHAIRMAN JACZKO: Got early fatalities on the order of -- the number of health effects I assume is individual -- I mean, essentially -- I mean, is it --

KARL FLEMING: That's the total health effects in the population surrounding the sites. The --

CHAIRMAN JACZKO: -- of about 1,000 people?

KARL FLEMING: Yeah, this is typical of a Level 3 PRA result of that day if you looked at NUREG-1150 and, you know, WASH-1400 with the source terms that we were using. This is typical --

CHAIRMAN JACZKO: Today, would you expect -- again, recognizing that those are conditional probabilities --

KARL FLEMING: These are conditional --

CHAIRMAN JACZKO: -- 10 to the minus four --

KARL FLEMING: Yeah, these are conditional on the accident and the accident already has a very low probability. I mean, there would be certain conditions in which you would see numbers of early fatalities. Now, the consequences in today's source terms would be significantly less based on the advances in source term technology, but, you know, the message I wanted to get across here is the relative contribution of dual reactor versus single reactor accident. That might be scaled down in today's context.

If we go off to the next slide, which shows an integrated risk assessment that has the accident frequencies and consequences all blended together for latent cancer fatalities, this shows the total risk of the two reactor station in terms of the conditional complementary cumulative contribution from latent cancer fatalities. And basically what this slide shows is that in the high frequency, low consequence end on the upper left-hand side of the risk curves, the risk is dominated by single reactor accidents, having been elevated in frequency by having two reactors there. And on the low frequency, high consequence end on the lower right, the results are dominated by dual unit events. And I want to point out that this is the case where we have very, very highly separated reactor units. If we had integrated units, I'm sure that the results would look a lot different.

So to get on to the next slide which will sort of wrap up this part of the Seabrook insights is that there's just no way to manipulate single reactor risk metrics in order to produce a perspective on integrated risk. And I think that combined with the fact that most of our reactors in the fleet are on multi-unit sites, that really raises questions about the ability to link the QHOs to the single reactor risk metrics. I mean, you have to sort of wave your arms around the

multi-unit risk issue to do that, so I think that's one of the motivations to proceed with this Level 3 work is to get a better handle on how to do the -- how to link these risk metrics to the QHOs.

The final point on this slide I wanted to mention is that after having done this early work on multi-unit effects at Seabrook, my view is that this -- the reason why we're not doing integrated risk assessments today, I think, is less of an issue with the limitations of the state of the art as it is with the willingness to do it. I'm sure that whatever we did at Seabrook can be improved upon. I know there's gaps, there's challenges that -- but the only way we're going to make progress on those challenges is to actually do it. Can you go on to the next slide, please?

On the Fukushima insights, just want to make a couple comments about that. You know, when the Three Mile Island accident happened, in the PRA community, we realized that there was a big gap in PRA technology and that human errors of commission wasn't really very well handled. I feel a little bit differently about the Fukushima accident in the sense that given the conditions that the plants were exposed to and the loss of equipment and electric power and instrumentation, in standard PRA modeling assumptions, those conditions would've just been assumed to be core damage. So it doesn't leave me with a lot of issues there except to go back and say, "Well, what was the role of the seismic PRA? Did they do a seismic PRA at Fukushima?" I don't think they did one. I'm not 100 percent sure about that. I was also surprised to learn a number of years ago that it has not been standard practice in Japanese plants to do internal flooding PRA. And I'm confident that had they done a basic ordinary, you know, garden variety internal flooding PRA, they would have realized the

vulnerability they had to having the switch gear located in the basement of the turbine building.

So I think that we need to, you know, work on more of an integrated perspective on how we do our PRAs and get out of the business of fragmenting the seismic PRA from the fire PRA from the flood PRA, which even our standard has sort of fallen into the trap on. We need to get more of an integrated perspective.

If I go on to the next slide, please, the -- just wanted to mention that in the modular reactor licensing arena, this integrated risk issue has come up and we're working on a standard for advanced non-light-water reactors and we are putting requirements in those standards to do PRAs on an integrated basis. And that includes looking at multiple reactor scenarios, looking at multiple sources of radioactivity, and we're trying to make some progress on this issue on that standard. This standard has been working on for the last five years and it's about ready to go out for a pre-ballot review in the near future.

And if I might, final -- conclude on my final slide on the recommendations. I agree with my colleagues that it makes sense to move forward with Option 3 according to the ACRS recommendation. My concern about Option 2 is that doing research without an endgame in mind may not be fruitful. It may be better to do Option 3 and figure out better what the research ought to be in the future. So, again, I want to thank the Commission for the opportunity to speak and I conclude my remarks.

CHAIRMAN JACZKO: Well, thank you. We will start our questions, comments with Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Mr. Chairman.

Thank you all for your presentations. Biff, I'd like to start off with you if I could, please. And you mentioned in one of your slides about a pilot and the advantages of having standards development in a reference study. I wanted to hear from you and your colleagues if they want to add to your comments, do you think one pilot or maybe two pilots would result in the ability to extrapolate or have broader applicability? How would that be viewed on the industry side of the house, as far as taking one or two plants, doing a PRA there and then trying to have those results serve as a broader industry standard?

BIFF BRADLEY: I believe our intent -- I'm not sure how much you can extrapolate directly those results to other plants. Generally our experience with PRA has been things don't extrapolate very well, that there's a lot of plant unique situations. I think what we view the value of doing some selective Level 3 studies would be to inform the current decision-making process and confirm that making decisions on the basis of the kinds of the decisions that we make on the basis of CDF and LERF is -- just to confirm that. I'm really not sure how far you can extrapolate. I will defer to my more technically astute colleagues if they would like to --

COMMISSIONER OSTENDORFF: Well just to make sure, I may have misunderstood. Could be my misinterpretation, but are you trying to maybe standardize the methodology? I'm looking at your slide that says PRA standard development once complete we provide reference studies. Is that trying to provide a framework for other plants to use?

BIFF BRADLEY: Yes.

COMMISSIONER OSTENDORFF: Is that the spirit of that?

BIFF BRADLEY: Yes.

COMMISSIONER OSTENDORFF: Would that be generally something that you think is feasible to extrapolate? Maybe not the results, but the methodology?

BIFF BRADLEY: That's an excellent question. What we've found is it's not always simple, even as we've gotten into fire PRA where we get very plant-specific, configuration-specific, spatial-specific kinds of situations come up, and methods narrowly have to be looked at on a plant-by-plant basis. So how far that assumes into Level 3 space I don't know, but I think what we're learning as we get beyond internal events and start looking at broader scopes and going beyond Level 1, 2, it does become difficult and very plant-specific. I do think there's value in having methods that we understand and that NRC staff and industry agree on. The standards have been a good start, but there's also methods that can come up that are under the standards that can still be controversial. The standards don't necessarily solve all the issues, so having methods that we all agree to, I think, would be valuable.

COMMISSIONER OSTENDORFF: Anything?

STUART LEWIS: I think I agree with what Biff said. I think that performing a pilot-plant Level 3 PRA would expose and help us resolve many of the gaps that would be common to any other PRAs we would engage in. That doesn't say that the next time we did a Level 3 PRA, we wouldn't run into some new issues that hadn't been fully resolved, and there might need to be some incremental improvement or development done, but certainly taking a really hard look at performing a comprehensive PRA right now would help all the future PRAs that would be done.

COMMISSIONER OSTENDORFF: Karl, do you have anything?

KARL FLEMING: Yeah, I think the whole concept of standards is that we want to hold off on writing standards so that we can codify best industry practice, and I think in the early days of PRA we were working mostly on developing methods for how to do PRA, and then in the last 10 years or so, a lot of the efforts now have been writing standards. And I think we've gotten things a little bit out of balance now on this integrated risk and Level 3 PRA. We need to do the work and establish the industry practice, and the standards should follow that after the fact. But I also have a little bit of a concern that the oxygen in the room has been kind of consumed in the standards areas and conforming to the standards, and there's a gap I think in the methods on how to do it. So the practitioners are tied up writing standards, and they should spend a little bit more of their time working on these areas of uncertainty.

COMMISSIONER OSTENDORFF: I'm going to turn another question. Stu, you started to talk about post-Fukushima areas that EPRA is interested in, and Karl hit on that in one of his examples on flooding. I'd be interested, from -- informed by what we know today about Fukushima, is there a top-three list from the EPRI perspective of those substantive areas that warrant further exploration and refinement in the PRA arena?

STUART LEWIS: Well, I think that it's not necessarily an area that we didn't recognize as important before, but Fukushima has certainly reminded us that we need to do a lot more work on the treatment of other external hazards. But there are a variety of reasons for that. One of them is, Karl mentioned for example that the Seabrook risk results are at least an order of magnitude or so lower than they were back in the 1980s when they were first assessed, and that's pretty much true across the industry. And with our focus on internal events, that

now means that it's likely that external hazards are more significant on a relative basis. So if we focus all our efforts on internal events, we're perhaps misleading ourselves, not making the best decisions we could. So I would put that down pretty far at the top of the list in terms of insights that are at least reinforced by Fukushima.

Beyond that, there are other things. We were all very concerned about the status of the spent fuel pools. That's an area that we haven't spent a lot of time on. It turns out our concerns were probably not so well-founded based solely on Fukushima, but we have started to do some investigations that lead us to believe there is more that ought to be done in the area of understanding spent fuel pool risk and addressing perhaps better severe accident management guidelines or perhaps a different regime or procedure, but some sort of better integrated response. And also understanding the impact a spent fuel pool can have on operation and response to events involving the reactors. So I would put that lower, certainly, than the external hazards, but important there. I think largely, much of our work right now is really trying to understand what the more subtle implications of Fukushima are, and make sure we make good choices in terms of what we do going forward as opposed to trying to react too quickly without having full knowledge. We still all have significant gaps in our understanding of the event that we really hope to try to participate in filling.

COMMISSIONER OSTENDORFF: Anything, Karl?

KARL FLEMING: My big three from Fukushima would be the multiple concurrent reactor accidents, the need for integrated treatment of multiple hazards -- tsunami, seismic, floods, and so forth -- in an integrated fashion, and the third that's obviously a big deal, and that is that once one has

some radiological contamination at the site, that greatly impedes accident management strategies, so how the accident management can continue on in light of high radiation fields on the site.

COMMISSIONER OSTENDORFF: Biff, you want to add anything to any of the comments?

BIFF BRADLEY: I believe between the two of those, that was a good comprehensive list.

COMMISSIONER OSTENDORFF: Karl, thank you. Let me get one final question here. On your slide, not sure I had it marked -- it was the back of your slides, your recommendation slide.

KARL FLEMING: Yeah.

COMMISSIONER OSTENDORFF: Your second bullet says, "Should avoid letting existing PRA standards inhibit PRA development." Could you maybe explore that just a little bit more?

KARL FLEMING: Yeah. Part of this is -- sort of two parts to this. One is what I mentioned. The resources, the standard has gotten to be kind of onerous. It's a large standard, it's many pages of requirements, it's kind of onerous for the users of the standard to maintain, and given the investments they're making to try to conform to the standard, we even have difficulty upgrading the standard. We want to put changes in the standard. There's a lot of resistance because they have to go through another administrative hoop-jump, if you will, to address that. So that's an issue. And the resources of the practitioners being consumed in the standards area, and not enough time being spent to look at these areas of larger uncertainty. And I think the other part of this is that it goes back to really the first bullet on the same slide, is that one of

the concepts that we used to have in some of the early days of PRA is that we had the ability to focus the resources in the PRA on the areas for that site and that plant that had the greatest source of uncertainty. So we didn't have a one-size-fits-all kind of model, so that we could optimize the project plan and resources to focus on what was important for that site. And that was an issue because we don't have standardized plants. The sites are different, the vintages of the licensing requirements are different, and so forth. But the standards make it difficult to do that. If you want to claim that you're going to meet the standards for risk-informed applications, you need to bring everything that's risk significant up to a certain level of treatment, and that consumes the resources so that it's difficult then to have any resources left for these areas of higher uncertainty. So that's basically the point there.

COMMISSIONER OSTENDORFF: Thank you. Thank you, Mr. Chairman.

CHAIRMAN JACZKO: Commissioner Svinicki.

COMMISSIONER SVINICKI: Well good morning. Thank you all for your presentations here today. This first question, any of you may respond, but Biff in particular, if you could share some thoughts with me. You've all mentioned competition for resources, but let's set that aside for a moment and say that a Level 3 PRA, perhaps the suggestion of a PWR and BWR pilot, could be pursued with some kind of expediency. It may take, of course, then some years for any of the outcomes of that to be reflected in a regulatory framework. What benefit, Biff, for those units that are interested even in engaging and maybe being pilots? Is there some use that they would put of their Level 3 PRA results in the near term that would be the reason that would motivate them to want to be pilot sites, or are

there just generally -- for any of you who want to respond -- are there things that licensees, uses they could put to the Level 3 PRA results? How would they use the results?

BIFF BRADLEY: Yeah, let me speak to that. I think the sites that have an interest are all sites that have a fairly extensive risk-informed culture already, and are interested in moving in that direction. And I think as a general rule, they see this as confirming where they're headed. I would expect, and I can't say that I've had explicit discussions with them on exactly how they would use this, but I expect there could be value in the SAMA work as well possibly as EPs, as I mentioned earlier. Our current applications, the classic risk-informed applications we're doing now generally are not Level 3 applications, with the exceptions of the ones I mentioned. But I do believe that they're interested in supporting the cause and moving this technology forward. I can get more information about explicit --

COMMISSIONER SVINICKI: Okay, I realize it's just speculation but I just wondered if you let your mind wander, what you thought that they might do with it. Would either of -- yes, Karl?

KARL FLEMING: Just very briefly, is that I think by doing the type of Level 3 PRA that's discussed in especially Option 3, one gets a better understanding of what the risk levels are and what the contributions to risk are, and that gives you a greater opportunity to allocate your resources where it makes the most difference. So that's --

COMMISSIONER SVINICKI: Okay, so much as they do now. They just have another tool that would have informed them in that process. Okay. There's been some discussion about using these activities to inform post-

Fukushima regulatory response or industry responses. If you were to look at that from completely the other direction, is there anything that you think would be a key piece of knowledge to have coming out of whatever accident reconstruction or sequenced chronology that is eventually done for Fukushima, that would inform Level 3 PRA efforts going forward? Meaning that we would have real-world information about, I guess this is obviously more relevant for BWR, but I don't know if I thought broadly, maybe there are things that would be informative for a PWR as well. Could any of you speak to that, just what you think are the key technical areas that might be useful in that regard?

KARL FLEMING: Well the first question that comes to my mind in answering your question is still with the big thirst for knowledge about just exactly what did happen at Fukushima. I mean, my knowledge base today is based on everything that I can read, and I think I've gotten about as good insights from the Wall Street Journal as some other technical reports as to what actually happened. So I think understanding what happened in more detail, what was damaged by what, how did the hydrogen get in the building, and what level of damage if any was done by the seismic event and what level of damage if any was done by the hydrogen detonation event -- these are all important questions that I'm a little bit concerned that we don't get too far down the lessons learned trail without understanding more clearly what happened. I think once we have better understanding, I think it should be obvious what the lessons would be from that.

STUART LEWIS: I think that when we can actually gain some sort of access, whether it's through fibro-optic cameras or some other means to assess the real state of the cores, to try and do some benchmarking of the tools

we use to assess severe accident response, that will be very valuable. Fortunately we have very limited experimental data that are really applicable to this situation, and we need to take advantage of the understanding we eventually achieve of the status of the three cores that are damaged to some extent. To what extent we don't yet know, but that's going to be very important to us, I think, informing the Level 2 part of our PRAs. At the same time, I think that there are measurements all over Japan and beyond that may help us to understand how realistic some of our consequence models are. We have the meteorological data and the depositions to infer from some measurements, at least, perhaps to help us in that area as well. So I think both of those are going to be important. Both of those are going to take quite awhile to evolve.

COMMISSIONER SVINICKI: And again Biff, I don't know if you wanted to add anything, and I appreciate that, Stuart. Because what I'm trying to get to, is there anything that if we were to run full speed ahead on PRA work for BWRs, is there anything that suddenly we would maybe have information out of Fukushima that might really affect that work?

BIFF BRADLEY: I think some of the areas could be containment venting. The sequence, and which we still don't really understand too well, that's a key issue for the Bs, as well as the SBO sequence and exactly what equipment failed and what didn't. I think that's really important to inform how we address SBO here. A full understanding, because there are a lot of different ways you can potentially expand your coping, but I want to make sure you do it in the right way and not still exposing yourselves to the situation they had. I think that's important.

COMMISSIONER SVINICKI: And I would ask a very general

question. If, again, we were to proceed but laying aside the resource constraint issues and resources were available to move forward in a very full way on Level 3 PRA -- again, perhaps with some pilot locations -- what do you see as perhaps the biggest mistake we could make, given what we know right now? And we in that case is just the community of practice that's the practitioner, PRA practitioners, the regulators, and the industry generally. Is there anything that you think is a potential lack of knowledge we have now, or something we could potentially be overconfident about?

BIFF BRADLEY: Yes. I think there is overconfidence on the schedule and possibly on the resources to do this. You know, I think we do need to be reasonable and realistic in our expectations. ACRS, I think, spoke to that to some degree. We've been working on PRA for about 30 years now. Some of these problems are difficult nuts to crack, so not everything is the same. Just because we can do internal events at power, doing seismic shutdown fire, that's a lot more tricky of a proposition. So I think we need to be realistic about how many of these permutations of modes and initiators can we really do and especially given the pedigree and the expectations now with respect to standards and methods -- that, to me, is the challenge. This is a big chunk of work, and we shouldn't underestimate that.

COMMISSIONER SVINICKI: Would either of you like to comment?

KARL FLEMING: Yeah, I think one area that we could examine our overconfidence perhaps would be in the source term development area, and if we could sort of reverse-engineer the source term at Fukushima, try to figure out what we know from a scientific basis, what's the nature of that source term, and see if we can reverse-engineer our severe accident codes to see whether, you

know, what we observed at Fukushima is consistent with what our models did. I recall this kind of exercise was done after Three Mile Island, and I also recall there wasn't a very good agreement between what the severe accident codes would have predicted under those conditions, and what they actually observed in the core. But it's unfortunate that the accident happened, but it's empirical evidence and we want to make sure we milk it for every insight we can.

COMMISSIONER SVINICKI: I'm so glad you said that, because I'm not a PRA practitioner but that's been something that I think going forward would really be a way to have some learning out of this tragedy that I think would be, just again as an engineer, I think that would be so beneficial. So I feel kind of validated now. Thank you. Stuart, did you want to add anything?

STUART LEWIS: I don't think I have anything to add.

COMMISSIONER SVINICKI: Okay, thank you. Thank you, Mr. Chairman.

CHAIRMAN JACZKO: Commissioner Apostolakis.

COMMISSIONER APOSTOLAKIS: Thank you Mr. Chairman. Thank you, gentlemen. Very informative presentations as usual. Let's start with you, Biff. On your first slide, you say that the studies should complement, not replace, the use of CDF and LERF, and I agree with that. Although as you know, with LERF we have had some problems when it comes to power uprates. The question is whether that was a good metric, so I think a Level 2 PRA and a Level 3 PRA would help us answer questions like that. Maybe we could still continue using LERF, but we will have a better basis for saying yes, it's okay. I notice that you couldn't resist quoting the near-term task force regarding the Level 3 PRA. I think the near-term task force did such a great job in everything else that they felt

they had to prove that they were human, and they inserted this paragraph.

[laughter]

Stuart, you said that the EPRI is ready to, quote, "collaborate with the NRC." In fact, we do have I believe at least one MOU, memorandum of understanding with you, and we're doing this work on fire and other areas.

STUART LEWIS: We are working together on --

COMMISSIONER APOSTOLAKIS: Human reliability.

STUART LEWIS: HRA seismic, and several others.

COMMISSIONER APOSTOLAKIS: One issue that the staff also will raise, I believe, is that you know, doing a Level 3 PRA is a matter of resources and so on, so I'm wondering whether collaborating with you, if the gentleman on my left here allows us to do that from the OGC, whether that would maybe make the problem go away or reduce its significance, because then the burden will be shared.

STUART LEWIS: I would hope that it would reduce the level of burden. I certainly don't expect it would go away entirely. Again, we certainly have constraints on our resources as well. What I tried to convey was that there are areas we already have plans to engage in, that I think would help in this process as well. We're not in a position to be able to apply substantial new resources because the NRC undertakes a Level 3 PRA, but I think we can find some synergy there between our efforts and yours that would help to reduce the loading to some extent. To what extent, well I haven't tried to explore in any detail yet. It seems likely that would be the case, though.

COMMISSIONER APOSTOLAKIS: On your slide five, you said Fukushima response further complicates scheduling. Well, here's another

thought, though. Seems to me that in the context of Fukushima, we would have to do some work that will be beneficial to the effort of the Level 3 PRA, and the Level 3 PRA would give the context for the Fukushima work. So I view those two things as being mutually beneficial. Is that the correct view?

STUART LEWIS: I think they can be, and all I was trying to point out was that we really need to think in that context and not add another set of development activities or analyses to what we already know we need to undertake. I think we need to find the overlaps and the areas where we can feed back and forth between those two objectives in the most efficient manner. From our perspective, we've engaged our staff and the competent contractors that we can bring in to help us with activities to a very significant extent, and there's not a lot of bandwidth left to draw on. So we need to make the most efficient use of all the resources we can. Nothing new in that concept. It's just that Fukushima adds some complexity and some additional burden to that consideration, I think.

COMMISSIONER APOSTOLAKIS: Karl, when you did the two-unit calculations, did you consider the possibility that there would be a release from one unit at time T, and the release from the other unit would be at another time later, in which case maybe the weather pattern would have changed? Did you go into that detail?

KARL FLEMING: We did that to a limited extent, but I wouldn't want to overstate what we did there. I would like to point out, though, as far as our early health-effects calculations are concerned, we modeled realistically the evacuation model so that all the early health effects we were calculating were close in to the site and were folks that were exposed before they were able to get out in the evacuation plan. So while we were able to do that, in terms of early

health effects it's not clear that that would have been too important because if we stretch out the time beyond the evacuation -- well, we discovered that if the second release took place several hours after the first one, that would certainly eliminate the early health effects because of the evacuation effects. So I think we understood that. But this is an important issue that you bring up, and when you get into multiple releases, the timing of course would be a factor to consider.

COMMISSIONER APOSTOLAKIS: I remember that there were some problems that the utility had with the State of Massachusetts regarding evacuations and so on. Did the work that your team did help in any way there with the emergency planning?

KARL FLEMING: Well I think it did, but an indirect way. What happened at Seabrook was that given the fact that the State of Massachusetts was not participating in emergency planning, there was effectively a roadblock in getting the license approved. And seeking a way out of that, the plant owners petitioned to shrink the emergency planning zone to get it out of Massachusetts, and we put together a technical case pretty much along the lines of NUREG-0396, which was one of the supporting documents that helped define the 10-mile EPZ, so we put together a case to shrink the EPZ. That case was denied by the ASLB. However, the signal was sent to the Commission that effectively, the plant had no way to proceed with its license because of the emergency planning issue, so a new rule was passed by the Commission to allow the plant owners to basically compensate for the lack of participation by Massachusetts. So we think in the end that the work paid off, but the licensing pathway into that was not --

COMMISSIONER APOSTOLAKIS: But what role did the work play? I mean, you said the work paid off. Was it just a matter of the ASLB and

the Commission taking action, or the technical work?

KARL FLEMING: Well, yeah. I think the work paid off in the sense that I think everybody got a better understanding of the role of emergency-planning issues and the actual risk at Seabrook station, and I think it was clear from our results that all the concerns about early health effects were actually within one to two miles of the plant, and all the sensitivity studies that we did assuming no evacuation, with evacuation, different speeds, and so forth -- we did extensive studies and we were able to show that whatever early health effect risks did exist at Seabrook station was confined to the --

COMMISSIONER APOSTOLAKIS: Do you think it's a -- I think when we talk about Level 3 PRA, automatically we're thinking in terms of acute and latent fatalities. It seems to me that we would have the benefit of that study by doing only dose calculations. I mean, we still could do emergency planning, sensitivity studies, and so on. Do you think it would be best to stop there and produce frequency, dose calculations, which is by the way what the technology-neutral framework proposes, a common metric for all types of reactors. Or is it essential that we go all the way to health effects?

KARL FLEMING: I think using the frequency dose metrics is more optimum for looking at design questions, okay? How do I manage my licensing events? How frequent can they be? How my design and operator actions are influencing that, and having a simple metric for offsite consequences make sense of that application. But when you're trying to resolve emergency-planning issues, I mean, the emergency plan, the roads, the speed of evacuation, the two-dimensional map of people moving around the place -- you absolutely need to have a good full-scope Level 3 model to address that.

COMMISSIONER APOSTOLAKIS: Thank you. One last question. This was a full-scope Level 3 PRA sponsored by the utility.

KARL FLEMING: Yes.

COMMISSIONER APOSTOLAKIS: Can you summarize? I mean, did they see any real benefits from it? Were they pleased at the end? Did it help them with anything? Just to say understanding, it's always nice to understand, but in terms of real benefits, some decisions were based on it, are there any examples of that?

KARL FLEMING: I believe -- and you'd have to ask the executives at, then, Public Service New Hampshire -- this question directly, but I believe they would tell you that the Level 3 PRA was instrumental in helping to resolve the emergency-planning issue. It brought out information about the strength of the containment at Seabrook, which since Seabrook was designed for an aircraft crash of an F-111 aircraft, the design strategy that United Engineers and Constructors used to build the containment led to what I think we know today is probably the strongest containment in the country. The median pressure capacity found for that containment was five times design pressure, and that stood up to the scrutiny of the Brookhaven and NRC reviews. So all that work that was done to look at severe accidents at Seabrook station put information on the table that I think calmed the fears of many in terms of the emergency planning risk issues for that plant. Had they not done it, it's questionable in my mind whether they would have been able to succeed.

COMMISSIONER APOSTOLAKIS: Thank you very much, Mr. Chairman.

CHAIRMAN JACZKO: Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you and good morning. Appreciate your comments today. They were all very helpful. I was particularly interested in hearing about the Seabrook work. I hadn't heard about that before. It's very interesting. I think I hear something a little bit different across the three of you. I think I hear from Mr. Fleming a real belief that there's a real value in proceeding with Level Three PRAs. I want to make sure I understand what I'm hearing from EPRI and NEI. It sort of reminds me of the analogy of the space program that people always talk about. Maybe going to the moon wasn't really such a wonderful idea, but we got some great technology out of it along the way and trained a lot of really smart people. And I guess what I hear you saying is something analogous to that. I don't really hear from you that you believe there's an intrinsic value into moving to Level 3 PRA as a general practice, but there's value in things we'll learn along the way. Can you disabuse me of that, or explain that further?

BIFF BRADLEY: Probably can't disabuse you. I think that is generally correct. In the current regulatory framework the way the decision-making is done, there isn't an obvious compelling practical value for a plant to perform a Level 3 beyond what's being done currently for license renewal. Now, it's conceivable the regulatory environment will be in some state of flux going forward. That could change, but I do believe there is intrinsic value in having a modern version of NUREG-1150, because that's just a foundational study that we can always look back on to confirm that what we're doing is correct. So I guess the space program analogy is not too far off. It doesn't have immediate practical value currently, however it does have that overall value intrinsically.

STUART LEWIS: Yeah, I think outside the specific framework of

risk-informed regulations, I think a utility could expect to gain some additional insights from performing a Level 3 PRA. I think that you would have a different perspective on the kinds of severe accidents that are important for a plant, and you might make somewhat different decisions. I think those are incremental improvements in your ability to make decisions beyond Level 1 or a Level 1/Level 2 PRA. Most of the things that would be done, would be done to prevent core damage in the first place. There are things we learn in performing Level 3 PRAs that help us make changes or make improvements, that limit the potential for releases, and could conceivably in the future be used to better inform emergency planning. But that's not -- there's not an obvious path for doing that right now, I believe. But beyond that, I think that's why you hear maybe a little less enthusiasm for the specific value to a plant in performing a Level 3 PRA versus perhaps a more comprehensive Level 1 or Level 2 PRA that looked at a broader set of hazards, looked at different modes of operation, and that sort of thing.

COMMISSIONER MAGWOOD: I don't know, do you figure just a bunch of Luddites, or --

[laughter]

KARL FLEMING: No, I think you captured my passion directly. I also wanted to point out, listening to these comments about maybe a distinction between the operating plants and the new plants coming down the pike in the sense that small modular reactors, non-light water reactor technology, and so forth -- I think there will be a much greater need for Level 3 PRAs for those types of plants, so that we can figure out what their unique safety issues are. Because the light-water reactor risk metrics don't translate very well at all, and if you have modular reactors that are very small, even light-water reactor based like 100

megawatt thermal that are being discussed, then the risk metrics, the CDF and LERF don't enable you to take credit for, if you will, the much lower inventory of fission products that you have to deal with. So I think that there would be a difference between the new advanced reactors, and the existing reactors in the context of what Biff and Stuart were talking.

COMMISSIONER MAGWOOD: And sort of along the same lines, it seems to me that one of the insights that you and the Chairman were sort of talking about, the multi-unit effects, which I found quite interesting. It's not clear to me that you are able to gain those insights without a Level 3 PRA. Give you a chance to comment on that. Because it seems to me that what you're really looking at is not just simply whether the core damage frequency of the two units are -- in fact, I'm not sure you can link the two unless you have a Level 3 PRA. I'll give you a chance to comment on that.

KARL FLEMING: Well I think the Level 3 is necessary to get the full appreciation of the multi-unit effects, but if you were just doing a Level 1 multi-unit study, I think you would have a better handle on the interdependencies and the competing of resources. If I have core damage going on on two reactors concurrently, my operational resources and my emergency planning resources are going to be spread over those issues and there could be interactions, and if there are differences in terms of what's going on in the units at the same time, that could increase the probability they don't do the right thing. And those kinds of interactions in multi-unit sites haven't really been done very well for the single-reactor PRA models. I mean, there's requirements in the standard that you're supposed to look at multi-unit effects while doing a single-reactor PRA, but I'm not sure how well that's done unless you do the whole package.

BIFF BRADLEY: I think our existing Level 1 PRAs have done a fair job. We do know there are multi-unit effects, that there are some sequences that lead to multi-unit core melts. That's done through Level 1. I agree with Karl that to get all the insights from that, to get more insights, you could have a Level 3, but I think we have a pretty good handle right now on which sequences can go to -- and it's not always just external events. You can even have some internal event sequences that can lead you to a dual-unit situation. So we do, I think, have a pretty good understanding on that from our Level 1 and LERF work already, but icing on the cake kind of thing, I think.

COMMISSIONER MAGWOOD: I wanted to ask this next one just for my information. Are we all using the same tools? Does the industry and NRC staff -- everyone using Sapphire Eight? Are we using different tools? What's going on out there?

STUART LEWIS: No, actually there are a variety of tools out there. You mentioned Sapphire, and we actually have our own suite of PRA tools. It's called the CAFTA suite of codes that's widely used within the industry. There are some individual utilities that use Sapphire in a very limited way. I'm not aware of anyone who relies on Sapphire as their primary PRA tool within the industry. Most widely used is CAFTA, WinNUPRA from Scientech. There are a few plants that still use the wristband code that was developed in PLG. Karl can tell you all -- you want to know about wristbands, certainly. Up until recently, there was one plant that used a program called Risk Spectrum that was developed in Sweden, but they are converting to CAFTA. So we use comparable tools, but they're not the same tool.

COMMISSIONER MAGWOOD: But the fact that we're using

different tools, would that impact or ability to cooperate in doing projects together on some of these subjects?

STUART LEWIS: I don't think it would matter in a really significant way. I think that the tools all attempt to achieve the same objectives, and to some extent they have similar structure. We have the ability to communicate back and forth between different software platforms with our tools, so I don't think that would be a big impediment. It might be a minor problem from time to time, and every time I say that about any kind of software, it turns out that I'm wrong.

COMMISSIONER MAGWOOD: I want to come back to Mr. Fleming for another question. One of the things about Level 3 that I'm still sorting out in my own mind, and I think your comments would highlight this -- you end up looking at not just the effects at individual plants, but you start looking at these much broader effects, and I think your earlier work pointed out that it's the low-probability, high-consequence events that really drive the worst sequences. And I think seismic came up quite prominently. Now if you have a large seismic event, it isn't just going to be isolated to one nuclear power plant site. Depending on what party of the country you're in, you could have impacts on several nuclear power plant sites, and you could also have impacts on dams -- I think there was a dam issue related to the Fukushima incident. Certain refineries, LNG terminals -- I guess, where does it end? How do you responsibly go forward with a Level 3 analysis if you're looking at a large event like a seismic event? Do you have to encapsulate all of that into your model, or do you just ignore that? How does one approach that?

KARL FLEMING: Well I think that first of all, with respect to the seismic, when you're doing a Level 3 analysis of a given site, your modeling of

the emergency planning process, i.e. the evacuation and sheltering, needs to take the seismic conditions into account if we're going to fail bridges and roads and dams and things like that. Some thought needs to be given, and not just using your standard evacuation model for those types of things. I'm not sure how fruitful it would be to try to model what's going on at different reactor sites at the same time. It seems like -- I don't know whether that would be value added to the risk insights, but, you know, I think that -- I think we have the tools and the -- and the capabilities to address these issues and sometimes we have to address them with maybe some simplified, maybe conservative assumptions in some cases. But we have to do it to understand it rather than speculate on what might happen if we may or may not do it.

COMMISSIONER MAGWOOD: Just one last -- my time is up. One quick question for you. I think I heard you say that you believe the tools are in place to proceed to do this now and just figure it out as we go. And then there's not a -- I don't hear from you the need to go do several years of work to develop more tools. Is that --

KARL FLEMING: Well, I think if you look back at the PRA development, you know, when we first started doing PRAs, we didn't have very good handle on fires or floods, seismic events, common cause failures, human reliability, and we finally got through -- worked our way through to the point where we're at least able to do those to a certain degree. But in each one of those instances, the progress towards solving those technical issues came from doing it rather than doing research and development -- I don't want to minimize the importance of research and development that fed into it, but the -- if you take the position that we're going wait for the R&D to give us the tools, I don't think you

ever get there. I think you got to just go ahead and do it.

And you're going to find holes and gaps as you go along, and those can be taken into account when you draw conclusions from your studies. And then after doing it, you'll have a better handle on what additional R&D you need to do. So I've always been a believer in just try to do the problem, work your way through it, because until you do that, you don't fully appreciate what the issues are. I mean, that's my practical --

COMMISSIONER MAGWOOD: It's like going to the moon, right? Thank you, Mr. Chairman.

CHAIRMAN JACZKO: Just following up on that, it -- you know, there's been a lot of talk about the resource challenges. What are we talking about when we talk about resource challenges? I mean, is it money? Is it knowledge of individuals? Is it lack of individuals with appropriate knowledge? Is it the inability to translate a physics model into code and then put that into a probabilistic framework? What -- I mean, what are the resource issues? I mean, why can't I just have a bunch of undergraduate nuclear engineers go out and in a year have Level 3 PRAs for a bunch of sites?

BIFF BRADLEY: Where do we start? All right, I'll start by saying that I think we have state of knowledge issues. And for --

CHAIRMAN JACZKO: But what -- I mean, what do you mean by state of knowledge issues? I mean, do we not understand reactor physics? Do we not understand computer science? I mean, which is it?

BIFF BRADLEY: It's not so much computer science. I think it -- it's phenomenology, it's initiating event itself, the state of knowledge we have on initiating event frequencies, states of knowledge relative to -- we spoke about

combinations of initiators. That's an extremely difficult problem that I don't think we've tackled --

CHAIRMAN JACZKO: But it's a difficult problem from the standpoint of having the right -- being able to put the right parameter into the PRA or not knowing and understanding how to incorporate that kind of issue into a PRA. I mean, we don't know the event frequencies for seismic. Okay, but we can -- could I today put -- run a PRA -- Level 3 PRA with some value, and the model would, based on that value give me an answer?

BIFF BRADLEY: Well, yes, you could, and I think the types of PRAs we did in the past were aimed at sort of trying to bound the risk or to get general insights. And as I mentioned earlier, I think now that we're in a -- there's a much more strict regulatory envelope for the use of PRA, so the types of things we did in the past get much more scrutiny now. And there's a high expectation for proof -- there's an expectation of proof of assumptions. I've seen a lot of this in fire; fire's a, you know, a great case study in the difficulties in getting this right. And it's basically acceptance, you know, what's realism? What's conservatism? How do we account for lack of data? Those kinds of things are the difficult problems. Uncertainty, I know --

CHAIRMAN JACZKO: But those are -- I mean, these are all fundamentally Level 1 problems. They're not Level 3 problems. I mean, having bad initiating events isn't -- or not having a good understanding of the initiating events, not having a good understanding of these issues affects your Level 1. It doesn't prevent you from being able to carry that calculation through to Level 3 PRA --

BIFF BRADLEY: It introduces --

CHAIRMAN JACZKO: But you're -- I mean, what's the holdup and the inability to get to the Level 3?

BIFF BRADLEY: Well, I don't -- I think you're right. I think that -- at least in my experience, and you have to understand most of what we've been doing over the past several years is heavily concentrated on Level 1, so that's where we know what we run into. I don't -- we haven't done a lot of Level 3 and I'm -- and I know Karl and others have and they may be able to speak better --

CHAIRMAN JACZKO: Well, maybe but --

BIFF BRADLEY: -- but I do want to say that even at Level 1, you know, there are challenges that remain, especially when you start looking at low power shutdown. You're looking at, you know, hundreds of different plant operating states in a single outage. So how do you really model something like that?

CHAIRMAN JACZKO: But -- and again, I'm just raising it because what I'm hearing is that there's resource challenges to getting to a full Level 3 PRA, but what I'm hearing -- and I mean, maybe Karl and Stuart, you can explain to me -- is that there's problems with Level 1 PRA. So what is the -- I mean, today do Level 3 PRAs exist or what is the gap to get me from the Level 2 -- again, recognizing and acknowledging our initiating events may not be good yet for Level 1, et cetera, et cetera. Is there a huge delta in resources to take the existing Level 1 models and run them out to giving me dose assessments that incorporate EP -- I mean, does the computing technology, does a code exist to do that today?

BIFF BRADLEY: I believe it does and I'll let you guys speak to that.

STUART LEWIS: I think we certainly have the tools and I think

there are areas where if we were going to do this, we know we would like to enhance the methods, but we -- we have the technical ability to do that work. It's not a trivial exercise to go from a Level 1 PRA to a Level 3 PRA as I think I alluded to earlier --

CHAIRMAN JACZKO: Yeah, that's what I'm trying to figure out. What's non-trivial about it?

STUART LEWIS: Well, for one thing, the Level 2 is a significant amount of work to understand really the evolution of the severe accidents, but before that -- again, as I alluded to earlier -- defining the accident sequences in such a way that you can carry information from the Level 1 into the Level 2 and then to the Level 3 means that that affects the way you delineate your accidents in the Level 1. So you can't necessarily tack Level 2 and 3 onto the Level 1 part, you have to go back almost to the beginning and make sure you've covered the bases. That's not an insurmountable problem --

CHAIRMAN JACZKO: Right, but that's -- isn't that something I can give a bunch of undergraduate nuclear engineer students to figure out -- I mean, it doesn't seem like that is -- that's kind of a brute force exercise of -- you know, it's not an issue of understanding of -- I mean, I could probably give that to chemistry students because it's -- it doesn't matter what the underlying physics are, it's a modeling problem. So how do I carry through information from this to this model? I mean, why is that something that we can't just get done?

STUART LEWIS: Well, I think that -- and speaking as somebody who for most of my career has been a practitioner, I suppose I'd like to think that it takes some level of expertise to do this kind of work. But we -- it really requires -- there's nothing that's very much cookbook about the way you do a PRA. It

really requires a pretty good understanding of how the plant works, of severe accident phenomena and how those two things interact, how the models can be built in a way that reflects those aspects of the accident scenarios. There's not a lot of work that can be effectively done by someone without any specific technical knowledge about the way PRAs are put together.

CHAIRMAN JACZKO: So we've got to use the -- but --

STUART LEWIS: You at least have to have involvement of people who know what they're doing. And they may be assisted --

CHAIRMAN JACZKO: Well, I'm not saying we give random people who don't know what they're doing, but I'm saying I'm not -- I'm trying to understand what, you know, what -- I mean, I'm hearing "resource problems" and I'll be honest. I'm not -- I mean, I'm not convinced that this should be a problem for this industry. I mean, I really don't see -- I mean, everything you're telling me leads me to believe that our Level 1 and now even Level 2 PRAs are in terrible shape, that we don't have a good understanding of phenomenology, we don't have a good understanding of how to take from Level 1 to Level 2. I mean, that's surprising for me to hear that. So what -- if what you're telling me is the challenge is simply a modeling problem where I just have to make sure that I develop and prepare my inputs in the right way so that when my Level 1 spits out a core damage and a frequency, that I've got the ability from a modeling perspective to carry that information over to my Level 2 to spit out my containment impacts with some source term. But I've just got to make sure I have a good way to carry that through. That doesn't seem like a huge challenging problem.

STUART LEWIS: Well, first of all, somehow we've led you to

believe that our Level 1 and Level 2 PRAs are in terrible shape. That's a misimpression and I don't want to leave you with that impression there. We've been doing Level 3 PRAs for more than 30 years, WASH-1400 was a Level 3 PRA and we've extracted.

CHAIRMAN JACZKO: And I'm running out of time--so tell me in a --so what is the problem? I mean, Carl maybe you can, and maybe you're telling me and I'm just not listening.

KARL FLEMING: Yeah I think in terms of resources, it may be useful to separate the qualitative and the quantitative. First of all, get the quantitative out of the way. When we were doing full-scale Level 3 PRAs we would go out for bids, and we'd send our proposals in, and put together teams, it was about a 60-20-20 mix in terms of 60 percent of the resources was in the Level 1 PRA, about 20 percent in Level 2, and 20 percent in the back end Level 3. So that's one cut on resources, and maybe that'd be different today, I'm not sure, but ballpark would probably be reasonable. But on the qualitative side, when you go from Level 1 PRA to first of all, Level 2 PRA, you've got to bring in different kinds of expertise. You have to have thermo hydraulics and structural expertise and people that can deal with severe accident phenomena and pressures and stresses and what's going to break the containment.

CHAIRMAN JACZKO: You telling me we don't know how to do that?

KARL FLEMING: No we do.

CHAIRMAN JACZKO: It's a different set of resources it just takes people --

KARL FLEMING: It's a different set, resources, it's a different set of

people, then of course the back end analysis is a further set of people. The thing I want to comment on is, in the early days of PRA it was done by consulting companies and the NRC and the NRC contractors. And after the IPEs and IPEEEs, there was a very effective technology transfer to the utility industry where the utility industry built up very, very substantial capabilities to do their own PRAs. Well that technology transfer was heavily focused on the Level 1 PRA part of the process. So you can go into any utility industry and find very competent, very skillful Level 1 PRA practitioners. But it's -- from a business model perspective, it's not very easy to hire in severe accident guy, a probabilistic structures guy, a radiological consequence person and so forth, so, the resources are spread around in different places. And the --

CHAIRMAN JACZKO: What are the--

KARL FLEMING: The utility resources are consumed on the Level 1 part of the problem right now. And to go and get the technical resources to do the Level 2 and Level 3, I think that's where maybe the problem is. It's -- we have--

CHAIRMAN JACZKO: The problem is that we don't have literally enough bodies in the country that know how to do this.

KARL FLEMING: Yes, that's it. Enough people with the right expertise that together with graduates -- people coming out of college can get the job done. You have to have a mix of senior people.

CHAIRMAN JACZKO: If that's where the problem is, I don't know that the Commission can solve that, I mean we can't solve that problem. I mean we can't, I mean we could I guess. We have a grant program. Should we take our existing grant program and focus that exclusively on PRA and developing

PRA practitioners or model developers?

BIFF BRADLEY: Oh you're talking to a bunch of PRA people here.

CHAIRMAN JACZKO: So you should say yes.

BIFF BRADLEY: It wouldn't be a bad idea. Obviously you can't do that.

CHAIRMAN JACZKO: Well I don't know why we couldn't –

BIFF BRADLEY: We would certainly support --

CHAIRMAN JACZKO: I'm just trying to find what the root, the problem is, you're telling me I need 10 years worth of research to better understand some element of reactor physics before I can develop a model that I can then turn into some kind of code that I can run in a PRA. That's one problem. If it's just, I need to get the pipeline filled with more people to get more people to go out and do the grunt work of developing the models, that's a very different problem. And it sounds like it's the latter, not the former.

BIFF BRADLEY: It's some of both but it's certainly the latter, but there's also some fundamental issues that I think do need more attention. We --

CHAIRMAN JACZKO: But those seem to be what I'm hearing, is Level 1 issues, not Level 3 issues.

BIFF BRADLEY: But from my perspective, having been sort of embedded in the Level 1 world, yes, I do think there are, and it has to do mainly with combinations of modes of power operations and certain initiators that we really, there's work that remains to be done there.

CHAIRMAN JACZKO: Okay, good, well thank you. I appreciate that and you know, certainly it's something I have strong interest in, and I don't mean, I'm not trying to criticize you -- I'm just trying to really understand what the

problem is so we can figure out how to solve it. Because just hearing that it's resources doesn't necessarily help. But knowing where those resource gaps are really fundamentally is important. So, any other questions for this panel? Okay great, thank you, appreciate it. Take a quick recess an then we will hear from the staff.

[break]

CHAIRMAN JACZKO: Ready Bill?

BILL BORCHARDT: I'm ready.

CHAIRMAN JACZKO: Okay, go for it.

BILL BORCHARDT: Good morning. I appreciate the first panel's discussion. I think it highlighted the fact that there's good agreement about the importance of doing some additional work on Level 3 PRA. I think the issue comes down to what's the best path to get to where we all want to go, which is to be able to have this capability and that's the basis for the three options that we prepared. And Dan Hudson, who is the project manager for this effort's going to give a presentation this morning on our views and on the options that were presented in the paper. Before that though, Brian's going to give an introduction on severe accidents, just as some background into the context of this overall effort. So I'll turn to Brian first.

BRIAN SHERON: Good morning. I'm Brian Sheron, the Director of the Office of Nuclear Regulatory Research and I'll provide an overview on severe accidents. If I can get slide three.

I'll begin my overview of sever accidents by reviewing some nuclear power plant terminology. First off, a design basis accident is postulated accident assumed coincident with the worse postulated single act failure of a component.

It's a performance intended safety function for which a nuclear facility is designed to withstand without exceeding offsite exposures in excess of 10 CFR Part 100. Beyond design basis accident is one which involves either a more serious initiating event or multiple failures following an accident initiation. Although not specifically designed to do so, nuclear power plants are capable of handling many design basis, or I'm sorry, beyond design basis accidents without resulting in core damage. However there are some beyond design basis accidents involving multiple failures that could lead to core damage. For some, the extent of damage could be minor, for others, such as those involving a prolonged failure of core cooling systems, substantial core damage could result. A severe accident is an accident which results at a minimum in substantial damage to the reactor core. Slide four please.

Prior to the accident at TMI-2, the NRC and nuclear industry were largely focused on design basis accidents and particularly the large break loss of coolant accident, referred to as an LB LOCA, as the accidents of concern for commercial nuclear, light water nuclear power plants. Adequate protection of public health and safety was demonstrated by designing plants to withstand these DBAs and by using defense in depth safety strategy which promotes the use of multiple, independent defense mechanisms to prevent or mitigate the consequences of a severe accident, should one occur.

Four years prior to the TMI-2 accident, the NRC completed the first comprehensive, probabilistic risk assessment of two nuclear commercial power plants, Peach Bottom and Surry, as part of the Reactor Safety Study, published in WASH-1400. While this PRA concluded that accidents initiated by transients or small break LOCAs were more likely to cause core melt than traditional DBAs,

it was not until the TMI-2 accident that this realization became apparent. The accident at TMI-2 was not a stylized, large break LOCA. Instead, it was a small break LOCA due to a stuck open valve that was initiated by a loss of feedwater. Off-site power was not lost. The worse single act of failure didn't occur and most importantly, operator error was a major contributor to the event. Slide five.

Following TMI-2, NRC research was redirected to focus on severe accidents. The objectives of this research were to one, obtain a better understanding of the physical phenomena of severe accidents. Two, develop models of these phenomena to predict the ways that sever accidents might progress. And three, develop more realistic estimates of the radionuclide releases that could result from severe accidents. And four, examine available data sources and existing PRAs to identify important accident sequences. To meet these objectives, the NRC invested millions of dollars in major research programs. In August, 1985, on the basis of available information from the severe accident research program, the Commission issued its severe accident policy statement in which it concluded that the existing plants pose no undue risk to the public health, and no immediate additional regulatory changes were recommended for these plants to address severe accidents. However, acknowledging that safety could be further improved by identifying and addressing plant specific vulnerabilities to severe accidents, the Commission articulated its desire to perform an individual plant examination, or IPE, of each nuclear power plant. Next slide please.

Three years later, in November 1988, the NRC issued Generic Letter 8820, requesting that each licensee perform an IPE to identify plant specific vulnerabilities to severe accidents that could be fixed with low-cost

improvements. Based on guidance provided in Generic Letter 8820, the scope of the IPE submittals was limited to internal initiating events occurring during at power operations. Therefore in June 1991, the NRC issued supplement four to Generic Letter 8820, requesting that each licensee perform an individual plant examination of external events, or IPEEE, to identify further severe accident vulnerabilities. Scope of the IPE submittals included consideration of internal fires, seismic events, floods, high winds, and other external initiating events. The IPE and IPEEE programs led to improved understanding of PRA and severe accidents and served as catalysts for further improving nuclear power plant safety.

In April 1986, a severe accident at Unit Four at the Chernobyl Nuclear Power Station in the Ukraine released huge amounts of radioactive material to the atmosphere that were detected worldwide. Subsequent assessment of this accident concluded that the cause was due to certain design features of the Russian RBMK type reactor that were not present in Western reactors. However, human error and safety culture were found to have been key contributors to the accident and these elements are not necessarily unique to Russian reactors.

Since the accidents at TMI-2 and Chernobyl, and also the events of 9/11, the NRC and the U.S. nuclear industry have used insights from research programs and PRAs to identify and implement numerous and substantial additional measures to reduce the vulnerability to or mitigate the consequences of, severe accident events. Example measures include the implementation of the risk informed regulations such as the hydrogen combustion rule, 10 CFR 50.44, anticipated transients without scram or ATWS, 10 CFR 50.62, and the station

blackout rule, 10 CFR 50.63. The addition of hardened vents to the boiling water reactors, the BWR Mark I containment, and the development of severe accident management guidelines and the extensive damage mitigation guidelines or B.5.b measures. Next slide, slide six.

The progression of a severe accident can be divided into multiple, successive stages, with each stage beginning with a specific event. To illustrate this progression, a station blackout example scenario will be discussed. The first stage begins with a loss of off-site power initiating event, which leads to a reactor trip. Concurrent assumed failures then lead to the unavailability of emergency on-site A/C power sources, resulting in a station blackout. Failure to restore A/C power and depletion of D/C power sources ultimately leads to a loss of injection and core cooling capability. Next slide.

The second stage begins with the onset of sustained core uncovery as the water level drops below the top of the active fuel due to coolant boil off. Because of low vapor flows, the cooling of fuel in the uncovered part of the core is relatively ineffective resulting in core heat up. Third stage begins with the onset of steam-induced oxidation of the Zircaloy cladding, which results in heat release and hydrogen production, cladding failure and the release of gaseous fission products from the fuel cladding gap into the reactor coolant. The fourth stage begins with the melting of the remaining Zircaloy cladding and subsequent melting of the fuel, which releases fission products from the fuel into the reactor coolant. Next slide please.

The fifth stage begins with the flow of molten fuel material into the lower plenum of the reactor vessel. The sixth stage begins with the failure of the reactor pressure vessel, with consequent discharge of hot core debris and

radionuclides into the containment. Reactor pressure vessel failure can result from weakening of either the lower head or its penetrations due to contact with the hot core debris. Challenges to containment integrity can occur during different time periods including at accident initiation. Example phenomena that can present challenges to the containment include hydrogen combustion and containment over pressurization due to non-condensable gas generation. Final stage begins with containment failure or bypass, which leads to the transport, dispersion, and deposition of radionuclides through the environment. Next slide.

Through years of severe accident research, sophisticated computer codes have been developed for performing severe accident progression analyses. NRC uses the MELCORE code for performing integrated severe accident analyses by modeling important severe accident phenomena, such as accident initiation, reactor coolant thermo-hydraulics, core meltdown, and relocation, reactor pressure failure, fission product transport and release, and containment thermo-hydraulics and failure.

Figure on slide nine illustrates an output from a MELCOR simulation of a long-term station blackout involving a GE BWR reactor. The graph illustrates how reactor pressure vessel pressure changes as the accident progresses from initiation to pressure vessel lower head failure. Note the pressure spikes at core relocation and reactor pressure vessel lower head failure. Next slide.

Figure on slide 10 is a graphical display of a MELCORE simulation of the TMI-2 accident, which illustrates the probable relocation routes of the melted TMI-2 core. Note the debris located in the core's support assembly in the lower plenum. This concludes my overview of severe accidents and now I'll turn

it over to Dan.

DANIEL HUDSON: Thank you Brian. Good morning Mr. Chairman and Commissioners. As you heard, my name is Dan Hudson. I'm a technical assistant in the Office of Nuclear Regulatory Research and I'm the project manager for the staff's new Level 3 PRA initiative. I'm pleased to have the opportunity this morning to discuss the staff's proposed options for proceeding with future Level 3 PRA activities that were provided for Commission consideration earlier this month in a notation vote paper. As to whether or not I'll be pleased to have the opportunity to address the questions that will be coming my way, especially coming those from Commissioner Apostolakis, guess that's to be determined. Slide 12 please.

To set the stage for our discussion related to Level 3 PRAs and for the benefit of our audience members who might not have a background in this area. I'll begin by providing a brief overview of both PRA and the levels of risk characterization that have traditionally been used in PRAs for nuclear power plants.

At its core, PRA is a structured, analytical process that provides both qualitative insights and quantitative estimates of risk that can be used to support decision-making and risk management. It does this by systematically answering three basic questions. First, it answers the question, what can go wrong by developing a set of possible accident scenarios? Each accident scenario begins with an initiating event that disrupts the system's normal operations and ends with an undesired outcome or end state. Within each scenario, there can be multiple intermediate events, such as the successes or failures of equipment and/or operator actions that can determine whether and

how an initiating event leads to a particular end state.

Next, it answers the question, how likely is it by estimating the likelihood of each accident scenario, using its initiating event frequency and the probabilities of different combinations of successes and failures that can lead from the initiating event to a particular end state. Finally, it answers the question, what are the consequences by estimating the consequences of various damages or losses that can occur at the end states of interest. Slide 13 please.

Within this PRA framework, risk can be characterized in different ways, depending on the end states and consequence measures of interest for a particular risk informed application. PRAs for nuclear power plants have traditionally been organized into three levels of risk characterization that are based on three sequential end states of interest within a severe reactor accident scenario. The end states of interest in a Level 1 PRA are either the onset of reactor core damage or the achievement of a safe state. A Level 1 PRA therefore models the possible equipment and operator responses to various initiating events to identify those sequences of events that can result in the onset of reactor core damage. The estimated frequencies of possible core damage accident sequences are then added together to calculate the total core damage frequency, or CDF for the analyzed plant. The end state of interest for a Level 2 PRA is the release of radioactive material from the container to the environment. Therefore in addition to the Level 1 PRA analyses, a Level 2 PRA models the progression of possible core damage sequences to evaluate system and containment performance under accident conditions. A Level 2 PRA can therefore be used to estimate conditional containment failure probabilities, radioactive material release frequencies such as large early release frequency or

LERF and various characteristics of the released radioactive material, otherwise known as the source term. The end state of interest of a Level 3 PRA are various off-site radiological consequences. Therefore, in addition to the Level 1 PRA and Level 2 PRA analyses, a Level 3 PRA assumes various models for atmospheric transport and dispersion, emergency response, dose response, and economic phenomena to estimate off-site radiological consequences. Inputs to a Level 3 PRA include the source term characteristics from a Level 2 PRA and several site specific factors such as local weather patterns, population density, emergency planning measures, and land use. Outputs from a Level 3 PRA can include estimates of population dose at various locations around the site, early and latent cancer fatalities, and economic costs associated with evacuation, relocation, property loss, and land decontamination.

By combining both the core damage sequences from a Level 1 PRA and the radioactive material release frequencies from a Level 2 PRA, with the offsite radiological consequences associated with each release, a Level 3 PRA directly estimates the risk to the public from nuclear power plant accidents. Slide 14 please.

The staff's new Level 3 PRA initiative began with an overall vision. Our vision was ultimately to enhance regulatory decision-making by extracting new and improved risk insights. We envisioned that these insights could be realized by performing new Level 3 PRAs that include three fundamental enhancements when compared to the last NRC sponsored Level 3 PRAs that were performed in the late 1980s as part of the NUREG-1150 study. The first enhancement would be to incorporate important technical advances made in the more than two decades that have passed since NUREG-1150. Examples of

such technical advances include various modifications to enhance nuclear power plant operational performance, safety, and security; improvements in our understanding and modeling of severe accident phenomena; and improvements in PRA methods, models, tools, and data, which we collectively refer to as PRA technology.

The second enhancement would be to expand the scope of the analysis beyond that of prior NRC sponsored Level 3 PRAs, to provide an assessment of site accident risk as opposed to reactor accident risk. The envisioned scope would therefore include an assessment of not only single unit reactor accidents, but also accidents involving additional site radiological sources, such as multiple reactor units and spent fuel. The third enhancement would be to achieve better analytic consistency by using more consistent PRA technology, assumptions, and level of detail in the modeling and assessment of the broad spectrum of possible accident scenarios, and this was an issue that was raised earlier with the stakeholder panel. Because of our early focus on the single unit reactor accidents initiated by internal events such as a loss of cooling accident, our existing PRA technology has evolved and is quite capable of modeling and assessing these types of accidents. However, for modeling and assessing accidents involving additional site radiological sources, and accidents initiated by various external events, our PRA technology is somewhat less mature. These differing degrees of sophistication can introduce additional challenges when attempting to identify the most significant contributors to risk. Our vision is therefore to achieve a more level playing field so that in the end, we can make a meaningful comparison and obtain a relative ranking of the various contributors to risk at a nuclear power plant site.

To realize this vision, the staff thought a three phased approach would be needed. The first phase would consist of a scoping study, to evaluate the feasibility of performing a new and more comprehensive site Level 3 PRA that includes these enhancements. The second phase would consist of a pilot study to demonstrate our ability to develop such a Level 3 PRA. And finally, the third phase would consist of any needed follow-on studies or activities. Slide 15 please.

During the annual Commission meeting on Research Programs, Performance and Future Plans that was held on February 18, 2010, the staff presented this vision and proposed to move forward with the scoping study. In the subsequent Staff Requirements Memorandum dated March 19 of 2010, the Commission expressed its conditional support for proceeding with Level 3 PRA related activities and directed the staff to first continue internal coordination and external stakeholder engagement activities in formulating a plan and scope for future actions. And second, provide various options for proceeding, which include cost and perspectives on future uses. Slide 16 please.

Through numerous interactions with internal and external stakeholders including staff workshops, Advisory Committee on Reactor Safeguards briefings and a Category 2 public meeting, the staff identified a set of seven high-level potential future uses for Level 3 PRAs. In doing so the staff explored not only the ways in which the NUREG-1150 PRAs were used to support the development of our existing risk informed regulatory framework, but also potential enhancements that could be made to this framework by performing new Level 3 PRAs. It should be noted that this set of potential uses that we're about to discuss is meant to apply to future Level 3 PRAs in general, and not

specifically to the Level 3 PRA proposed as one of the options for proceeding. As with any PRA, the use of a single site specific Level 3 PRA would ultimately depend on its scope, and the extent to which its results and insights can be generalized to apply to the larger population of nuclear power plant sites. The seven high level potential future uses identified by the staff include (1) assess the agency's current use of PRA and risk informed regulatory decision-making. An example could be to confirm the acceptability of using the results of Level 1 and limited scope Level 2 PRAs to support various regulatory applications. (2) verify or revise regulatory requirements and guidance, particularly those that were developed using information from the NUREG-1150s PRAs. An example could be the regulatory analysis guidelines used to evaluate the cost and benefits of proposed backfits. (3) support specific risk informed regulatory applications in areas beyond those we have historically addressed using risk insights. Examples include providing the technical basis for risk informing the regulation of spent fuel storage and handling, siting, and emergency preparedness. (4) prioritize generic safety issues and nuclear safety research programs. Slide 17 please. (5) develop and pilot test PRA technology, industry consensus standards and regulatory guidance. This could include evaluating potential risk metrics for future use. (6) support both PRA knowledge management including the development of in-house PRA technical capability and risk communication activities. (7) support future risk informed licensing of new and advanced reactor designs including small modular reactors. Slide 18 please.

In addition to these potential future uses, the staff coordinated with internal and external stakeholders to identify and develop various options for proceeding with future Level 3 PRA activities. The three primary options deemed

by the staff to be the most feasible and cost beneficial are presented on slide 18. Each of these primary options, including its relative advantages and disadvantages will be discussed in more detail momentarily. Slide 19 please.

In developing options, the staff recognized that the Commission has considerable flexibility in selecting an option for proceeding with future Level 3 PRA activities. Therefore in addition to the three primary options we are about to discuss, the staff also considered other options for proceeding. These options included for example, a limited scope Level 3 PRA that could be used to address specific issues of interest; a full-scope Level 3 PRA for new or advanced reactor design; and a licensee to develop Level 3 PRA, supported by NRC staff participation. The staff used these other options as essentially variations on the primary options that could allow for completion of a Level 3 PRA with different schedule and resource implications for the agency. Slide 20 please.

I will now discuss in more detail the three primary options presented for Commission consideration. Option 1 maintains the status quo in ongoing and planned activities related to the development and implantation of PRA technology and risk informed regulation. The objection of this option would be to continue the evolutionary development of PRA technology on a resource available basis. Like other agency research activities, the scope of this option would ultimately be determined by program office user need requests, Commission tasking and the agency's long-term research plan. For example, as part of its strategic long-term research plan, the staff has identified Level 2 and Level 3 PRA as areas that would benefit from examination of more advanced methods and is therefore performing limited scope research in these areas. Slide 21 please.

When compared to the other primary options, an advantage of Option 1 is that it's consistent with the current fiscal climate, by focusing limited available staff and contract support resources on ongoing and planned mission critical work. If Option 1 is selected, resources that have already been requested to support future Level 3 PRA activities, could be reallocated to support other important activities. One disadvantage of Option 1 is that insights from a new and more comprehensive site Level 3 PRA would not be realized. Another disadvantage is that this option can result in an inconsistent and more costly treatment of potential future issues by developing the necessary PRA technology on an ad-hoc basis, rather than developing up front a useful tool that can provide an integrated perspective. I realized earlier this week as I was preparing for this meeting that I needed to be careful about how this last statement can be interpreted and I want to be clarify that as a regulatory agency, the NRC always strives to be stable and consistent in its decision-making. So when I talk about consistency in this context, I'm talking about striving for consistency in the quality of the information and the tools that we use to support our decision-making, not necessarily the decision-making itself. Slide 22 please.

Option 2 involves conducting near term focused research over the next two years. The direct objective of this research would be to prepare for developing a new, full-scope comprehensive site Level 3 PRA by addressing identified gaps in existing PRA technology. These technical gaps that we've identified relate primarily to the proposed expansion in PRA scope and the differing degrees of detail and sophistication in existing PRA technology that can be used to assess the risk from various site radiological sources and initiating event hazards. Example areas for further research that could be included in the

scope of Option 2 include: modeling of consequential multiple initiating events such as seismic induced floods and fires; modeling of multi-unit dependencies and accidents involving multiple units; post core damage and external events human reliability analysis including the modeling of severe accident management guidelines and extensive damage mitigation guidelines and extensive damage mitigation guidelines, or B.5.b measures; development of spent fuel PRA technology; and Level 2 and Level 3 PRA uncertainty analysis.

It's important to note that this list of research areas is not intended to be comprehensive or fixed. Moreover, given the proposed resources and two year schedule, we recognize it would not be possible to address all identified areas. So if Option 2 is selected, the staff would prioritize its research efforts and use budgeted resources to address the highest priority areas. At the end of the two year period, the staff would assess the agency's progress and readiness for performing a new and more comprehensive site Level 3 PRA and would provide the Commission with various options and a recommendation for proceeding with future Level 3 PRA activities.

I want to just take a brief moment to deviate from my prepared remarks here because it's become clear to me through the earlier discussion with the stakeholder panel, that Option 2 might be misunderstood. I get the impression that people see researchers operating in their vacuum, maybe in the offices of Research, performing this research without a clear focus or context. And that's not what we meant at all and it's become clear to me that maybe I didn't articulate that quite as clearly as I should have in the paper. But the vision for Option 2 is really to make important progress over the next two years. The ultimate purpose is to prepare for doing a Level 3 PRA. And we wouldn't be

doing that research in a vacuum. The idea here is to engage with licensees and to perform this research within the context of a PRA, whether it's the licensee's PRA or it's one of the agency's standardized plant analysis risk PRA models. But it would be performed in a context and the advantage that it gives us is that we have the flexibility to engage with multiple licensees rather than restricting ourselves to a single site like we would with proceeding with Option 3. So just thought I'd put that out there, in advance, anticipating that we might be receiving some questions about that. Slide 23 please.

An advantage of Option 2 is that like Option 1, but to a lesser extent, it focuses limited available staff and contract resources on ongoing and planned mission critical work. Another advantage is that it focuses additional staff and contract support resources that have already been requested to support future Level 3 PRA activities on research that is needed to support the eventual development of full scope comprehensive site Level 3 PRAs. Yet another advantage is that it produces results and insights that would advance the state of practice in specific PRA technical elements and would thereby enhance our PRA technical capability in these areas. A disadvantage of Option 2 is that when compared to Option 3, it delays the insights that could be gained from performing a new and comprehensive site Level 3 PRA. Slide 24 please.

Finally, Option 3 involves planning for, and performing a new, full-scope comprehensive site Level 3 PRA for an operating nuclear power plant. Research identified in Option 2 also would be conducted as part of this option, but on an accelerated schedule to support the completion of this study within a proposed three year schedule. Three main objectives for the proposed site Level 3 PRA have been identified. Consistent with our overall vision, the first and

primary objective would be to extract new and improved risk insights. The second objective would be to enhance our PRA capability, expertise, and documentation. The third and final objective would be to demonstrate the technical feasibility and evaluate the realistic costs of developing new site Level 3 PRAs. Slide 25 please.

This figure on slide 25 illustrates the envisioned scope for the proposed site Level 3 PRA. The approximate scope of NUREG-1150 is captured by the blue shaded region in the lower left corner of the figure. As you can see, these Level 3 PRAs were limited to the assessment of single unit reactor accidents occurring at power and that were initiated primarily by internal initiating event hazards, with a very limited treatment of some external initiating event hazards. Consistent with our overall vision, we have proposed to expand the scope beyond NUREG-1150 to provide an assessment of site accident risk. The proposed scope would therefore include an assessment of accidents involving all reactor units and spent fuel on site, accidents initiated while at power and during low power, shutdown plant operating states, and accidents caused by both internal and site specific external initiating event hazards. The only factors specifically excluded from the analysis would be radiological sources involving fresh nuclear fuel and radiological waste and initiating events involving deliberate malevolent acts such as terrorism and sabotage. Slide 26 please.

When compared to the other primary options, an advantage of Option 3 is that it provides the new and improved risk insights that we are seeking, and it does so earlier than Option 2. Another advantage is that it enhances our PRA capability, expertise and documentation earlier by developing up front, a useful tool that can provide an integrated perspective for addressing

potential future issues. The major disadvantage of Option 3 is that it is resource intensive, requiring more staff and contract support resources than have already been requested to support future Level 3 PRA activities. As such, it would require reallocation of qualified risk analysts from other ongoing and planned important activities, such as reviews of license amendments to support the voluntary implementation of National Fire Protection Association Standard 805, refinements of the agency's standardized plant analysis risk PRA models, used to support the reactor oversight process, and reviews of PRAs in support of combined operating license applications. Slide 27 please.

Through numerous interactions with internal and external stakeholders, the staff has concluded that performing a new and more comprehensive site Level 3 PRA would be beneficial. And I think that everyone would agree that there's some agreement on that today. However, obtaining additional resources to support this initiative would be challenging in light of the existing fiscal climate and in particular, the need to otherwise reallocate a limited number of qualified risk analysts from other ongoing and planned important activities. The staff therefore recommends the Commission approve Option 2. Selecting this option would enable the staff to use resources already requested to support future Level 3 PRA activities to continue important progress toward ultimately performing a new and more comprehensive site Level 3 PRA. Moreover, it would enable the staff and the Commission to better understand the potential needs and implications of both the recently completed near term task force review and the pending recommendations from the task force for assessment of options for developing a more holistic risk informed and performance based regulatory approach before committing substantial resources

to support the development of a new and more comprehensive site Level 3 PRA. Slide 28 please.

Thank you very much Mr. Chairman, this completes the staff panel's prepared remarks.

CHAIRMAN JACZKO: Anything else? Okay, great, Commissioner Ostendorff?

COMMISSIONER OSTENDORFF: Thank you Chairman. I was intrigued by the Chairman's question, questions on the previous panel associated with resources and so forth and I think given the nature of that element being very prominent in the staff's recommendation for Option 2, I wanted to maybe just ask a couple questions along these lines to start out. Dan, I'm going to put you on the spot here. I'd be interested in knowing what is your background as Level 3 PRA project manager? I've never had a discussion with you so I'd just be curious to see what you've done, where you've been, what your education is.

DANIEL HUDSON: Sure, I'll start off by saying I am not a PRA practitioner. I came to the agency in the fall of 2009. I had served for seven years in the Navy as a submarine warfare officer so I have experience in the operation and supervision of the operation of nuclear power plants within the naval nuclear power regime. So I came into this position having some experience with operations. I also had a background in human factors and some experience with human reliability analysis but hadn't really operated in the context of a full PRA, let alone a Level 3 PRA. So I was relatively new to the PRA field when I took over this position and just dove right in and started developing the knowledge that I needed to serve in this role.

COMMISSIONER OSTENDORFF: And I assure my colleagues, I did not know in advance the answer to this question, that I knew he was a Navy guy.

CHAIRMAN JACZKO: Did you know him when you were in a submarine?

DANIEL HUDSON: I did not.

COMMISSIONER OSTENDORFF: Full disclosure. Well thanks. You know, when I look at, on page 10 of the SECY where, and I'll but the EDO on the spot here a little bit, because I'm trying to really understand, I think, what I'm hearing is all the recommendation towards Option 2 was really predicated upon a resource constraint. Is that a fair characterization?

BILL BORCHARDT: Yeah, and it's based, I mean it's a resource constraint based on input from all of the program offices and the -- recognizing the support that they asked for from the Office of Research and the limited resources. So it all folds together in kind of an integrated assessment.

COMMISSIONER OSTENDORFF: Okay so I'm looking, I'm going to read, I'm going to provide a couple of examples because I'm going to ask you for a rack and stack where this fits in, that's where I'm going with this question. Page 10 of the SECY it talks about other Commission work that's already been directed in evaluation of different HRA models. It goes back to 2006 SRM. Development of guidance will be used for the development of expert, use of expert guidance and decision-making. Development of guidance will support risk informing SMR reviews. Program office work on the SPAR model development, transition to 805 implementation by our licensees, simulated research, et cetera, et cetera. There's probably 10 or so different elements here. Where does the

Level 3 PRA, if the Commission approved that, where does that fit into the list of priorities for the limited, what I understand. limited risk analysts in the agency? And whoever wants to answer that.

DANIEL HUDSON: I'll start by saying that the areas that you've just identified on page 10 of the SECY were meant to be examples of some of the ongoing and planned work that some of the qualified risk analysts that we've talked about would be participating in. So we're not saying up front that this Level 3 PRA initiative would be more important than that work, it's just examples of ongoing work that would be competing for the same resources. And we put in the SECY that if the Commission were to direct the staff to proceed with Option 3 or some other option involving a Level 3 PRA, we would take an approach that is very similar to what the ACRS recommended, and that's that we would engage with industry to identify a site that would participate in the study. We'd develop a more detailed project plan and obtain more realistic resource estimates than we have today. And then we'd engage with the program offices to identify what resources, the more realistic resources that would be needed to support that effort. And then we'd try to determine at that point where this initiative fits out, or plays out with the other ongoing activities and what's more important.

COMMISSIONER OSTENDORFF: Well, but -- okay, what's less important than the PRA work? I'm just trying to get a feel for this on a relative basis. Because I'm hearing that the PRA three, Level 3 PRA work overall appears to have merit, that pursuing Option 2 will delay getting to that end state. Everything is not an equal priority; there's certain things more important than others. I'm just trying to, curious to -- where does this fit in the list of other things?

BILL BORCHARDT: My initial answer to that question anyway would be consistent with every other prioritization that we make in this agency. The top priority's got to be operating reactor safety. So that goes to reactor oversight, to the SPAR models, to making sure that they're as usable and functional as possible. So that's at the top of the list. I see there's kind of a large middle of the priorities that -- I would say currently licensing actions in which fire protection would fall, other license amendments where licensees use, rely on risk information to support the submittal, those are equally important. The new reactor reviews would fall into that great middle. And I think I would put that Level 3, because it's going towards the future, as being in there. But I certainly couldn't displace current operating reactor issues with the Level 3.

COMMISSIONER OSTENDORFF: Brian, do you have anything to add to that?

BRIAN SHERON: Well, the only thing I'd point out is that the resource estimates are very uncertain right now. And actually this two year period gives us a little bit of time to kind of think through what makes sense. For example, if we were to start a Level 3 using the SOARCA plants, we've already got a fair amount of the work done, okay. The question is, do you learn something more by doing a Level 3 on those two plants versus you know, just looking at the SOARCA results and the like. Should I pick, for example, a different kind of plant? Should I pick an ice condenser? Should I pick a B&W plant for the Level 3? Are these two utilities, Peach Bottom and Surry utilities, would they be willing to continue to participate? We don't know. So I look at this two year period as giving us some time to kind of scope out what makes sense. We can work with the ACRS, and the like, and come back then, and say okay we

really kind of rung this through. Here's the kind of plant we think we ought to do. Here's the -- we met with the industry, here's the utilities that are willing to participate. Here's the kind of reactors they have; this is what makes sense.

Obviously the resource estimates we put in the paper were sort of like, if we were to start from a blank piece of paper. If we were to start with an existing plant that already had a PRA or one of the Peach Bottom or Surry, I think the resource estimates would be less, okay. But it would still be more than what we have budgeted right now, but not the full amount.

COMMISSIONER OSTENDORFF: Brian, a follow up question for that. Is there anything from your current understanding of the Fukushima events or anything else in the operating reactor side of the house that would create a greater urgency to do the Option 3 route at this time?

BRIAN SHERON: This is my personal opinion. I think looking at site risk, as long as I've been in the agency it's always been a pro-reactor year type of risk. And I'm very interested personally in what kind of synergy as we saw like at Fukushima. Are there external effects that can affect multiple units? Can they affect the spent fuel pool which might in turn have an effect on a reactor or vice versa? So you know, doing it for that reason I think, in my mind, would give us some new and important information.

COMMISSIONER OSTENDORFF: Thank you, thank you Mr. Chairman.

CHAIRMAN JACZKO: Commissioner Svinicki.

COMMISSIONER SVINICKI: Thank you for those presentations. That was very helpful. Brian, I'd like to return to SOARCA. Can you just describe the status of the SOARCA right now? I mean, the analysis is done, are

we still in the peer review?

BRIAN SHERON: We're finishing up the peer review. I think there's one more meeting planned where we're going to go through and basically just show the peer review panel how we responded to their last set of comments. We're not asking for further comments from them. We're finishing up the analyses, finishing up the documentation. The plan would be to then put it out for a draft, out for public comment. We would then get public comments; we want a disposition the comments. I think there's a final ACRS meeting involved and then we would bring it to the Commission.

COMMISSIONER SVINICKI: And is it true that there are not at this time any, there's no specific direction as to how the SOARCA results might inform any kind of regulatory decisions at this time? Is that true that that direction doesn't exist right now?

BRIAN SHERON: Not, I would say not officially or anything. I mean we've been thinking about what kind of uses it might be used for and the like. And I think one of the plans we had when we send the SOARCA results to the Commission, would be with a recommendation at least on where we think we would go next with it, or how it could be used.

COMMISSIONER SVINICKI: So if I were to lay that answer alongside the comment you made earlier about thinking about how SOARCA might at least inform the conduct of Level 3 PRA depending on how NRC decided to proceed here, what would be the plusses and minuses in your mind at a very high level of utilizing the SOARCA sites?

BRIAN SHERON: Well the plus obviously would be lower resources, obviously since we've done most of analyses and I think we could

probably focus more attention on the multiple unit and the spent fuel pool aspects for say, the less than full power shut down rather than at the full power. That would be the biggest benefits I would think of using of the SOARCA plants.

COMMISSIONER SVINICKI: And the down side is just as you indicated earlier is that they may or may not be representative of what you're most interested in right now?

BRIAN SHERON: Well I've mean, we've done these two plants; they were done for WASH-1400. They were part of NUREG-1150. We just did them with SOARCA. I guess the question is should we do a different plant, you know with a different design and stuff. What we found in SOARCA is there are some subtleties in the design that can have significant affects on what the results are, even though they may -- you may think that all plants, all BWR-1s look alike or something like that, or Mark-1s, But there can be subtle differences based just on licensee changes made over the years that can have big effects. So looking at a different plant may shed some insights on that.

COMMISSIONER SVINICKI: And so if we try to understand better Dan, Option 2 and Option 3 and the difference which you said upon hearing the first panel, you thought maybe Option 2 is being characterized as a let's just stand down and study for a couple more years. Do you have an idea of if the difference between Option 2 and Option 3 expressed as the time differential of how many years before we would have gotten to the Level 3 PRA completed? What is the difference in terms of timing? Is it just the two year delta.

DANIEL HUDSON: Well I think making an initial assumption that maybe two years from now, after performing some work in these research areas that we've identified, that maybe the fiscal climate might have improved, that we

might have more available staff resources to support moving forward with a Level 3 PRA. I think in an ideal situation then, we'd obtain approval from the Commission to move forward with the study at that point, which would give us just the two year delta. However, we may find after two years of work, that the climate still hasn't improved and we're still not in a very good position in terms of risk analysts to be able to support such an effort and we may need to delay further. That being said, I think the vision for Option 2 moving forward would be then, okay we might not be able to do the study at that point, but we still have more work that can be done. And to touch on some of the comments that were made earlier and in the ACRS letter, we're not disagreeing that a very efficient way to identify gaps that need to be filled is by proceeding with the study. But we do know in advance, especially in some of these areas that we've identified, that there is methods development work that needs to be done. And so we can make progress in those areas and then once we move forward with a Level 3 PRA study, we may identify some other gaps that may need to be filled, but I think we're going to be in a better position to complete the study more efficiently and not subject ourselves to potential costly staff turnover by having a very drawn out Level 3 PRA study.

COMMISSIONER SVINICKI: So you could potentially, if you pursued Option 2 at the end of that period of time, you could not only be better informed and ready to take on the Level 3 analysis, there's some chance in the positive scenario that your risk analysts may have gotten through things like NFPA 805 reviews and things like that, you may actually have some of the relevant expertise. It's possible that they could be more available in two years than they would be right now.

DANIEL HUDSON: That's the optimistic outlook.

COMMISSIONER SVINICKI: Okay, okay. And then returning Dan, and I don't know how closely you've followed SOARCA but I was just asking Dr. Sharon, if at the moment, there was specific direction to take those insights out of SOARCA and apply them to the regulatory framework and his answer was not officially. But staff must have some conceptualization both with SOARCA and with Level 3 PRA. How, what are those areas that would be early areas that would kind of identify themselves that you might want to take insights and apply them to the regulatory framework. Do you have any just informal thoughts, and then if Brian if you have some on SOARCA, you could add those as well.

DANIEL HUDSON: Well I think I might be in a position to talk about how we could potentially use some of those insights within the context of a Level 3 PRA rather than how they could be applied in the larger regulatory framework. But I can say that the SOARCA study had identified some of the issues that we want to go after with this Level 3 PRA. The issue of a large seismic event, creating problems with multiple units simultaneously and the resource issues in terms of managing simultaneous accidents involving multiple units. And there's a pretty generic issue on multi-unit risk that was initiated because of some of the insights that were gained early on with SOARCA. So I think it's going to be beneficial to inform that effort in terms of things that we might need to consider. There was also important developmental work in terms of the tools that we would use as part of the Level 3 PRA, namely the MELCORE severe accident analysis code and MAX2, the code that we would be using for the consequence analysis piece. So there are definitely insights that we have gained and advances that have been made as a result of the SOARCA study that I think we can take

advantage of.

COMMISSIONER SVINICKI: Okay, and those specifics are very helpful. I think the larger question I'm posing of course is that NRC isn't a research -- a peer research institution. Our research always has to have some application to our regulatory mission. And so SOARCA, it's not been clear yet what we would do with the SOARCA results. And so now, if we're using SOARCA to inform this Level 3 PRA, it really is just pushing that same question then further out into the future. So at some point, I think that knowing how well we can have two purposes here, one is to further inform the regulatory framework going forward. But we also of course need to conduct research to make sure that those things upon which we've had reliance in the past, that our knowledge was correct or perhaps to refine that and perfect that going forward. So, at some point those of course, that's how we best shape our research in the Office of Research is to know what its regulatory purpose and objective will ultimately be. Brian, did you want to add something?

BRIAN SHERON: Well I just, when SOARCA was first started, which was even before I was the office director here, my understanding is that there was a Sandia study, the Siting Study 1982 which used very conservative results. And it was being misused, okay, the results were. They were being cited as being realistic when in fact they were very, very conservative and I think part of the intent of SOARCA was to come up with a realistic assessment of a severe accident. So I mean that was, I think one of the original regulatory uses, was to just you know, show people that the, you know, that the 1982 citing study was in fact, you know very, very conservative on purpose.

COMMISSIONER SVINICKI: Yes. And that gets to the purpose I

described as making sure that those evaluations on which we've relied for a long time are adequate or appropriate so I agree with you. I'm acquainted with that same history. Again thank you all for your presentations. Thank you, Mr. Chairman.

COMMISSIONER JACZKO: Commissioner Apostolakis?

COMMISSIONER APOSTOLAKIS: Thank you. Brian, in your presentation you went over some of the accidents that have occurred and we talked about what happened and so on. I was a little surprised that you didn't say anything about human error. I mean, it was all over the place, wasn't it?

BRIAN SHERON: Well, I think I mentioned it in both the TMI 2 accident -- I could find it in here, but I think I mentioned it, "operator error" --

COMMISSIONER APOSTOLAKIS: But it is a major element. I mean --

BRIAN SHERON: Yes, and I pointed out we have even -- the Chernobyl Accident, human error was a big element.

COMMISSIONER APOSTOLAKIS: Yeah. Well, anyway, that's a side remark. It looks like the major argument that you gentleman are making for Option 2 is resources. And I'm wondering whether, you know, there are ways around that. For example, we heard earlier that EPRI would be willing to collaborate and presumably carry some of the burden. And I have a couple of more things, but what do you think of working with EPRI? I mean, you think that's reasonable?

DANIEL HUDSON: I think it's reasonable that there would be some degree of collaboration and I know that we talked about that with them at the Category 2 Public Meeting, and that was held in April. We started having

discussions then about the possibility of a relationship that we could maintain perhaps under the memorandum of understanding that we have with them. I guess some of the issues that might need to be worked out in terms of how feasible and how beneficial it might be to increase the degree of collaboration with EPRI and the industry, and completing a Level 3 PRA would be: how much are we willing to sacrifice some of the potential training benefit that we would receive in house by having staff participate and be directly involved and participating in the study. So I think you heard Biff Bradley talk about that, or maybe it was Stuart Lewis. One of them mentioned the fact that the way that you really develop good PRA expertise is by participating in a study like this, rather than participating in reviews of methods and things of that nature.

COMMISSIONER APOSTOLAKIS: PRA's another issue. I mean, I thought your argument was there are not enough risk analysts to do the work, but now you're saying you would bring people who are not risk -- who is a risk analyst, by the way? I mean, is -- it was discussed earlier, there are so many different kinds of expertise that are required. So, you know, just guys who do the level one PRA, that's not enough. I mean, you need thermo-hydrologists, you need structural people, you need health effects people. So, I don't know what we mean by not having a lot of risk analysts.

BRIAN SHERON: Well in terms of budgeted resources, okay, I think in the paper we said that we have two FTE budgeted for this. But you're right, okay. I mean, it's not just a PRA analyst, okay? You need seismic experts, you need thermo-hydraulic experts, you know, and the like. And you need to gather, you know, and a lot of times we have maybe the expertise that -- for the folks that can do those analyses and everything, but they're working on

other things, okay? And then it gets into a matter of priorities.

COMMISSIONER APOSTOLAKIS: I guess my point is the training issue. I mean, if we manage to sensitize people, you know, who are working structural mechanics or thermo-hydraulics, that uncertainty's important and that their work fits in the bigger picture in a certain way, then it seems to me that would be a major benefit. That they will appreciate what it means to do a PRA. Whether you want to call them risk analysts or not, I don't know, but that would be a very good opportunity here to achieve that.

And the third point with the resources. It seems to me that as a result of Fukushima, the Office of Research will have to do some work that really would be beneficial to a Level 3 PRA, right? You will have to consider things like emergency planning perhaps, or what can happen to the spent fuel pool under earthquake, and so on, or flood. I mean, some resources will have to be expended anyway on things that are part of a Level 3 PRA. So that also might ease the pain. I don't know.

BRIAN SHERON: I would agree. And yes, that information that we generate is, you know, on whatever we do on a follow-up on Fukushima, I'm sure will contribute to our knowledge in preparing for a Level 3.

COMMISSIONER APOSTOLAKIS: It seems to me that a major change in the way that we think about things, and, Brian, you mentioned it earlier, after Fukushima, is that we really have to talk about the site risk. We should start talking about site years rather than reactor years. So that is probably a major change. And again, to do that, we have to do a Level 3 PRA. But, it -- I like the cartoon you showed Dan, what Level 3 PRA would be, including spent fuel pool, and then you said that you are excluding security.

Now, again, this is an area where I don't think that risk information has been utilized to any significant degree. But if I have a Level 3 PRA, would that be a good first step, to actually evaluate, perhaps, some of the security strategies that we have and the industry has or some measures? And then start slowly getting into it and figuring out, you know, how valuable these things are and how they contribute to the security of the site. Would that be a benefit of a Level 3 PRA?

DANIEL HUDSON: A very quick response to that, is I don't think in terms of PRAs there's going to be a better framework to do it than a Level 3 PRA.

COMMISSIONER APOSTOLAKIS: There will not be a better?

DANIEL HUDSON: I think that that -- in terms of the options available to us, evaluating those types of things in the context of a Level 1 PRA, a Level 2 PRA, or a Level 3 PRA, I think of those different options that we're talking about, a Level 3 PRA that provides a more comprehensive and integrative perspective provides the best framework to evaluate those types of things.

COMMISSIONER APOSTOLAKIS: Okay. Now, a final comment here. I sort of like the ACRS recommendation of a Level 3 -- well, first of all, I was a little surprised when you said in your document, Option 2 would take two years, but Option 3, which includes Option 2, would also take -- will take three years, or two, three years, of -- with doing less work on research. But what if we, say, adopt the ACRS recommendation which is an expanded Option 3. To give you a chance to place everything in perspective, although I appreciate what you said, that you are, you know, you are not working in vacuum in Option 2. How much more time would you need? I don't think you can do it in three years. If we say an expanded Option 3 according to what the ACRS recommends, so you will have some time to also do a decent amount of research. Should we make it

four years, five years?

DANIEL HUDSON: My view on that is that, as we put in the paper, if the Commission decides that Option 3 in whatever variety or some other option that involves the Level 3 PRA, we'd begin the process of engaging with industry, developing a project plan, and obtaining more realistic resource estimates. And I think at that point, we'd in a better position to identify how long we'd realistically need to be able to organize the schedule to address our current resource limitations and still complete the study in a reasonable period of time. So I think that there's work to be done before we can be in a position to really say how long is long enough.

COMMISSIONER APOSTOLAKIS: But given the work that you have done to tell us that Option 3 would take three years -- I mean, you must have an idea how much time you could need. Are you -- You are saying that you want to come back to the Commission if the Commission approves that option, the expanded option, you want to come back and say, "Well then, this is what would be required," that's really your position right now?

DANIEL HUDSON: Yeah. Our position is that we would develop a more detailed plan, with the resource estimates so that the Commission would be in a better position to understand the resource implications and how this project might impact other ongoing work.

COMMISSIONER APOSTOLAKIS: Can you give me --

BRIAN SHERON: It still would -- it's a matter of, you know, the question of, you know, "What plant do you pick", you know, "Do I start from scratch?", "Do I start with an existing plant" -- which has a big effect on the resources. If you just take the resources estimate, we had three years, eight

FTE, that's 24 FTE total and $15 million. Okay, which was sort of a rough estimate for what we think it would take to do a full blown Level 3 starting from scratch.

COMMISSIONER APOSTOLAKIS: But are you saying, Brian, that if we go with Option 2, we don't need to have a plant in mind? I mean, can that research be done independently of some idea of what's out there?

BRIAN SHERON: Well, I think that if you follow the ACRS proposal, I think, and what we were talking about, I think Dan said it before and that is that, you know, we could actually start doing some of the studies we need to develop the models and the like, using, yeah, parts of different plants so we had -- because not every plant has the same --

COMMISSIONER APOSTOLAKIS: But your answer, a minute ago, you said that, you know, if we have to have an Option 3 element in it, you'll have to pick a plant and this and that. And my question is, you won't have to do that if you go with Option 2?

BRIAN SHERON: No, with option --

COMMISSIONER APOSTOLAKIS: You may not --

BRIAN SHERON: What we said with Option 2 is that we would actually do that, okay.

COMMISSIONER APOSTOLAKIS: Okay, so you -- the problem's there as well.

BRIAN SHERON: We would -- during the Option 2 work, we would still be interacting with the industry, with the ACRS, trying to decide, let's pick a plant.

COMMISSIONER APOSTOLAKIS: But my question is, to do the

work in Option 2, you don't need the plant?

BILL BORCHARDT: I think the answer is you would have a variety of plants. You would pick one plant to do one aspect of Option 2. Because, multi-unit, right? You'd go to a multi-unit site for the seismic element, you'd go to one that has an interesting seismic perspective and so there'd be -- you'd spread the wealth or spread the burden, if you will, across the industry to more plants rather than focusing just on one plant to do a complete Level 3 at a single plant.

COMMISSIONER APOSTOLAKIS: Thank you, Mr. Chairman.

CHAIRMAN JACZKO: Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you, Chairman. I always hate following Commissioner Apostolakis. Oh, first let me just reassure Brian that we know you don't work in a vacuum, so don't worry about that. The -- one question about SOARCA that just as -- now it's been several months since Fukushima and I know that the staff, you know, still doesn't have access to all the information -- none of us do -- but, just curious, I mean, as you've talked with the SOARCA staff has -- have you heard any thoughts about how the SOARCA model may have gotten things right or gotten things wrong, just sort of generally any impressions of this point, based on what you've seen so far since Fukushima? Any -- is there any reaction at all from the SOARCA staff?

BRIAN SHERON: I think, you know, for a long-term station blackout, you know, from what we've seen, I don't think we've seen anything that is, you know, horribly contrary to what we've concluded. One of the things that I did ask the staff to consider following Fukushima was to at least think through the question of whether any of that -- any of the scenarios that we considered would have affected the spent fuel pool such that the pool might have, you know, had

some sort of an accident that in turn affected the reactor. For example, if you assume operator action, down the road, to I think to restart like the RCIC and the like, would the spent fuel pool have produced any kind of a source term that would have made that area uninhabitable so that operators could not access -- take those actions?

So I've asked the staff to do a little bit of looking at that based on Fukushima. But I'm not aware of anything right now. But again, we're -- we signed -- I just signed a memorandum with the Department of Energy. They're going to conduct a -- they want to conduct a sort of a building of the sequence to find out what happened and the like and make sure we fully understand it. And so we'll be working with them and as, you know, information evolves, we'll obviously be going back and crosschecking against our calculations.

COMMISSIONER MAGWOOD: Is there a target date for that work or is it just kind of an ongoing activity?

BRIAN SHERON: I'm guessing it's kind of ongoing just because a lot of it will depend on when we get the information from the Japanese, when they can get into a containment and find out what really happened and stuff.

COMMISSIONER MAGWOOD: Marty, you're sitting here at a table, you look bored, so I thought I'd give you something to talk about. You know, one of the comments that I think Dan made was that -- or in the second paper perhaps it was made -- that one aspect of the level three work that would be pursued would be the development of spent fuel PRA technology. I wonder if you could give us sort of a little bit of a primer on what that means and what's involved in spent fuel PRA technology.

MARTIN STUTZKE: Basically we would develop a spent fuel PRA

using similar techniques that we would for reactor PRAs, so there's identification of initiating events and delineation of accident sequences. I suspect that that delineation of sequences is much less complex than it is for a reactor. There simply aren't that many systems involved. And one would hope that you could connect them and their common support systems: service water, electric, power, like this.

So the bulk of the effort in my mind for the spent fuel is in the Level 2, it's the understanding of progression of the accident. How is the fuel actually damaged to get it done that way? The other issue that one needs to deal with in spent fuel is what are appropriate metrics of risk in spent fuel? The staff has kicked around the idea that land contamination perhaps may be the most significant measure of risk from spent fuel accidents. I don't know whether that's true or not, but then one would like to be able to compare that, of course, to reactor risk as well, which means then you would have to look at land contamination from reactors so you could look at a relative proportion sort of thing like that.

COMMISSIONER MAGWOOD: I appreciate that. One of the things that, I guess that when used especially in the context of Fukushima, there's a definite opportunity to tie the spent fuel sequences with the reactor sequences and I think Brian mentioned this a few minutes ago. Are the -- is it your thought that this work would also include looking at the interactions between the spent fuel?

MARTIN STUTZKE: Oh, absolutely. In fact, we were debating this yesterday somewhat about how we could incorporate what we know so far about Fukushima into our PRA somewhat, and I think it boils down to basically three

areas. One is the human reliability that Commissioner Apostolakis had talked about, the implication of SAMGs and the EDMGs. In my mind, there's many questions about command and control sorts of issues. When I look at the timing of the scenario, it's like why did things take so long? And I can't tell whether the transcript is incomplete, these sorts of things like that.

So there's certainly great interest in HRA. At the same time when you envelope the external events on top of it, you worry about accessibility to plant locations. So even if operators know what they're supposed to do, they physically can't get there to do it. If I add the spent fuel on top of that where I have a radiation hazard or a contamination issue now, all three become very intertwined. And these are exactly the sorts of issues that we would hope to study in this project.

COMMISSIONER MAGWOOD: All right, thank you, appreciate that. Dan, sort of -- just a couple of things for you. I think Commission Apostolakis touched on this a little bit, but you're excluding the malevolent events. That's, I think that's how you put it, malevolent events such as, you know, terrorist attacks on nuclear plants from the initiating events. It -- why would we exclude that? Why not include that?

DANIEL HUDSON: I'd say that the quick answer to that is that that's one of the areas where there might be some large uncertainties right now. And we view this project in terms of the options that we're recommending right now as potentially a first step in an evolutionary process. We're not seeking this gold plated, gold standard Level 3 PRA at the end of this initiative, and say that by the end of it, we've done everything we need to do. I think the vision here is that there's still going to be more work that needs to be done, even after the

completion of the study. And this was just one of those areas up front that we said, you know, we might exclude from the scope for those reasons.

COMMISSIONER MAGWOOD: When you say there's uncertainties, are you talking about uncertainties about, you know, how to talk about the probabilities of an attack or are you talking about what happens after an attack?

DANIEL HUDSON: When I talk about that, I'm talking more specifically about the uncertainties in the threats.

COMMISSIONER MAGWOOD: Okay.

DANIEL HUDSON: And the frequencies of events.

COMMISSIONER MAGWOOD: Okay, what I think I would find most interesting is not so much the frequency of the event, but more what the -- once the initiating event has happened, what is the sequence of events that leads to core damage, because that's an insight that I think is extremely valuable to us, so that's something I'd like to keep on the table because I think it's actually quite important. Just for a final thought, I think that Commissioner Apostolakis and I think the Chairman's comments in the last panel -- you know, there clearly seems to me to be some desirable aspects of Option 3, but I recognize the resource constraints. Now I wonder, how much conversation did you have with, with the industry, with EPRI, with NEI, with others about cooperative activities, and is it really -- is it just really just very initial conversations, or --

DANIEL HUDSON: Yeah, I'll just say at this point that we started talking about this, we started broaching the subject with them in a public meeting, and all of the discussions at this point have been somewhat superficial. They've talked about the fact that he has a few licensees that have expressed interest,

but ultimately, the licensees, I think, would like to better understand the resource implications for them, how a PRA like this might potentially be used, and we haven't gone into detailed discussions of that nature because truly, in writing this paper, we wanted to provide various options for proceeding, some of which did not include moving forward with a Level 3 PRA for one reason or another. So we didn't want to invest substantial resources in developing a detailed project plan, having detailed discussions with industry about what their level of involvement would be, until we had a better sense that we would be moving forward with this initiative.

COMMISSIONER MAGWOOD: So, either Dan or Bill, it sounds like I guess what I hear from that then is that if the Commission were to decide, you know, we like Option 3, but we'd like to get some more fidelity as to how to proceed, one of your first steps would be to go back and talk to the industry, talk about the possibility of cooperative activities, and then come back with more, sort of, sub-options to that. Is that kind of the way you read that?

BILL BORCHARDT: That's right.

COMMISSIONER MAGWOOD: Fair enough. Thank you very much. Thank you, Mr. Chairman.

CHAIRMAN JACZKO: Brian, I want to follow up on a question or a comment you made in which I guess has me a little bit puzzled. Why wouldn't CDF and LERF -- I mean, maybe, you know, call it CDF, maybe you call it, you know, fuel failure, I mean, it's not in the core anymore, but it's just -- why wouldn't the onset of fuel failure and then LERF be reasonable metrics for spent fuel in the same way they're the metrics we use for, for reactors?

MARTIN STUTZKE: Well, one can certainly calculate the

frequency of spent fuel uncovery in the pool, which, to my mind, is almost a reliability metrics compared to risk. What you don't know until you get to Level 3 is, is that an appropriate surrogate for public health risk?

CHAIRMAN JACZKO: So what would you, wouldn't, I mean, wouldn't LERF still be, I mean, you know, ultimately at the Level 2 stage, or large release maybe is not a LERF, maybe it's just a large release frequency, or the, you know, I mean, presumably the issue with spent fuel is largely zirconium fire. That's -- so you'd have a metric which is not maybe -- I mean, fuel damage in the form of fire as your metric, I mean, again thinking in terms of Level 1, and I, again, I don't necessarily discount the land contamination might be a useful metric, but why wouldn't that then just as easily be a useful metric for, maybe the other way, for the power reactors, too, even if -- I mean, that is true that a more reliable form of understanding what the real impacts are to the public.

MARTIN STUTZKE: It may in fact turn out to be a useful metric, or at least something, you know, related to the frequency of release offsite, you know, like that. This issue is, in my mind, is a large early release of spent fuel equivalent, how does that relate to a large early release of the reactor? Also, LERF tends to be our surrogate for prompt fatalities, and we don't anticipate prompt fatalities from most spent-fuel types of accidents, so. There's a little bit of apples and oranges, in my mind.

CHAIRMAN JACZKO: So the issue seems to be more of this comparability with the comparable terms end up on the power reactor side, exactly? Okay, thanks, that's helpful.

Just taking a step back, I mean, we've talked a lot about Level 3 PRAs -- it's kind of been the whole basis of the meeting, but, one point has not

been perfectly clear to me. Is the goal here for the NRC to have Level 3 PRAs so that so that as we go about doing our regulatory work, we have the benefit of insight of a Level 3 PRA? Is the goal to have utilities to have Level 3 PRAs, so that they have safer plants? Or both? What, what is it?

DANIEL HUDSON: Well, in one of my slides, I talked about the overall vision for this new Level 3 PRA initiative, and we envisioned that vision being realized by going through three different phases, and the first phase was this scoping study to develop different options for proceeding, the second phase would be if we decided to move forward with the Level 3 PRA, would be a pilot study to demonstrate our capability to do so, and then --

CHAIRMAN JACZKO: "Our," meaning NRC capability or the nuclear industry at large.

DANIEL HUDSON: In the context of this paper that we've provided, we envisioned NRC staff participating in the study, potentially using the agency's tools, such as the SPAR models, as the foundation to start off with the study, and the idea was that in the end, the NRC would have a tool in-house that we could --

CHAIRMAN JACZKO: Like a SPAR 3, that would get you to Level 3 PRA.

DANIEL HUDSON: An enhanced SPAR model that could be used to address various issues.

CHAIRMAN JACZKO: Right. Well, I appreciate that, and I think that's a helpful distinction because, I'll be honest with you, I think my interest is for utilities and licensees to have Level 3 PRA. I think that there is more value from a safety perspective, and you can comment on this if you want, or Brian or Bill or any of you, there's more value in licensees having the Level 3 PRAs as I

can see it, than there is for us having a Level 3 PRA right now.

BRIAN SHERON: Well, yeah, I think there's always value for the licensees. The more information they have about their plant, I think the better they understand it and the like. But there is a value, I think, for example, as you know with SOARCA, one of the things --

CHAIRMAN JACZKO: I'm not saying there's no value, I'm saying there's a, we're in a resource constrained situation. You know, and I mean, and if that's what this paper was saying, we're talking about resource constraints for the agency, that's a completely different question from the ability of licensees to be able to produce Level 3 PRAs, which, of course, and now, I'm sure all the folks sitting behind you are about to, their jaws are about to drop, what I'm going to say, well, maybe one of them won't. Why don't we just require them to have Level 3 PRAs? I mean, if that's what we want, why don't we require them? I guessed right. The one jaw that I didn't think was going to drop didn't, but the others maybe did.

BRIAN SHERON: Well, I think that what we're proposing is that we think there's a benefit, at least for the NRC to have it, and a lot of times, we, we serve as the --

CHAIRMAN JACZKO: That's not what I'm asking. Why don't we require licensees to have Level 3 PRAs? I mean, new reactors, we require them to submit a PRA.

BRIAN SHERON: Right.

CHAIRMAN JACZKO: Why don't we have a provision that says that all utilities shall be required to have a PRA, and within five years, they have to have a Level 3 PRA? I mean, seems to me that that's really, we've got two

different questions in front of us, one is this issue which we can talk a lot about, about how we manage our resources, how we figure out how we get to the point of having a level -- you know, expanding the SPAR models to be able to go on to a Level 3 PRA. That's a totally different question, though, from whether or not utilities should have Level 3 PRAs, and if we think they should have them, why don't we require it?

BRIAN SHERON: Well, let me back off. I don't think we're saying that we think that all the utilities have to have them because, and I'm not in NRR, and I can't speak for NRR, okay? But I would say, you know, unless the agency articulates what do we want them to do with it once they have it, okay? What I think is that a lot of times, we provide the leadership, and show the industry the benefit, okay, and then they get on board, okay? For example, SOARCA, even though it's not a Level 3 PRA, it's still a, it's a good consequence analysis, and I think it showed the benefit of the B.5.b measures that the agency put in place.

CHAIRMAN JACZKO: Those -- we already put them in place, so we have --

BRIAN SHERON: I understand.

CHAIRMAN JACZKO: -- already issues orders to do it.

BRIAN SHERON: I understand, but we used it to confirm --

CHAIRMAN JACZKO: Yeah.

BRIAN SHERON: -- that they actually showed a significant benefit, okay? And perhaps if we had this tool, in advance, as the Commission was considering, say some other requirement, we could put it into the Level 3 PRA and be able to at least articulate, at least for an example plant, what kind of benefit might accrue or not accrue from it.

CHAIRMAN JACZKO: Well, no, and I appreciate that, and I think there's a point there, but again, I think we just have to be careful that we distinguish the two problems. I mean, I don't think the way we should get licensees to do Level 3 PRAs is to spend all the time and effort to develop our own Level 3 PRAs. I mean, I don't think -- and Brian, you'll be the first one to tell me -- I mean, it's not our job to do the industry's research for it. Nor is it, I think, our job, if they should have Level 3 PRAs, for us to take all the time and effort and leadership to develop the Level 3 PRA, so that they can go on and do that.

You know, and so I'll say quite clearly, one of the things I really appreciated Biff mentioning was the use -- the ultimate goal of a risk conformed, performance-based EP regulation. I don't think that can be done, and I think -- but if you said that was one of the, you know, I think one of the potential uses of a Level 3 PRA, you can't do that without a Level 3 PRA. And in my mind, that would be one of the tremendous opportunities and enhancements, and I think that would be a real enhancement to our EP program -- is to have a regulation that is more risk informed performance based, and much like the NFPA 805, would go hand-in-hand with a Level 3 PRA. They would be inseparable. You know, I think -- well, not that NFPA 805 is a Level 3 PRA, but the PRA goes hand-in-hand with the adoption of NFPA 805.

So, you know, in looking back at the paper, to me in a way that was the issue to really talk about, is what -- and it's not really in the papers -- what do we want licensees to do? And I think that's a separate question. I don't think it was really hit upon, but certainly from my perspective, I would like to see them have Level 3 PRAs. And I think it's something we should explore in our regulatory tool. Maybe it's through a Generic Letter, maybe it's through a -- some

other mechanism to get there, but I don't know that it's the best thing in the world for us to just go on and do it and then turn around and say, okay, we've spent all this time and effort doing this, now don't you all see it's a great idea? If we think they should do it, we have other ways to get them to do it. So, again, you may not necessarily agree that they should, but I'm certainly interested in pursuing that.

BRIAN SHERON: I was just going to say that, you know, it wasn't the intent to just have them follow by example, but --

CHAIRMAN JACZKO: Yeah.

BRIAN SHERON: -- we have a number of uses I think we would have for a Level 3 PRA. I think we had mentioned, for example, in our generic issue program, using this to help in the prioritization and to understand what the impact is. And there's just a lot of other of these, in the normal things that we do every day which help us make our decisions.

CHAIRMAN JACZKO: Couldn't -- I mean, as I say prioritizing the generic issues program, why couldn't we rely on, you know, on utility Level 3 PRAs? I mean, we could, if we got to a generic issue and part of the decision-making process could be as we go out for comment on the generic issue, which we do, you know, tell us, you know, show us as part -- you know, through a generic letter or whatever, demonstrate to us why this is a, you know, where this falls in priority based on your Level 3 PRAs.

Now that probably -- we'd probably want to have the capability to confirm that independently, but I don't think we need our own Level 3 PRAs to do that. I think we could rely on licensee Level 3 PRAs to do the same thing. I mean, we would ask them for the information in much the same way we do with

other things. You know, is this flooding, you know, GSI more significant than, you know, a sump GSI? What do your Level 3 PRAs tell us? You tell us at your site which of these is a higher priority based on your Level 3 PRAs. I mean, I think we could get, I think, the same information through that or not.

BRIAN SHERON: I would ask Marty if you want to comment a little bit if -- in terms of --

CHAIRMAN JACZKO: And I'm way over my time, so I probably should --

BRIAN SHERON: I was just going to say for an industry, when the industry comes in and gives us their risk assessment, how well does it really line up with, say something we do independently?

MARTIN STUTZKE: Well, it's a matter of perspective. You know, clearly because the industry has greater resources, their PRAs would be more detailed than things we could reasonably produce in the amount of time. One of the issues I see with relying on industry's PRAs for generic issues is, you know, first of all, the staff is the one that surfaces the generic issues, so then we could be forced to go to the industry and say, "We think you have this problem. And there's regulatory mechanism --"

CHAIRMAN JACZKO: Don't we do that now? To some extent, don't we put -- isn't there a part in the process of generic issues where we go out and get comment on whether --

BRIAN SHERON: Well, but we have to kind of establish first that there is a real problem. Okay, or at least there's a potentially real problem.

CHAIRMAN JACZKO: But we don't do that with a Level 3 PRA now.

BRIAN SHERON: No, not right now.

CHAIRMAN JACZKO: What you were talking about is ranking those generic issues, so we're identifying the issue without the Level 3 PRA and then it's the ranking where we could go to the industry to get an input from them about the ranking -- the relative ranking, relative to other.

BRIAN SHERON: Well, we try to understand the relative significance first --

CHAIRMAN JACZKO: First, okay.

BRIAN SHERON: -- before we go out and say, you know, "We need you to expend resources and provide us all this information."

CHAIRMAN JACZKO: Okay, good. Well, that's helpful. Well, I've taken too much time as it is anyway, so we're -- I appreciate your answers and I appreciate our previous panel being here as well, and I think it was a very interesting meeting. Thanks.

[Whereupon, the proceedings were concluded]