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# DISCLAIMER

## UNITED STATES NUCLEAR REGULATORY COMMISSION'S
## ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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586TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THURSDAY

SEPTEMBER 8, 2011

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Said Abdel-Khalik, Chairman, presiding.

COMMITTEE MEMBERS:

***SAID ABDEL-KHALIK, Chairman***

***J. SAM ARMIJO, Vice Chairman***

***JOHN W. STETKAR, Member-at-Large***

***SANJOY BANERJEE, Member***

***DENNIS C. BLEY, Member***

***CHARLES H. BROWN, JR., Member***

***MICHAEL L. CORRADINI, Member***

***DANA A. POWERS, Member***

***HAROLD B. RAY, Member***
***JOY REMPE, Member***
***MICHAEL T. RYAN, Member***
***WILLIAM J. SHACK, Member***
***JOHN D. SIEBER, Member***
GORDON R. SKILLMAN, Member

NRC STAFF PRESENT:

EDWIN M. HACKETT, Executive Director, ACRS
ANTONIO DIAZ, Designated Federal Official
PERRY BUCKBERG
ANDREW CARRERA
AMY CUBBAGE
DANIEL DORMAN
ANDRZEJ DROZD
DON DUBE
DAVID ESH
JACK GROBE
JOHN HONCHARIK
DEBORAH JACKSON
STEVEN JONES
JOHN LABINSKY
EILEEN McKENNA
PRAVIN PATEL
SIMON C.F. SHENG

ALSO PRESENT:

TOD BAKER, Westinghouse

KENT BONADIO, Westinghouse

BRAD CARPENTER, Westinghouse

MIKE CORLETTI, Westinghouse

ADRIAN P. HEYMER, Nuclear Energy Institute

TOM KINDRED, Westinghouse

RICK OFSTUN, Westinghouse

SUSAN G. STERRETT, Carnegie-Mellon University*

LEO TUNON-SANJUR, Westinghouse

ROLF ZIESING, Westinghouse

*Present via telephone

# A G E N D A

P R O C E E D I N G S

(8:35:51 a.m.)

CHAIRMAN ABDEL-KHALIK: The meeting will now come to order.

This is the first day of the 586$^{th}$ Meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following.

One, Near-Term Task Force Report regarding the events at the Fukushima Dai-Ichi Site in Japan. Two, Technical Basis and Rulemaking Language associated with low-level waste disposal and site specific analysis. Three, Safety Evaluation Report associated with Revision 19 of the AP1000 Design Control Document Amendment. Four, Draft Final Revision 2 to Reg Guide 1.115, "Protection Against Turbine Missiles." And, five, preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Dr. Antonio Diaz is the Designated Federal Official for the initial portion of the meeting.

Portions of the session dealing with the Safety Evaluation Report associated with Revision 19 of the AP1000 Design Control Document Amendment may be closed in order to protect information designated as proprietary by Westinghouse.

The Nuclear Energy Institute has submitted written comments on the Near-Term Task Force Report regarding the events at the Fukushima Dai-Ichi site in Japan. Mr. Adrian Heymer from the Nuclear Energy Institute has also requested time to make an oral statement regarding this session.

In addition, Dr. Susan Sterrett has requested time to make an oral statement regarding the session on the SER associated with Revision 19 of the AP1000 DCD Amendment.

There will be a phone bridge line. To preclude interruption of the meeting, the phone will be placed in a listen-in mode during the presentations and Committee discussion. At the appropriate time, the phone will be open to allow Dr. Sterrett to provide her comments to the Committee.

A transcript of portions of the meeting is being kept, and it is requested that the speakers use one of the microphones, identify themselves, and speak with sufficient clarity and volume so that they can be readily heard.

We will now move to the first item on the agenda, Near-Term Task Force Report regarding the events at the Fukushima Dai-Ichi site in Japan. And I call on Mr. Jack Grobe to begin the presentation. Jack?

MR. GROBE: Thank you very much.

We certainly appreciated the opportunity a couple of weeks ago to spend several hours with the Subcommittee. The slides we've prepared today are a very brief set of slides that overarch or provide the overarching recommendations. We look forward to the questions that you may have come up with studying our report in the last two weeks, and new questions that might come up during the course of the meeting. Next slide, please.

Again, the Task Force was led by Charlie Miller, who is on the golf course somewhere. He's retired. Nathan Sanfilippo is not here with us today. He's up meeting with Region I in the State of New Jersey on Fukushima Lessons Learned, and Gary Holahan is trying to license new reactors. He had a number of important meetings that he couldn't reschedule, so I apologize for those two individuals not being with us, but the rest of the Task Force is here today.

High-level summary, the Near-Term Task Force concluded that a similar sequence of events is unlikely to occur in the United States that occurred at the Fukushima Dai-Ichi Nuclear Power Plant. And we have existing mitigating measures here in the United States that provide additional capability, and reduce the likelihood of core damage if they remain available during the event.

The Task Force further concluded that there's no imminent risk, and what that means is there's no need to take action to curtail operation of reactors or impose immediate changes to the licensing structure for the reactors. However, there's a number of recommendations; 12 overarching recommendations to enhance safety, including some near-term interim actions.

The 12 overarching recommendations, the first one --

CHAIRMAN ABDEL-KHALIK: Jack, before we get into the details of the recommendations, let me just ask a big picture question.

Would you agree with the statement that the recommendations of the Task Force were not based on detailed evaluation of the progression of the Fukushima accident; instead, they were based on facts that became self-evident to knowledgeable individuals as a result of the Fukushima accident.

MR. GROBE: I look for my comrades here to provide additional insights, but I would say it's between those two. We certainly had people on the ground in Japan, and we have had since the event occurred. We met with those people as they came back from Japan to gain insights. We asked questions regarding, for example, specifically the functioning of the hardened vents, and got detailed information back from our team in Japan on how the vents were designed at Fukushima, and the attempts that they made. So, it was somewhere in between there.

Clearly, at this point in time, we do not have a complete understanding of the core progression, the damage progression in the core, or the sequences that preceded that, but we have a lot of information.

One of the recommendations, not one of the overarching recommendations, but a recognition in the report is that that work is ongoing collecting that information, and that there could be additional lessons to learn as we gain more information. But the Near-Term Task Force felt confident that the basis of these recommendations had sufficient foundation both in what occurred in Japan, as well as thorough examination of how we regulate those particular aspects.

CHAIRMAN ABDEL-KHALIK: Okay. So, let me ask you a specific question then that follows from the first. And you touched on it in the last two sentences.

Would acquisition of more detailed information regarding the progression of the Fukushima accident negate or render invalid any of the Task Force's recommendations?

MR. GROBE: It's difficult to project what might happen, but I think the Task Force members feel highly confident that that's unlikely. Is that --

MR. DORMAN: Yes, I would agree. As we developed those recommendations, I think we had a consensus that it was unlikely that further detail of the progression of the events at Fukushima, it was unlikely that those would change the recommendations that we made.

MR. GROBE: And specifically in the area of hydrogen control. We could have made recommendations, and we had a lot of thoughts and ideas, but our ultimate conclusion was we really don't understand enough about how hydrogen transported between structures to make recommendations at this point in time.

CHAIRMAN ABDEL-KHALIK: But the specific

recommendations contained within your report, you believe that those remain valid.

MR. GROBE: Those are solid, yes.

CHAIRMAN ABDEL-KHALIK: Even if one were to acquire additional information regarding the details of the progression of the event at Fukushima.

MR. GROBE: That's correct.

MR. DORMAN: That's our expectation.

MR. GROBE: Yes.

CHAIRMAN ABDEL-KHALIK: Okay. So, one may gain additional insights that may lead to additional recommendations, if one were to know more about what happened.

MR. GROBE: Yes.

MR. DORMAN: Yes.

CHAIRMAN ABDEL-KHALIK: Okay, thank you.

MR. GROBE: Okay. Twelve overarching recommendations. One concerns a Policy Statement, and the Commission has requested that the Staff provide a detailed paper in 18 months providing options on that Policy Statement recommendation.

There's a number of rulemaking recommendations in areas where the Task Force felt that a lasting regulation was necessary. A number of orders that either form interim steps or orders imposing requirements where rulemaking is not necessary, and several Staff actions.

There were four longer-term studies, and we just mentioned one of them, one of them was hydrogen, but these were situations where the Near-Term Task Force did not believe we had sufficient information to make a recommendation that was well founded, and it required additional study. That doesn't mean that you wait four years to start the evaluation. You start the evaluation now, but it's longer-term. We need more information. Next slide.

The focus of the Steering Committee -- not the Steering Committee, the Task Force was to examine -- we examined our regulatory framework, and identified that the regulatory framework is founded on a defense-in-depth concept. And that defense-in-depth concept has been applied in a number of different ways in different parts of our regulations. But the one that seemed appropriate and lasting for us was the concept of protection, mitigation, and preparedness. So, that was the way in which we structured our recommendations and our study. And, of course, we also looked internal at ourselves, at our own programs.

So, the first recommendation had to do with the framework. This was a framework for beyond

-- what we currently call beyond --

CHAIRMAN ABDEL-KHALIK: I'm sorry to interrupt, but let's just get the terminology straight.

What do you mean exactly by the words "near-term", and "long-term?" Do you have a time line that that translates to?

MR. GROBE: Well, in the Tasking Memorandum that came from the Commission, there was an expectation of the time line, and that was that the near-term would be done in 90 days, and the long-term would be six months after that.

The 90-day near-term report took about 120 days, and I believe longer-term --

CHAIRMAN ABDEL-KHALIK: Well, my question pertains not to the preparation of the reports, but completion of the actions designated as near-term --

MR. GROBE: Oh, I'm sorry.

CHAIRMAN ABDEL-KHALIK: -- or the actions designated as long-term.

MR. GROBE: The -- I think the Task Force was very aware of the Agency's past practices in the area of following up on major events. We've done a good deal of time at the beginning of our work studying how the Agency responded, and the federal government, quite frankly, responded to Three Mile Island. We also studied how the Agency responded to 9/11.

Our conclusion from that was that we have to insure that we are very careful and methodical in how we approach these recommendations, and to insure that we don't overreach, and also to insure that if we cause action to be taken to change our regulations or to modify the plants and the way they operate that that is the right action, and it doesn't have to be redone in the future.

For that reason, there's a significant emphasis and recognition on the need for engagement with the industry and our stakeholders to clarify in some areas of these recommendations exactly what would be the best approach in implementing the recommendation. That recommendation was fairly high-level.

A good example of that, again, is the hardened vents. There's a clear outcome from Fukushima and from studying how we implemented hardened vents. There's a clear conclusion; two things. One is we should have a requirement, it shouldn't just be a voluntary situation. And secondly, we need to focus more attention on the reliability of the hardened vents, and that reliability has to do with passive function versus active function, it has to do with the ability to function without AC power, has to do with the accessibility of the valves, the location of the valves, things of that nature.

So, we should not -- the Commission should not independently define exactly how those systems should be designed, we should collect information on the best thinking. So, the timing for each of these regulations, excuse me, each of these recommendations would be dependent upon the level and need for engagement with folks like yourself, the industry, our external stakeholders. And it should be methodical and take into consideration all of those appropriate points of view. So, there isn't -- that was a long answer.

(Simultaneous speech.)

MR. GROBE: Yes, there isn't a specific time frame other than there's certain recommendations that should be begun, that should be initiated very promptly, meaning today, within the next couple of months.

CHAIRMAN ABDEL-KHALIK: Let me give you a reference point. The Koreans have come up with a list of 50 items that they need to implement at their plants, and they define near-term as actions that must be concluded by the end of 2012, and they define intermediate and long-term actions as things that must be completed in the years 2013 to 2015, and I emphasize the word "completed." Is that consistent with your understanding and/or expectations?

MR. GROBE: We have not provided that kind of context on our recommendations. I would think some of the recommendations can be completed in a matter of months, not years. I believe other recommendations are going to take a couple of years to complete, and there are some recommendations that will take multiple years to complete. So, we did not parse the recommendations in that way.

I don't know -- I haven't studied the 50 recommendations that Korea used, but it's entirely likely that they can parse them that way. We did not do that.

MS. CUBBAGE: In the context of our report, near-term was were areas where we felt we could come up with a specific recommendation in the near-term, and then the long-term evaluations would be passed to the longer-term evaluation. That's the near-term/long-term context for our report, but more details will be coming out with the Commission papers that are coming due soon.

(Simultaneous speech.)

CHAIRMAN ABDEL-KHALIK: So near versus long-term in your context pertains to when the actions are to be defined rather than when they are to be completed.

MR. GROBE: Yes. And that's not how we chose to define it, that's the Tasking Memorandum that we received from the Commission.

MR. DORMAN: I think we also -- the six of us were not in a position to make statements concerning availability of NRC or industry resources to implement these things. We were cognizant of the time frames of our normal processes, and we recognized that rulemakings typically take several years to accomplish to the point of a final rule. And then depending on the complexity of implementation may take a full operating cycle to achieve implementation. So, that's the multiple years Jack was referring to, we were looking at some of those things as potentially four to six years out before they get completed, which is why in several cases we recommended that in the interim there are actions that could be taken through orders that could be implemented in the 12 to 18-month time frame, or even less, that could provide an enhanced margin of safety, while that process runs its course. So, we have a general plot of time lines, but the Agency's Long-Term Steering Committee, and probably in the 45-day paper that's due to the Commission October 3rd will have more of a discussion of characterization and time lines going forward.

CHAIRMAN ABDEL-KHALIK: Thank you.

MR. GROBE: Okay. Recommendation 1 was to enhance the framework. The focus of this was two-fold. The principal focus was the fact that we have these concepts that we currently call beyond design basis, and that's founded in the regulations and the regulatory framework that was established in the `60s and `70s where we have a number of design basis accidents, and we've identified through risk analysis and further insights in the `70s, `80s, `90s that things like station blackout, like anticipated transient without scram, these are beyond design basis events that require our attention. And the Commission's description, its Policy Statements do not deal well with those concepts.

And we felt that it would be beneficial to both the predictability and the clarity of our regulations, as well as the ability for our licensees to understand our regulations, and to be able to operate within them in a reliable fashion from a business perspective, that we should have a more -- we should have more clarity in our regulatory framework addressing these areas.

Again, the Commission directed the Staff to study this issue and bring forward a clear recommendation in 18 months, and that's on our plate. That's a tasking for the Staff.

MEMBER CORRADINI: So, can we just take those two special events which are now in some sense regulated kind of in a gray area between design basis and beyond design basis. So, those two that you just mentioned as an example, one possible outcome of this enhancement might be that within certain rules and recommendations they would fall within the design basis, such that SBOs --

MR. GROBE: No.

MEMBER CORRADINI: I'm trying to understand potential eventualities of what you guys are suggesting. That's what I'm --

MR. GROBE: You guys can jump in here any time, but we weren't suggesting that we expand the design basis. What we were suggesting is that we create this new category called extended design basis. I think those were the words.

MEMBER CORRADINI: So, you're going to define the gray region. Is that what --

MR. GROBE: Yes.

MS. CUBBAGE: Define the region and apply it more consistently, and have more guidance on how and when to --

VICE CHAIRMAN ARMIJO: Yes, it's kind of hard to see the difference between an expanded --

MR. DORMAN: Let me -- if you take things like ATWS and station blackout and bring them into the design basis as currently defined in Part 50, you incur a set of requirements on those areas that they don't currently have in terms of --

MEMBER CORRADINI: System safety components.

MR. DORMAN: Yes, and QA requirements, Maintenance Rule requirements, and so on.

MEMBER CORRADINI: And then we'll see diversity --

MR. DORMAN: Yes. Our vision was that this extended design basis would have a consistent application of some graded application of those types of measures to things that are applied to low probability but potentially high consequence events, and in a manner that addresses the elements of defense-in-depth in a balanced approach so that we're addressing -- for those low probability high consequence events we're addressing protection, mitigation, and emergency response in a balanced manner.

MR. GROBE: Now, I want to make it clear, our Recommendation 2.1 regarding seismic and flooding could redefine the design basis events for individual licensees, because it requires them to reevaluate to current day standards.

MEMBER CORRADINI: The probable maximum --

MEMBER POWERS: Your explanation leaves me very confused. In the design basis we have an accident involving the double-ended guillotine pipe break which has an extraordinarily low probability, very high consequences, and we apply the QA things to that, so which of these gray area things is going to have less than that because its probability is less than the double-ended guillotine pipe break?

MR. DORMAN: Actually, one of the things that we talked about in one of our meetings with the Commission on this was the potential that the framework that we proposed would give them a structure in which to address the extremely low probability LOCAs, so that potentially the double-ended guillotine could move from design basis to extended design basis under this framework, and be addressed in that context. I think the --

MEMBER POWERS: Then we might create something called -- like a transition break size for want of a better term.

It seems to me that you're running into a problem of creating this gray area because -- in the name of consistency and gradation that it's never going to be consistent unless you do the whole regulatory structure.

MR. GROBE: Actually, there's a tremendous amount of good work in the -- oh, God, what is it called? Yes, thank you, technology neutral regulatory framework. There's a tremendous amount of good work in there, and we should leverage that work into our current regulatory structure for our operating plants.

We can't completely rebuild the plants, we can't rebuild the regulatory structure, but we should provide some clarity in these areas so that 50.46(a) has a home, and it is recognized within the context of our framework where it lives.

MEMBER CORRADINI: But if I could just restate how you tried to correct me. I want to make sure I get that right, so let's forget about gray or black. But this middle region which you're trying to define, your point is that you're defining it there such that things that reside there, and I just picked the two that you mentioned, others could reside there, others could move there, would be using systems and components that may not have the QA stamp of safety-related that are required for design basis events in all equipment and components that need to be safety-related to essentially survive and perform there. Is that --

MR. GROBE: That's the concept.

MEMBER CORRADINI: -- the essence of what this area is?

MR. GROBE: Yes.

MEMBER CORRADINI: Okay. But then it could be that as things roll out from the accident and we learn more and more, certain things that are in the gray region may move into the black region simply because their probability is higher than we expect, or their potential consequences are higher than we suspect. So, I'm just trying to get clear that -- I'm not going to disagree at the moment with what -- I just want to understand what it is, but my point is they could flow either direction in terms of what things will flow in and flow out, because Dana's point about -- and I was just thinking things were going to move potentially into a design basis space, or require the backfits such that -- that are safety-related so that I have a higher confidence that things will perform as needed. That's all I'm trying to understand. But I think I get what you define as this gray region.

Now let me try the region over here, severe accident. So, what is it about severe accidents that take it out of the gray region? Is there anything but gray and black?

MR. GROBE: One of the interesting characteristics of this conversation is that we're debating something that hasn't been clearly defined yet.

(Simultaneous speech.)

MR. GROBE: It's a very fluid conversation. There's flexibility --

MEMBER CORRADINI: That's why we enjoy talking about it.

MR. GROBE: Yes, exactly.

MR. DORMAN: I think in our minds, clearly there is an area beyond the gray area.

MEMBER CORRADINI: Okay.

MR. DORMAN: But that does not come into

regulatory control.

MEMBER CORRADINI: Okay.

MR. DORMAN: So, that in terms of transition points, obviously, you'd need a transition between design basis and extended design basis, and then you'd need a bound on extended design basis.

MEMBER CORRADINI: So, can you give me an example that might pop in your personal head about what's out there that doesn't flow into the gray, and doesn't flow in -- like, in other words, I'm trying -- I deal in specifics.

MS. CUBBAGE: The meteor strike.

MR. GROBE: Yes, the meteor strike.

MS. CUBBAGE: That is one that --

MEMBER CORRADINI: That was an easy one.

MR. GROBE: That was the easy one. Well, again, without the work that we're going to be doing over the next 18 months it's difficult to get into a really strong debate on the subject.

The concept is that the things that are in the beyond design basis are those that have -- that are beyond the design basis, meaning our current definition of design basis, have a lower frequency of occurrence than what we have in our design basis, and have a significant set of consequences associated with them. And we use the words that came out of the IEEE -- excuse me, the IAEA standards of cliff edge event.

MEMBER CORRADINI: Okay.

MR. GROBE: Which is what ATWS is, what station blackout is, cliff edge events.

MEMBER CORRADINI: I'm totally with you, because you then mentioned something else. You've mentioned all the good things that I wanted to draw in.

So, if I go back to the -- I think it's 18.60, the technology neutral framework, there is a figure in there that has frequency and dose. So, in my simple mind the area that's black is where I have potentially high frequency, or potentially high dose, and then I get into this region where things become low enough either in frequency and dose that I then have a different region.

So, is that what the Task Force was thinking about? Is that a visual mechanism that can at least kind of concretize what you're thinking?

MR. GROBE: Soften the concept of dose. I don't believe we were talking about Level 3 PRAs dose. What we were talking about was consequences on the reactor.

MEMBER CORRADINI: Okay, fine. Thank you

very much. That helps. Thank you.

MR. GROBE: Recommendation 1 -- I'm not done.

(Simultaneous speech.)

MEMBER-AT-LARGE STETKAR: Something you just said, I'll ask first. You're thinking about the reactor. Why would you not think about measuring risk to public health, which is dose, however I want to characterize how that risk is measured? Why do we retain this notion of core damage frequency as anything -- as the only thing that we're interested in, because we already know that the frequency of core damage, and the frequency of releases are not independent, especially when we extend out to some of these larger --

MR. GROBE: You can't have release without core damage. Right? But you --

MEMBER-AT-LARGE STETKAR: But the conditional probability of a release given core damage is not an independent issue for many of your external events.

MR. GROBE: We spent quite a bit of time talking about this, and independent -- we were not unaware of the fact that independent of the Task Force there was an ongoing debate in the Commission paper that was forwarded on Level 3 PRAs. Our conclusion, I think, was based simply on a practicality concept.

We can provide adequate protection to the public health and safety with reasonable confidence without the sophisticated analysis that's necessary for a Level 3 PRA. Level 3 PRA in our opinion when we wrote this report were difficult to perform. They have a lot of variability in them. And from a regulatory perspective, it's more of a practicality argument, and you guys can help me out here if I miss some points, but how much energy do we want to put into refining with some level of specificity the Level 3 PRA, and how would we use that to make --

(Background noise.)

MR. GROBE: -- and is it necessary in our current framework? And our conclusion was that it's not necessary. It certainly is interesting, and I think Gary even said it would be fun, but the conclusion that we rendered was that we don't need it today to do what we need to do to protect public health and safety at an appropriate level. Probably different opinions about that.

MEMBER-AT-LARGE STETKAR: Absolutely.

MR. GROBE: With unlimited resources there's no question that it's something that would provide a finer scalpel edge on what we do and how we do it. But the question is, are those the resources that you want to spend?

MEMBER-AT-LARGE STETKAR: Yes, and this is certainly not the forum to discuss resources, level of effort.

The other question I had, Jack, is you mentioned that Staff will prepare a paper regarding Recommendation 1 sometime over the next 18 months. How fundamental to the near-term recommendations, the scope of the near-term recommendations is this notion of changing fundamental regulatory framework? In other words, you know, as Mike mentioned, it's always easy and interesting to sit around and discuss things as long as they're in the future.

Why isn't Recommendation 1 something that we should be working on today internally in the Commission, not put off for 18 months with additional consideration, and five years down the road we'll think about eventually getting around to changing the regulatory framework that will take another decade to do.

MR. DORMAN: You used the term "fundamental change," and I want to start by perhaps somewhat challenging the premise that this is a fundamental change that we've proposed.

What we proposed to the Commission was that within the framework of the existing 51.09 and the associated criteria for evaluating potential backfits and exceptions to backfit analysis, that the staff has ample guidance and experience with cost-benefit analyses under 51.09, that with the compliance exception we deal in compliance space through our oversight process all the time. But in the criteria related to adequate protection or potentially redefining the level of protection to be regarded as adequate, clearly those are Commission decisions, but the Staff has virtually no guidance on how to frame a recommendation in that area, what factors to consider, how to apply that.

In the context of these low probability high consequence events, what the Task Force proposed was using the defense-in-depth as discussed in the safety goal Policy Statement, and reflected in other international standards as a framework for evaluating these events, and framing a recommendation relative to adequate protection.

Now, to go to the more particular question, we applied that framework in evaluating our recommendations. We originally had this --

Recommendation 1 was originally -- that section was originally at the back of our report and we moved it to the front because it was the framework that we used to look at the rest of it.

What the Commission has asked the Staff to do looking at our report is to take Recommendation 1 out 18 months, and look at the remainder of the recommendations with the framework that we have today. So, that's what the Staff is doing in the 21-day paper and the 45-day paper, is looking at the recommendations that we developed and used in the balanced approach to defense-in-depth that we proposed. And the Staff is looking at those in light of guidance that exists today.

So, in terms of do we need to be -- do we need to do this one to be able to get to these, I think that the Staff's answer is generally going to be no, but -- and then the Staff will address to the Commission --

MEMBER-AT-LARGE STETKAR: But if I understand your answer, you said that this type of framework informed your decisions about the recommendations, and any priorities, for example, that may come out of them. So, this basic notion is something that, indeed, you did use.

MR. DORMAN: It is. Having said that, one of the things we looked at, Jack mentioned, the response to 9/11. Many of the enhancements to security after 9/11 were imposed as redefining the level of adequate protection.

Those decisions were made in the Commission, no conditional guidance came back to the Staff on it. We decided that these were redefining adequate protection for these reasons, and consider that in the future. So, what we found is, the Staff has no better guidance today in 2011 than we had in 2001 in how to take a significant event and assess it in terms of our framework in terms of a new requirement based on redefining adequate protection.

So, we proposed that the Staff would benefit from such guidance. And, as Jack indicated, we think that the public would better understand why we do what we do, and the industry better understand what to anticipate in response to an event like this, if we had more guidance on how to frame such a decision.

MEMBER-AT-LARGE STETKAR: Well, I mean, even that anecdote about here we are in -- you know, the 10th anniversary this weekend, and the Staff yet has guidance, which is something that prompted my question about relative timing and priorities regarding this particular recommendation, recognizing the practicality of the time that would be required to actually fully implement it going forward. Anyway, thanks.

MR. GROBE: Recommendation 2. Okay. Recommendation 2 addresses seismic and flooding analysis. The Task Force looked at the various external events and identified flooding and seismic as particular areas that we recommend that the Staff focus on.

This is because the fundamental knowledge on these concepts, or the data that we have to think about these concepts, or the analytical tools have advanced sufficiently since the `60s and `70s when our current operating fleet was originally licensed, that these issues should be revisited.

We had -- let me finish my sentence. Good grief.

(Laughter.)

MR. GROBE: We had several recommendations in this area. One is longer-term, one is an interim action, and then a rulemaking to make this a lasting recurring activity.

MEMBER-AT-LARGE STETKAR: Okay. Suppose

the Fukushima event had involved the worst tornado that had ever occurred in the history of the earth, would Recommendation 2 still say update seismic and flooding analyses because these are the areas --

MR. GROBE: Yes.

MEMBER-AT-LARGE STETKAR: -- that we have -- we recognize were one of the most --

MR. GROBE: And if you're a marketing manager, you appreciate that this is difficult to sell. But, in fact, we actually looked at everything. We did. We talked to each of the experts in each of these areas, and the conclusion was the way the Agency handled winds, high winds, whether it's tornados, or hurricanes, the way it handled ice and snow, there hasn't been a lot of advancement which would cause us to call into question whether or not there's still sufficient basis --

MEMBER SHACK: Tornado winds are decreasing.

MR. GROBE: So, we actually looked at each of these and concluded that seismic and flooding were the two areas that we should focus on, the Staff should focus on.

MEMBER POWERS: Looking at your report, I came away saying, Jack, I need a little more background context, what you were thinking about on this particular one. In particular, on updating the seismic, how does this interface with GSI-199. And on the flooding analysis, I said this is an area that I have a dint of an ill-spent youth, I'm sure, had to deal with a lot in connection with early site permits and things like that, and the context of climate change. Because what -- I mean, what we do on the flooding analysis, typically, is they look at 50-year or 100-year data, and they say well, what was the worst flood we ever had, and we'll protect against that one. And it's a practicality. There's no data prior to 100 years for many, many of the plants, and even the data you have there's ahhh -- because you don't have to go back very far and people just didn't measure things.

So, that context was kind of missing for me on what your thinking was. I'm not criticizing the recommendation.

MR. GROBE: I mean, you guys have four questions in one question.

MEMBER POWERS: Yes, I did, but I'm really only asking for the context of your thinking about this recommendation.

MR. GROBE: Well, I mean, we've been

recently dealing with concepts of likelihood of dam failure, and consequences of dam failure at a site. And as I'm -- a novice in every technical area. I'm not an expert in any. But as we got into this issue, it became very clear to me that the analytical tools we have today to project the likelihood of consequences of a dam failure are far superior to what we had when we originally licensed these plants. The water flow, the levels, the rapidity with which the water gets to different places just simply are geosynchronous satellites in our ability to map the earth to be able to project that, far superior to what we had 40 years ago.

So, it was these two areas where based on our study of what we've done in the past, and extensive discussions with the experts in all of the external events areas, that we concluded warranted revisiting.

With respect to 199, let me -- I think was your other question. There is a very close connectivity. 199 addresses the increased likelihood of seismic exceedances east of the Rocky Mountains. Those increased likelihoods, principally, are at the high frequencies which are typically less damaging to structures and large facilities; notwithstanding, there is some likelihood that those safe shutdown earthquakes in the current licensing basis could be exceeded, and that should be studied.

We evaluated that and concluded that we didn't see a need for imminent action, but we needed -- we saw a need to take some action, and that's 199.

The way in which you establish the spectrum in new reactor licensing and in 199 is the same, the ground motion response spectrum. The way in which you design the plant for a new reactor license is that you will design it to meet that spectrum. So, the back end of 199 is different. 199 has you do a probabilistic analysis, either a seismic margins analysis, or a seismic PRA. And if you find exceedances of 10 to the minus 5, then 199 asks you to address those, and identify what would reduce it to below 10 to the minus 5 core damage frequency.

So, the back end of 199 is different than the back end of the new reactor licensing concepts. As a matter of fact, the design certs are based on a seismic spectrum that is anchored as .3g. And the design cert is done based on that. Typically, licensees only select sites where that .3g spectrum bounds a specific site ground response, ground motion response spectrum. Otherwise, there's a whole lot of analytical work that needs to be done to either show you have margin or redesign the specific parts of the plant. So, typically, licensees will select sites that are bounded by that .3g spectrum.

MEMBER SIEBER: Do you foresee that new or advanced studies is seismic, flooding, tsunamis, and other natural effects will affect the licensing basis for existing plants?

MR. DORMAN: What we recommended was what we termed the confirmation of the licensing basis, design basis on a 10-year interval anticipating that there will be advances in understanding, continue to be advances in understanding of seismic and flood hazards. And the confirmation --

MEMBER SIEBER: And new events.

MR. DORMAN: Yes. And the reason we use the term "confirmation," if you look at 2.1 Recommendation was to do an analysis now of the existing fleet. We used the term, I think, analysis for 2.1. In 2.2 we recommended a confirmation. So, the confirmation in our mind was look at what the change is in the state of knowledge and the state-of-the-art in analysis and if there are significant changes then you may need to do a re-analysis. But that's why we used the confirmation of the design basis, so if there are significant changes over that 10-year interval, then that may kick you into an analysis. But we were envisioning a lighter level of effort for the first step in that 10-year --

MEMBER SIEBER: Well, the term "confirmation," to me, you know, I can take it as a knowledgeable person on this Committee working with the Staff, or I could take it as a public individual who would say I'm going to confirm this, which means I'm going to do my level best to make sure it comes out the same as it was before. And, to me, the term is not exactly the right term to use.

MR. DORMAN: Okay.

MEMBER SIEBER: I think you ought to approach that with an open mind because as events occur, you may redefine the envelope of the severity of those events, and it may affect the licensing basis of existing plants, and you've got to do something about that.

MR. GROBE: There's been a lot of discussion. We have a very robust operating experience program, and if we -- and generic issues program. And if we identified some new knowledge either based on events or research that caused us to conclude that there was a prompt safety concern, we wouldn't wait for the 10 years. We would process that promptly through our existing processes.

This particular recommendation, it's 2.2 I think. It's really unclear. We have to spend a lot of time thinking about the guidance on when we have to redo the analysis, and when it's simply sufficient, and how you make those judgments. And it's this whole concept of confirmation.

MEMBER CORRADINI: Is the time frame also part of that hard thinking? I was trying to understand where you guys got the 10 years from. Is this just an example of some sort of periodic reassessment? Is that really the 10 years at this point?

MS. CUBBAGE: There's also a recognition of the time it would take to do a reassessment.

MEMBER CORRADINI: Okay.

MS. CUBBAGE: And you don't want to do it every two years.

MR. DORMAN: Yes, you want sufficient interval to allow the evolution of the knowledge and the technology, so you didn't want to do it so frequently that it became -- that you didn't get meaningful evolution in that time period.

MEMBER SHACK: So, it was easier to pick a time than it was to come up with the criteria for what we --

MR. DORMAN: That's --

MR. GROBE: And the timing -- I mean, the licensed life of the existing plants is 40 years. The current license extension is 20 years, and maybe life beyond 60 will be 10 years, don't know where that's going to take us. But it seemed like an appropriate interval.

MS. CUBBAGE: And keep in mind that this was a proposal for a rulemaking so there will be a lot of detailed engagement with all stakeholders.

MR. GROBE: And you may have the opportunity to engage.

MEMBER SHACK: Well, it's 2.1 that -- just come back to that one for a second, because that's an order. And my understanding is that that's a change in the design -- I mean, I look at 199 as kind of a risk-informed approach to this. You're going to go off and look at this, and okay, if you exceed the design basis but you're still okay from a PRA or a seismic margins event, you're okay.

You have introduced a new step here now. You're going to actually look at the design basis -- and I just want to check that that is, in fact, your intent.

MS. CUBBAGE: That was the intent.

MR. GROBE: That was the intention.

MEMBER SHACK: And why choose that over the risk-informed approach that I associate with 199, I guess is my question.

MR. GROBE: I can only speak as one Task Force member, but from my perspective it was a re-baselining. It was -- there's sufficient change in these concepts that we felt -- I felt that there was a need to re-baseline the design basis in these two areas.

MEMBER CORRADINI: The re-baselining could mean a new SSE.

MR. GROBE: Yes. It will like change SSE at a number of plants.

MS. CUBBAGE: Some sites the hazards may have gone down.

MR. GROBE: Yes, there are sites where it has gone down.

MEMBER SHACK: Did you think through what would happen -- you know, I can envision somebody coming up with a new SSE. I can change equipment, I can read the analyses. It's calling for me to redesign my basemat. And I assume that you will have some sort of an -- would there be an exemption at that point? You would go to something like a seismic margin analysis, seismic PRA. You would go to the design basis first before you went to -- which is the difference between 199 --

MS. CUBBAGE: You're raising some great issues, and I think it's premature for us to get into the details of how that would play out, because we've got -- the Commission has got to weigh in, et cetera, et cetera. And there'll be a lot of dialogue, I believe, going forward on it.

MR. DORMAN: But, I mean, you're touching on an issue that I think will be -- not to presuppose what the Commission will direct in terms of what process, regulatory process we'll go through. We said order. But I think that whatever regulatory process we're in, there's going to need to be a robust discussion of what the criteria -- what the Staff's acceptance criteria will be for what we've -- I think our words were something like upgrade equipment, as necessary, or as appropriate.

The acceptance criteria associated with that, because you're dead on. I mean, we can stiffen relays, and we can stiffen pumps, but we're not going to fundamentally change the buildings as a result of this re-analysis. So, whether that shows up as an exception to an order, an exception to a regulation --

(Simultaneous speech.)

MEMBER RAY: The draft Generic Letter refers to backfit three different times, the Backfit rule is applied. I took that to mean what it says.

MR. GROBE: Recognizing that backfit has four components.

MEMBER RAY: Yes.

MR. GROBE: Right.

MEMBER RAY: But, I mean, I think you're going beyond it just being quite as vague as you were saying. It very specifically says this would then be subject to the Backfit Rule if any change was considered necessary.

MS. CUBBAGE: Well, I think --

MR. GROBE: Actually, that's not what this says. The recommendation --

(Simultaneous speech.)

MR. DORMAN: Generic Letter for 199.

MR. GROBE: That's right.

MS. CUBBAGE: There's the Task Force recommendation as it stands, because the report is done. Then there's the draft Generic Letter, which is on the table. And then there's what's going to go forward to the Commission, and what the Commission will decide, that may or may not change the direction of GI 199, but there --

MEMBER RAY: Well, the Generic Letter is broader than GI 199. It includes it, but it also includes the west coast plants.

MR. GROBE: It does, and that was --

MEMBER RAY: And, like I said, I took it because of the timing to reflect an evolution of the next step of what you were just talking about. I realize you're not the author of the Generic Letter, but the Generic Letter does reflect, I thought, what these Task Force recommendations were saying.

MS. CUBBAGE: There's a parallel, but I wouldn't necessarily draw the --

MEMBER RAY: The two things may be disconnected.

MEMBER SIEBER: But they should mesh, so we should --

MS. CUBBAGE: Eventually --

MEMBER SHACK: But just coming back to your's, to me, this is part of your Recommendation 1. Right? When you said order and changing the design basis, you had, in fact, a notion of a redefinition of adequate protection.

MR. GROBE: Yes, absolutely. And it would replace that 199.

MEMBER SHACK: That is what happens with the Backfit Rule in this particular case. That's at least your vision --

MR. GROBE: That's one path through the Backfit Rule analysis, yes.

VICE CHAIRMAN ARMIJO: Jack, I'd like to go back to something that John brought up. The recommendation seems very narrow to me that it's seismic and flooding. That's what happened at Fukushima, obviously that should be in there. That's the way it comes across, but there's other severe natural phenomena of long duration other than earthquakes and tsunamis. And John mentioned tornados. I've experienced hurricanes, but there's also blizzards, long duration, isolation of a plant.

Could damage access and power in a way that's different from a flood. And you've kind of mentioned that yes, we covered that with this recommendation. I just want to make sure that that is, in fact, true.

MR. GROBE: That's our opinion, and that's the underpinning of the recommendation. Seismic and flooding is not here because that's what happened at Fukushima. It's here because those are the areas that we think we need to advance in the way in which we regulate our operating plants.

MR. DORMAN: Because there's a significant evolution of knowledge and state-of-the-art since these plants were licensed. When we looked at high winds and snows, and freezing, and other issues from external hazards, we didn't see that kind of significant delta in where we are -- where the state-of-the-art is today from where the plants were licensed. So, that's why those didn't show up in there. And we perhaps could have benefitted by a little bit more discussion in the report of why we left some things out, but if we started getting into a discussion of all the things we didn't include, the report would have been a lot longer. But that was the thinking.

VICE CHAIRMAN ARMIJO: Thank you.

MEMBER-AT-LARGE STETKAR: Dan or Jack, I want to come back to this notion of 10-year reconfirmation, if you want to characterize it that. First of all, the 10 years is an arbitrary. There are many, many international regulatory bodies that invoked a licensing framework that involves a 10-year periodic safety review. That's fairly standard in a large part of the world.

MEMBER POWERS: Also completely arbitrary.

MEMBER-AT-LARGE STETKAR: Well, but consistent -- we get points for consistency.

MR. GROBE: Our 10 years is not arbitrary.

MEMBER-AT-LARGE STETKAR: The question in seriousness is why restrict that 10-year periodic examination, if you want to call it that, to seismic and flooding? You know, you mentioned well, we haven't really learned much about fires in the last four years. I would challenge that substantially.

I think we've learned a heck of a lot about fires in the last decade, compared to where we were in the late 1990s. We've done an awful lot of research work, experimentation that has changed our notion about the behavior of fires. We've gathered data that has changed our notions about the frequency of various types of fires, the consequential damage from fires. So, it's not clear to me why fires shouldn't be included in that notion.

We've learned an awful lot about how pumps behave under near-cavitation conditions. We've learned an awful lot about what cavitation might be. We've learned an awful lot about what margins might exist for net positive suction head conditions in various types of designs over the last decade compared to 40 years ago. Why shouldn't those issue and the fundamental design basis credit for adequate net positive suction head also be reviewed on a 10-year basis?

All of those issues are folded into a regular periodic safety review. Many of them, it's easy to look at the last decade and say well, we really haven't learned very much. Others, you do learn. So, it's not clear to me why simply seismic and flooding.

MR. GROBE: There's not a scientific answer to th is question.

MEMBER-AT-LARGE STETKAR: Okay.

MR. GROBE: The -- we had debates, why not other natural events? And then you get why not other things that are not natural events, and why not do a periodic safety review? And we provided a very comprehensive articulation of our regulatory processes as contrasted with the others around the world, and provided that to the IRS team and they acknowledged that our regulatory structure is equivalent to what -- the robustness of our operating experience, our generic issues, our revisiting of issues on a realtime basis, but it's equivalent.

This was simply a recognition -- this particular recommendation was a recognition of the advancements in these areas and appreciation that those advancements may continue. And it's a judgment. There's nothing scientific about this.

MEMBER-AT-LARGE STETKAR: The problem is that historically a lot of our revisiting of issues based on operating experience has been a reactionary process, something has happened in the industry. We have a station blackout, so station blackout becomes important. Reactor trip breaks fail to open, so ATWS becomes important. That's a different notion that sort of stepping back every decade or so and asking yourself what have we learned, and what does that knowledge tell us looking forward.

MR. GROBE: Yes, I'd like to just expand that a little bit. It's not just response to events, for example, the hardened events was from PRA. And there's other things that we've learned from PRA. And need to continue doing that. And our view, as contrasted with others in other parts of the world is that we should do that on a realtime basis, and not wait every 10 years to do it.

This particular recommendation was simply a continuation of the concept of why we're ordering this re-analysis. It's because the state of knowledge has changed so dramatically, maybe it won't change in the future. It's possible that we know all that we're going to know. Of course, we never know all that we're going to know, but what changes is not significant, in which case a re-analysis is not necessary. It's not a satisfying answer. I apologize.

CHAIRMAN ABDEL-KHALIK: Okay. Let me just point out that we are on Recommendation 3, and we have already been --

(Simultaneous speech.)

MR. GROBE: Recommendation 3 is a bit easier to deal with. There have been situations where seismic events have caused fires. It's a very common thing in industrial, or in residential, and urban situations. It also occurred at the KK earthquake in Japan a number of years ago, where they had a fairly significant transformer fire as a result of the earthquake.

This needs to be studied. We couldn't come up with a specific recommendation on how you would modify, how you would apply seismicity protection to fire, weather systems and things of that nature. This was a longer-term focus area, not meaning to take 10 years to do it, but just take the appropriate amount of time. And we couldn't provide a specific recommendation.

Recommendation 4, station blackout. Gosh, one, two, three, four, five, six, seven words. A huge topic. It's clear the Station Blackout Rule that we currently have is predicated on the concept of some event removes electrical power from offsite, and reliability results in loss of electrical power onsite. And that's the foundation for the regulations that we currently have.

The Task Force visited that in light of what occurred at Fukushima, and the concept of cliff edge events, and clearly station blackout is a cliff edge event if it occurs. And it should be protected more holistically in the opinion of the Task Force than what our current regulations provide.

And we conceptualized a three-phase protective scenario with eight hours of protection, what we call coping, with minimal operator action, recognizing that during those eight hours the operator should be focused on recovering electrical power and preparing for a longer-term station blackout, if it's necessary, but not manipulating lots of equipment; that that should be given to the operators to do the operating job of dealing with the casualty.

An extended period of coping of 72 hours, the point of that coping period is to give enough time to essentially have the calvary arrive to receive support from offsite, and that's a not normal operator action, beyond normal operator action to establish that 72-hour coping period, but still equipment that's available on site. And then offsite equipment that would be made available to the facilities in the event of a station blackout exceeding 72 hours.

So, it's a three-phase concept. It also includes protections beyond the design basis protections. For example, in the proposal the concept is that you provide this 8-hour coping in such a way that it's protected from at least one elevation in the plant beyond the projected flood levels, so it's conceptualized to be protected beyond design basis events at some level.

CHAIRMAN ABDEL-KHALIK: What is the logic for selecting eight hours and 72 hours?

MR. GROBE: The logic for eight hours was simply to give the operators enough breathing space to respond to the casualty, and if it appears that they're not going to be able to respond to the casualty successfully, to have sufficient time to put in place the equipment that would get you for a longer period of coping. And this is equipment that would not necessarily be installed in the plant.

MEMBER CORRADINI: So, can I ask a question here, because I understand you had to pick some time, and that makes some sense to me. But at least as I read the information from the event in Japan, for Units 2 and 3, they were successful in having RICSI and HIPSI run for two to three days.

MR. GROBE: Don't know how they did that. I'm very interested in that. That's true.

MEMBER CORRADINI: Okay. So, I'm struggling with what -- I mean, I don't want to lessen -- because I do agree with the recommendation, but on the other hand, there is a fatal -- there is a flaw in the design base that caused the event. So, if you go through Recommendation 2 where you've now very diligently relooked at the design base, maybe even re-baselined what the design base is relative to seismic and flood, what I see here is almost an assumption that somehow you've missed the design base, now you've gone beyond design base, and now from a defense-in-depth standpoint this is what you're requiring. That's my only justification for understanding why you came to this. Am I off base?

MR. GROBE: You're exactly within the regulatory framework in Recommendation 1.

MEMBER CORRADINI: Okay, fine.

CHAIRMAN ABDEL-KHALIK: Would you agree that the selection of -- for specifying eight hours and 72 hours may not be optimal for all sites?

MR. DORMAN: Yes. I think, ultimately, the question is-- we put out eight and 72 hours to frame the strategies that we were talking about. And in our discussions, those were reasonable times to enable the operators to get the 72 -- get the extended coping in place, and then get the offsite equipment. But I think it depends on how much action needs to be taken to get the extended coping in place. It's potential that you might need more than eight hours to get the extended coping in place. It may -- it's possible that you can show that under conditions associated with a station blackout and the initiating event that caused you to be in a prolonged station blackout, that you can demonstrate that you can with confidence get that extended coping in place in four hours, then maybe you could justify a four hours.

Similarly, if the offsite equipment is near enough and you have confidence in infrastructure to get it to the site and connect it, you might justify something less than 72 hours. If you go for something more regional, you may need to go longer than 72 hours.

So, yes, I think there's room for discussion in the rulemaking process of a performance basis for those things. I think there's an elegance to having one set of answers. We noted that we're kind of several different answers across the fleet today in terms of four hours, or eight hours, or alternate AC. But, ultimately, the best thing for a site is the best thing for a site, so I think there's room for discussion of performance basis --

MR. GROBE: You're going to get a little taste of what it was like in the cave for four months. And Amy and Nathan just sat there when Gary, and Dan, and I would get into it, and they just kind of sat back and said oh, man. But I wouldn't answer that question the same way Dan did.

Eight hours, in my opinion, is a minimum. You're talking about an operator that is having to deal with a casualty. It's very significant. It's clearly beyond anything we've analyzed and contemplated, because we changed the design basis.

This is a situation where the operator is having to deal with something that he does not understand, possibly, and is not -- his plant has not been designed to deal with this in a normal way.

The operator is going to have to deal with two things, trying to figure out why he's lost offsite power and onsite power, and what he needs to do to deal with this. And it might be at 1:00 in the morning where he doesn't have a whole maintenance staff, and a whole electrical staff, and engineering staff to help him or her, and then deal with the concept of hey, I might not get it done in eight hours, and we've got to start getting ready for beyond eight hours.

That's a lot of stuff. In HRA analysis perspective, you're putting the operators in a difficult situation. So, I would not go below eight hours, personally; 72 is debatable, 72 is simply based on making sure there's ample margin to get stuff from offsite. But the eight, in my mind, is a fairly firm concept just from the standpoint of looking at what operators have to do in the control room in a casualty situation that they don't understand.

MEMBER SIEBER: Actually, the use of eight and 72 is sort of deterministic in nature, and I suspect that each plant has its own unique circumstances. And we ought to have sufficient flexibility to accommodate the circumstances that exist, and provide sufficient margin because not everything happens the way you would like it to.

MR. GROBE: Yes.

MEMBER SIEBER: So, rather than nail down specifically what these times ought to be, and have a licensee say I meet the time, but I can't perform the function under his breath, I would prefer a more open mind toward what the baseline should be. And a risk-basis time line serves us better than deterministic times.

MEMBER-AT-LARGE STETKAR: Jack, the Task Force spent, obviously, a lot of time on this issue. And I need to ask you a question so that I can understand the thought process.

In the Task Force deliberations, what is a station blackout? I mean, let me ask you two questions so you can give me a yes or no answer. Is a station blackout the complete absence of any alternating current power whatsoever? Yes or no? No alternating current.

MR. GROBE: I believe the answer is yes.

MEMBER-AT-LARGE STETKAR: Okay.

MR. DORMAN: Yes, I think that fits how we applied it, which is --

MEMBER-AT-LARGE STETKAR: Okay. Let me ask you the second question, because I was hoping that that would be yes.

Is a station blackout a situation where my only source of alternating current is from an operating, perhaps non-safety, perhaps manually started generator that I've connected to the plant so I have alternating current lighting my lights and powering some minimal equipment. Is that a station blackout? Yes or no? Because I need to understand this distinction.

MS. CUBBAGE: In our minds, that type of equipment would only come into play after the initial eight-hour period.

MEMBER-AT-LARGE STETKAR: So, a station blackout is no alternating current in this notion. The eight-hours is to cope with no alternating current.

MR. DORMAN: Yes.

MEMBER-AT-LARGE STETKAR: Thanks. I'm -- honestly, you know, yes or no was fine. And I didn't hear a lot of --

MEMBER POWERS: I really honestly think you don't want that answer. I think you want to say lack of adequate alternating power.

MR. DORMAN: Yes. I think what's different from -- what's different at Fukushima from what's envisioned in the station blackout reg guide is it's not just the power source from offsite and the power source from onsite, but all of the switch gear was flooded out, as well. So, my it depends on your answer is, where is that generator hooking into? If it's hooking into that same switch gear it's not doing any --

MEMBER-AT-LARGE STETKAR: In some sense it doesn't. I'm interested in the fundamental concept of the thing that we call a station blackout, because that concept has been twisted in a regulatory and an application framework with many, many different interpretations to the point where people say well, I'm coping with a station blackout, but I have alternating current power available, but that's part of what I call a station blackout. So, I was fundamentally interested because you do have recommendations that are explicit, regardless of whether it's eight hours or some arbitrary time of coping with a particular condition in the plant. And that's what I was trying to understand. Thanks.

MR. GROBE: There is an interim recommendation that goes along with the rulemaking, and that is to -- we do have this B5b equipment in our plants --

MEMBER BROWN: Can I ask one question relative to his thought? Talk about no AC power, John, I presume you mean also any batteries that they --

(Simultaneous speech.)

MEMBER-AT-LARGE STETKAR: No, I'm -- things that spin around and create --

MEMBER BROWN: Well, that's why I asked the question. AC power relative to batteries would be -- if you develop for eight hours, or six hours, or two hours, is not within the I've lost all AC power. It's available. Okay. I wanted to make sure I understood that context.

CHAIRMAN ABDEL-KHALIK: Please continue.

MR. GROBE: Let's move on to Recommendation 5. Recommendation 5 has to do with reliable hardened vents. The word "reliable" is clearly undefined. At least we've all defined it in our own minds, but there's no consensus, necessarily, on what reliable means.

I think I addressed this briefly earlier. In our minds, reliable embodies the concepts of passive action versus active action. It involves the concepts of availability without AC power, the concept of accessibility to the equipment that needs to be operated in different scenarios. So, embodied also in this recommendation is to study other containment designs and identify whether or not there's a need for any change in other containment designs.

MEMBER SIEBER: Is the Staff taking any steps to fully determine what caused the hydrogen explosion at Fukushima, so that there are Lessons Learned, because they supposedly had hardened vents even though they had more than one unit connected to a single vent. It resulted in destruction of three reactor buildings, and potentially a containment pool, four reactor buildings.

MR. GROBE: There's a number of things that are going on. The industry has a Task Force that's working on developing a sequence of events. The Government of Japan has directed the completion of a detailed study of the events and developing a sequence of events. Department of Energy is going detailed study of the core progression -- the accident progression and utilizing our severe accident modeling to, essentially, benchmark models. So, there's a number of things going on.

Actually, Recommendation 6 is hydrogen

control. The difficulty the Task Force had was that there wasn't sufficient information. The common belief at this point in time was that the containment vessel was pressurized to a point where gases escaped through the seals, the O rings on the head, that there was elastic deformation of the bolts at the head, and that allowed gases to exceed, which allowed hydrogen to get into the reactor building, and the common speculation at this point is that there was -- and there's some data to support this, that there was crossflow between Units 3 and 4, but that's not yet confirmed. And we expect that that will be something that we understand better in the future, and that forms the basis for this long-term recommendation.

MEMBER SIEBER: So, work is going on, and it appears as though you understand all the intricacies, so I'm satisfied.

MR. GROBE: Right.

MEMBER SIEBER: Thank you.

MR. GROBE: Recommendation 7 has to do with instrumentation, electrical power for instrumentation for the spent fuel pool, electrical power for spent fuel pool makeup, as well as an independent capacity to provide spray into the spent fuel pool in the event of a severe beyond design basis accident.

VICE CHAIRMAN ARMIJO: That instrumentation problem with the spent fuel pool, there were instrumentation problems related to the vessel and the core. I wonder why your recommendation was limited to the spent fuel pool, when the real problem was in the core.

MR. DORMAN: I think we touch on instrumentation in the station blackout recommendation in terms of the instrumentation available to the operators relative to the reactor during a station blackout.

Here we were focused on the recognition that the problem was not in the spent fuel pool, but absent information about the spent fuel pool, the operator spent tremendous of energy addressing a potential problem in the fuel pool, that if they'd had adequate instrumentation they may have been able to focus more of their energy on the reactor. So, I think the answer for instrumentation for the reactor is in our station blackout recommendations of what instrumentation which should be available under those conditions.

MEMBER REMPE: That's not consistent with what I've read. For example, the thermocouples that they use were Type T thermocouples. They had temperatures of 500 degrees C for some of the units or higher, so power, or low power is not just the only issue, there's also an issue that since this protects beyond the maximum operating temperature, the water level was needed to make some near-term actions, so I guess I would be more concerned about the adequacy of the actual sensors, not just the need for power of the sensors.

MS. CUBBAGE: I think that's the type of area where as more information becomes available, it could form future recommendations as part of the NRC's long-term. But as far as our 90-day review that wasn't a level of detail we were able to get into.

MR. GROBE: Yes. It clearly was beyond our capacity in 90 days to deal with this issue. We could have had a longer-term recommendation to look at it, because it was a challenge, and it's becoming more clear as we understand the condition of the reactors and the cores that the instrumentation was significantly challenged.

MEMBER POWERS: Without being too critical of the recommendation, I just have to point out that I have now been through three severe accidents, and every one of them people come back and said gee, we need more instrumentation. And I think one of the problems you run into is that whatever instrumentation you put in would probably be inadequate for the next severe accident, because it will be different.

I think the recommendation is fine, but I caution you that if we rely on additional instrumentation you get into two problems. One, any additional instrumentation is a distraction to the operator, at some point it's a distraction. And second of all, it probably will not help on the next accident. Every accident is just different.

CHAIRMAN ABDEL-KHALIK: Well, that doesn't mean that you don't sort of take actions to correct events of similar nature.

MR. GROBE: There's a unique absence of information regarding the spent fuel pool beyond normal conditions. And this was intended to address that.

MEMBER POWERS: Well, I mean, the problem is it's almost a regulatory problem. The regulation is don't let the water pool drop below a certain level, so the instrumentation is designed to make sure it doesn't drop below that. One it drops below that level, you've got nothing -- there's no help.

MR. GROBE: Okay. Recommendation 8 has to do with three sets of documents that were developed at different times. The emergency operating procedures are actually procedures that are step-wise, and they're expected to be implemented. The severe accident management guidelines are not procedures. They're guidelines for things you might think about doing if you get beyond your capacity in your emergency operating procedures. And the EDMGs, the Extensive Damage Mitigation Guidelines are specifically tailored to a loss of large areas of the plant due to fire and explosion.

As I said, these documents were developed over a period of time, different periods of time, and what we found is that EOPs are required, EDMGs are required, SAMGs are not required. The things on implementation, you will likely go through them. At least, certainly, there's a relationship between them that is not necessarily recognized in how we develop the procedures. Command and Control training exercises was not as robust as it could be, so the recommendation here is that we focus some attention on the relationship between these procedures, make changes, as necessary, to make that relationship seamless, address Command and Control issues as you transition into these different regimens, and then address appropriate training and exercises once this activity is completed.

CHAIRMAN ABDEL-KHALIK: Now, the industry at the August 31st meeting expressed concern about the level of training that is implied in this for operators with regard to SAMGs and EDMGs, and the point that was made was that we should, essentially, focus the training of the operators on things that we expect them to do; meaning that training with regard to SAMGs should only be limited to familiarization.

MR. GROBE: And that could be completely appropriate. Once you complete the integration of this to build that framework, and you clearly define the Command and Control structure and how things are going to be done, familiarization training could be sufficient, as long as it's repeated and it -- this is not a definition that all operators have to be actionable as if they were the person that's going to be making the severe accident management decisions in the technical support center. Many of those decisions will be made in the technical support center, and we don't expect operators to be severe accident management experts.

CHAIRMAN ABDEL-KHALIK: So, would it be fair to say that the word "integrate" has not been clearly defined at this stage?

MR. GROBE: Actually, that's recognized in the report, and it specifically references that we need to engage with those people that develop the individual guidelines for each of these documents, get them all in a room and figure out how these procedures would work together.

MS. CUBBAGE: And our recommendations with regard to training are specific to those that are expected to implement the strategies and decision makers, not necessarily targeting control room operators. That will have to play out in what level of training -- additional training may be required for operators.

MEMBER BLEY: Is the work in this area now that Staff is taking a more deep plan to things like the SAMGs, is the work necessarily being coordinated with industry, and how are we moving forward to kind of make sure we keep the operator's perspective in this, as well as --

MR. GROBE: The answer is no, the work has not been coordinated with the industry. The Task Force was charged with generating this report --

MEMBER BLEY: I mean, after your 90-day report.

MR. GROBE: I understand the expectation

from the Commission as well as the expectation from all our stakeholders is that we talk to them. But the Commission has clearly set that expectation. And this is an excellent example of where the Task Force actually recognized that, as well.

These are very complex things. We need to work with the industry and the experts.

MEMBER BLEY: And that's not yet begun.

MR. GROBE: No.

MR. DORMAN: No, the 21-day paper is due to the Commission tomorrow, and then we'll get direction from the Commission. We anticipate that assuming they direct the Staff to move forward on this one, that then we will be reaching out and beginning that engagement.

MR. GROBE: Yes, we've had two lengthy public meetings with all of our stakeholders to date; the one the Task Force conducted, the second one was conducted by a group of Office Directors just a few days ago.

MEMBER-AT-LARGE STETKAR: You mentioned something and we discussed this a bit at the Subcommittee meeting also. I have to paraphrase what you said, but you said something to the effect that well, we only envision training the operators to the extent that they have some notion of the severe accident mitigation guidelines because the real decision makers will be the people in the technical support center.

We license operators in this country and around the world to be the people who are legally responsible for operating the nuclear power plant. They are the most informed people on a day-to-day basis for how the plants operate, the function of the equipment, the particular status of the plant. Are you proposing to remove the responsibility for making decisions about managing the progression of events at a plant and put that responsibility in the hands of the technical support center decision makers? And, if so, how are we going to license those people and give them the same knowledge level that the operators have?

MR. GROBE: Actually, it's addressed in the recommendations.

MS. CUBBAGE: Right. And I think you mischaracterized. If you said that's what we said last time, what we were saying is that is consistent with what's going on today, and we were recommending that --

MEMBER-AT-LARGE STETKAR: But what I just heard is this notion of well, maybe just limited training of the operators so they're familiar with the general concepts is okay because the real technical expertise and the decision makers will be out there in that technical support center. And I believe that's what you just said this morning, unless I'm really misinterpreting what you said.

MR. GROBE: I think we all understand this. The -- once you get into a severe accident -- the reason these are guidelines and not procedures is because you can't write a set of procedures that contemplates all potential scenarios. And operators operate per a set of procedures within that construct of a set of procedures.

The operators need support. If they get into a severe accident situation that's beyond the scope of training and procedures they have, they can't make decisions in the control room without support. The SAMGs are contemplated to provide a framework for supporting the operators.

There may be decisions on strategies that are beyond the capability of the operators to understand because you need to get a bushel basket of Charlie Tinklers and put them in a room and tell me what's going on and what do you recommend, and why? And that's the way this would progress, and recommendations would then go from the TSC to the control room. But I cannot imagine us being in a position of training the operators to understand all of that.

It would have to take -- and the focus of this recommendation is we really haven't spent enough time on this question of how the Command and Control structure is defined. And if, in fact, there will be decisions made in the TSC, then those should be licensed people. And we haven't focused on that either, and that's part of the recommendation.

MEMBER SIEBER: There is a legal issue. The only one who is authorized to manipulate the reactivity of the reactor is a licensed operator. And if the plant manager is not licensed he can't tell the operator what to do --

MR. GROBE: That's right.

MEMBER SIEBER: -- to manipulate the plant. And at least in the facilities that I have worked in or inspected, that's the way it operates.

MR. GROBE: Absolutely. And that's --

MR. DORMAN: But I think the -- part of what I heard in the industry comment in this regard is, you've got these operators 99.999 percent of their time they're going to be in normal operating procedures, abnormal operating procedures, EOPs, that's where we want to focus their training. If we end up doing a whole bunch of training on SAMGs detracting from the things that we expect them to do, then we may be introducing a different kind of risk in human performance, so we want to focus the training on the SAMGs to the people who are doing the different kind of thinking out in another room under those conditions. Have the operators be familiar with what that is, so that when they get the phone call from the TSC it's not total shock, but that ultimately it's the operators who are going to be manipulating the --

MEMBER SIEBER: That's right.

MEMBER-AT-LARGE STETKAR: I know we're short on time, but let me just say that I was an operator and a shift supervisor after Three Mile Island, and the notion that we had in the plant was that people were changing the fundamental bases of how we dealt with certain events. And we were told to don't bother your little heads, really smart people out there who know a lot more than you do are making these decisions, and you just worry about implementing them. I certainly hope we're not getting into that, regardless of what the industry says about training the operators in the control room. I hope we're not getting back into that mind set.

MEMBER SIEBER: Well, the operators should have sufficient knowledge to know that these exist and how they apply to their plant so that they can take advice from the TSC.

(Simultaneous speech.)

CHAIRMAN ABDEL-KHALIK: Let me just point out that we have promised NEI 10 minutes to make a presentation; and, therefore, I would appreciate it if you try to conclude your presentation by 20 after the hour.

MR. GROBE: Okay. I'll need some assistance on that.

(Laughter.)

MR. GROBE: Recommendations 9, 10, and 11 deal with emergency response, the preparedness aspect of the defense-in depth. Nine are actions that we think should be taken on a short-term, and as you progress through 9, 10, and 11 you get into some research.

Just to give you an idea, part of 9 with respect to ERDS is converting to a -- I'm not going to get this right, a computer-based -- a more sophisticated computer-based communications technology. When you get to 11, it's looking at how might we use satellite technology to communicate with the cloud and make that available to everyone. So, that's kind of the progression that you have through 9, 10, and 11. And what we're dealing with here is multi-unit events, extended station blackout, and those types of concepts and how you would deal with those.

MEMBER SIEBER: Do these recommendations contemplate enhancements to your predictive dose projection tools?

MR. GROBE: Yes, that's specifically addressed.

MEMBER SIEBER: That needs to --

MR. GROBE: Recommendation 12 is an internal recommendation. How is that? Who-who. Recommendation 12 focuses on how we train our operators, and how we utilize our reactor oversight process. Excuse me, thank you, our inspectors. How we train our inspectors and how we utilize our reactor oversight process. And unless there's any questions, I don't know that we need to talk much more about that.

The next slide is --

MEMBER POWERS: When you think about more attention to defense-in-depth, does that mean that you would go back and revisit the issue of containment over pressure?

MR. GROBE: I'm --

MS. CUBBAGE: The last item is specific to oversight, so allocation of inspection resources and prioritization, and whether that's a risk-informed or a risk-based, and the incorporation of more defense-in-depth considerations so that there's some attention paid, or more attention paid to beyond design basis features such as SAMGs, hardened vents. I mean, this is really an inspection oversight recommendation.

MR. GROBE: You weren't asking a question about the recommendation, were you? You wanted to get into CAP, didn't you?

(Simultaneous speech.)

MR. GROBE: In the CAP papers that we've provided you, there's -- let's not go there, please. It's -- that's another conversation.

MEMBER POWERS: One we'll likely have.

(Laughter.)

MR. GROBE: Slide 12. This is new, I believe, since the last time we met with you. We got a Commission Staff Requirements Memorandum. We had three -- actually, four actions. The first action was to provide a Commission paper in 18 months on

Recommendation 1. The second action was to provide in five -- I think it was five days the charter for the path forward in studying the Task Force recommendations. That Commission paper is up at the Commission. We don't have a direction on that yet. Second was to prepare -- or third was to prepare a 21-day vote paper on those actions that should be initiated without delay. And I apologize for being a bit late, but we were working on that paper and I lost track of time this morning, so that paper goes up tomorrow and will be available. And then the --

MEMBER SHACK: This is a preview. Are they different from the recommendations you discussed last week?

MR. GROBE: It's a subset, and there are some differences. And this is the -- the Task Force was set up in a odd way, to be quite frank. It was set up differently than task forces in the past, where it reported directly to the Commission. And the Commission decided to put us back in process, and have the Task Force recommendations report to a higher level body within the Staff to make decisions on how the Staff should proceed in recommendations to the Commission in those areas of policy. So, the group of folks which is our Office Directors, essentially, and

Regional Administrators have made some decisions on what should be initiated without delay. And the way in which some of these recommendations are being handled is different than what the Task Force recommended. And that's assuming that the paper doesn't change a whole lot in the next 24 hours, which is always possible.

The 45-day paper is really the compendium. It addresses what's in the 21-day paper, but it also addresses all the other recommendations and contemplates things beyond the recommendations with the exception, of course, of Recommendation 1. And it is intended to provide some structure on prioritization, and resources, and things like that.

It will not be sufficient -- there will not be sufficient time to provide a tremendous amount of clarity, but there will be a framework for prioritization and resources, and will address the recommendations that are not addressed in the 21-day paper.

CHAIRMAN ABDEL-KHALIK: We were tasked with the evaluation of this 45-day prioritization report, and we hope and expect that you will come back and brief us after that report is prepared so that we will be able to prepare our evaluation of such prioritization.

MR. GROBE: Let me just -- it will likely not be us.

MEMBER CORRADINI: Who's the lead on that? That's maybe what --

MR. GROBE: That's what I was just going to say. Let me tell you a little bit about the structure that we've set up and recommended to the Commission, and we're expecting an SRM from the Commission that will either approve that or give us different direction.

But, essentially, all of the major program office directors and the regional administrators sit on a body that is going to provide oversight. And in the Commission paper it's contemplated in the context of a Steering Committee. It's chaired by Marty Virgilio, the Deputy Executive Director for Reactors.

That Steering Committee is advised by a number of groups, and it's supported by a staff. That staff is led by Dave Skeen. They're not expected to do all the work of implementing the recommendations, but they're expected to run air traffic control, and Amy is currently on that team. It's a team of what, about six or eight folks, something of that nature.

So, Dave Skeen is a key individual in

this. Marty has clearly articulated his expectation that NRR will be the lead implementing organization and coordinating organization. For that reason, Dave is currently reporting to Eric Leeds, and Eric will have a very strong role in this going forward. So, the presentation on the 45-day paper will likely involve Dave, or Eric, or others once that paper goes forward.

CHAIRMAN ABDEL-KHALIK: Thank you. Are there any questions for --

VICE CHAIRMAN ARMIJO: Yes, I have one. Going back to Recommendation 7, other than being a distraction to the operators during Fukushima, the spent fuel pools turned out not to have been the source of significant radiation release, if any. And the earlier assessments during the accident or during the events were that they were in serious trouble, and it turned out not to be the case. So, I was just wondering why -- some of the recommendations you make about improving makeup capability and instrumentation, those are all good things to do, but you're proposing orders which seems like a very heavy regulatory hammer for something that was not, in fact, a safe -- you might even argue that it demonstrated the ability of the old pool designs to protect health and safety. So, I'm just wondering why there was, in your view, a need for an order for this issue.

MR. GROBE: Yes, let me talk a little bit about the spent fuel pools, and then talk about our regulatory structure a little bit, and you guys can help.

The spent fuel pools in Japan at Fukushima Dai-Ichi contained between 150 and 500 assemblies, something like that. They have a seventh spent fuel pool in a different building that's separate, and they move fuel from the spent fuel pools that are in the reactor -- associated with each reactor to this other spent fuel pool. So, that's very different from an operational perspective than the way we do things here in the United States.

Our spent fuel pools contain anywhere from 2,000 to 5,000 assemblies. And, of course, the heat load is much more than that during a refueling outage. So, from a certain perspective the spent fuel pools were in a much different condition in Japan than our's are here in the United States, as far as heat load.

But specific on regulatory structures, we have four clear opportunities on how tools to collect information, and we have two tools to require licensees to do things. Our tools to collect information are a NAM for information, a 50.54(f) letter, a bulletin, and a Generic Letter. And they have different purposes, but they were all sired from the same law, okay? So, that the underpinning legal structure is the same for all four of those tools.

Those tools cannot impose requirements, they can only ask for information. The only two ways that we can establish requirements -- I guess there's three ways that requirements can be established. A licensee can request that a requirement be imposed on them through licensing, and we typically call those license amendments. But the only way that we can impose requirements on licensees is either through an order, or through a rulemaking.

The rulemakings take at best -- the best we've done with any rulemaking is 23 months, and typically it takes substantially longer than that because of the administrative procedures that are necessary to engage people, and make sure that you're doing it properly, develop the guidance so everybody understands the regulation. And then the implementation of the rule takes years after that, especially if it involves modifications.

So, the intention of the Task Force was to establish regulations. It's clear from the Task Force study of this that voluntary initiatives have mixed outcomes. There was a -- we have a number of little stories, but one of them was you can only expect what you inspect, and we only inspect what is required. And we found that with the SAMGs, there was a spectrum of behaviors among the licensees, and those were voluntary.

So, the Task Force concluded that these things should be requirements, and the ones that are orders it's not that they're imminent threats, it's just that those -- that's our only tool to establish a requirement in the near-term.

VICE CHAIRMAN ARMIJO: Okay, thank you.

CHAIRMAN ABDEL-KHALIK: Thank you. At this time, I'd like to call on Mr. Adrian Heymer from the Nuclear Energy Institute to make some remarks. We have received a copy of written remarks made by NEI, which were actually provided to the Staff after the August 31st meeting. They're dated September 2nd, so everyone has seen these remarks. Mr. Heymer.

MR. HEYMER: Thank you, Mr. Chairman. My name is Adrian Heymer. I'm the Program Manager for the Regulatory Response to the events at Fukushima from the U.S. perspective, and I appreciate having the opportunity to chat with you today.

What I'm really going to cover is a little bit of -- repeat a little bit of what we covered on the August 31st meeting, and open it up for questions. And I think most of you are aware that since the Fukushima events started to unfold on March 11th, the industry mobilized and has been engaged in that activity.

By Sunday, the 13th we had a team in Tokyo, and a team has been in Tokyo since, and has been subsequently reinforced, and has been working and is now embedded in the Tokyo Electric Power Company's offices to really, one, to provide advice and assistance and support during the event as it was needed, and as requested. And, two, to feed back information back to Atlanta to the Institute of Nuclear Power Operations so that we could better understand what was going on, what caused the events, why they made the decisions they made.

And really since about the second week or first week of April, we've had a team trying to reconstruct the events as they happened, trying to put together a time line to make sure that we take the correct action so we don't go down any cul de sacs as regards our activities.

That team has concluded its activities, but we have a lot of questions and open issues even though we got the team embedded with TEPCO in Tokyo. And they're going over next week to discuss the open issues, and the questions that we have to try and find out more about the basis and the rationale of what occurred, what was the design basis, how they reached that conclusion on the design basis.

So, I think that one of the messages we don't really know everything that went on. We've got a good idea. We have been surprised, and why we need to move forward. And we can take -- and we agree with a number of the Near-Term Task Force recommendations that we need to move ahead, and we can in some instances. In others, I think if we just food for thought until we get the answers, and then a better position to actually take action, it'll be more beneficial, and more efficient and effective use of our resources.

Therefore, we propose that at some stage, probably once the team gets back and has finalized its report, incorporating the insights from Japan, that we sit down with the NRC Staff and go over what we see as the time line to make sure that there is a common understanding of what occurred so that we can go forward with improving and enhancing the safety margins for our facilities.

The other item, and it's been discussed here today, is the need for flexibility. We do have 104 designs, different technologies, BWRs, PWRs, different AEs, different geographic locations, different credible risks that are posed for the facilities. In some cases it may be a sandstorm, in other cases it may be a flood, but it may not be that the facility that's subject to a sandstorm might not be subjected to a flood. So, I think we need some flexibility going forward, and a risk-informed performance-based approach would really sort of begin to achieve that end.

We've made our comment in the letter, and you've seen a copy of that, about why there's a certain amount of uncertainty out there. We've done a very high-level qualitative risk assessment of the Task Force's recommendations to try to determine okay, where is the biggest benefit both in terms of protection, mitigation, and consequence. And by and large, although in some areas there could be what we call a moderate impact from a mitigation perspective, in most of the other areas, especially in the consequence areas it's small or negligible.

So, why orders? And I think orders to us, especially bold orders, and the criteria that are --

you have to develop to impose that order, from our state of knowledge at the moment, it was a little bit of a surprise, especially when there are other vehicles that perhaps we can move forward with, and have been successful in the past.

On the re-evaluation of the design basis, seismic we believe -- we made a good start with GI 199, and we think that kind of gets us there. But really what we need is not to wait, as we saw it, or the way we read the report, and I thank Jack and his team there for giving some clarification, to wait 10 years before we take action.

We believe that if you identify -- if something is identified to you, there's new information that comes along, and it could impact, you need to assess that as regards its significance. We do that today, we should continue to do that, and we shouldn't wait 10 years to have a periodic update. It should be on an ongoing basis just as we do today, so we're not quite sure why we would want to go down that path.

On extended loss of AC power, we made our point about well, what's the rationale behind 72 hours, but we agree that we need to take some action in that regard. But it's not as easy as it may appear at first glance. And one of the things that we're beginning to recognize, and we have task forces set up in most of these areas -- and I would say that we agree with the subjects, perhaps the vehicle and how far we're going at this point in time is probably where we've got a slight variance.

But as regards extended loss of AC power, as we call it, the operator has to start making the decision in the first hour, especially as regards if he's in this condition because he wants to make sure the batteries are going to last as long as possible, so we've begun to look at what would it take to get us to eight hours, in fact, what would it take to get us to 24 hours, because we agree with the Near-Term Task Force that the operators really need to focus on stabilizing the reactor. And if we can increase that focus by not having to worry about certain other areas, that is beneficial.

I think as regards new plants, we were a little surprised to see the fact that you have to go beyond 72 hours, and we were wondering why an additional requirement was being imposed on new plants. And the fact that it appeared to us from reading the report that ITAAC is being used to impose new requirements, and we don't think that's the right vehicle.

There are advances on new plants, I think you recognize that in the Task Force report, and so what we believe is that new plant designs and activities should be evaluated on a case-by-case basis because you have much improved designs both from the passive perspective, and from the designs like the AREVA EPR and the Mitsubishi APWR, that have bunkered systems and better protection.

On venting, I'm not sure from our evaluations and the evaluations at INPO we really know what was the rationale. We know they had problems. Why they had problems and what worked and what didn't work, and what was the path of hydrogen, we just don't know. So, I think at this stage we would agree that you can go -- we should go forward and say okay, can we access the valves, can we operate the valves given a loss of AC condition. But to go much further at this point, we don't think we should go down that path until we have more information. And hopefully by the end of the year, we will have that information, and we can go forward with those discussions.

On the spent fuel pool, I mean, that's an area where we thought we knew what had happened. And now we know it's a -- we were wrong. There were a lot of people, including many in the industry, that believed there had been a spent fuel pool accident. And, in fact, from the sampling and the visual inspections that have occurred in this last month, we now know that that doesn't appear to be the case.

So, I think we do have time. We do agree that we should be able to monitor the fuel pool and the condition of the fuel pool. And that's something that we need to move forward with, and the industry is beginning to look at that hard. But we don't really understand why it has to be safety-related.

And if you look at what happened at Fukushima, we do have time, even though I agree with the Task Force, that our reports are higher fuel inventory than what we have in Japan, but we still have time. And we've taken some action as regards making sure that the operators are aware of time to reach 200 degrees Fahrenheit in the pool as a sort of improvement and enhancement. But we don't really understand why the power supplies have to be safety-related, because if they'd been safety-related in Japan, you'd have been in the same position. So, I think based on that aspect, we certainly can move forward with monitoring.

On EOPs and SAMGs, a lot of discussion you had here this morning, and I think, Dan Dorman, I think you got it right where we're coming from. It's not the fact that we want to take the decision making necessarily away from the operators, but once you get out there into extremely low probability events, don't expect the operators to have the same degree of knowledge that they do for the more likely events, such as the EOPs, abnormal operating, and normal operations.

So, I think there is need for training, additional training, especially on the emergency response organization. But what confused us a little bit is when we started talking about Tech Specs, and operator exams. And if you're going to start quizzing operators as regards severe accident management guidelines to the same details as you're quizzing the operator about abnormal operations, or EOPs, that's expecting a lot, and I think you're going to dilute the capability of the operational response.

On EP, basically, our -- because I'm running out of time, our message here on EP is let's implement the new rule that's being put in place that is an improvement, does implement certain enhancements, and at the same time let's begin to move forward in parallel with some of the recommendations that have been made as regards EP.

As regards multi-unit staffing, we don't think we can deal with multi-unit staffing and develop the scenarios and the criteria in the time frame that would enable us to be able to implement the rule that's about to be introduced in the time frame that's being suggested for that element. So, we may have to have an extension if that -- if we want to make it part of the new rule.

If that is a require -- we think most of the recommendations can be implemented through guidance, but if there is a need for rulemaking, we can deal with that at a later date.

That's fundamentally the 10-minute --

CHAIRMAN ABDEL-KHALIK: Thank you, Mr. Heymer. Are there any questions for Mr. Heymer?

MEMBER POWERS: Yes, I'd like to just ask him one question, maybe broader, as well.

In the area of hydrogen control in the reactor building when we did the hydrogen rule, we presumed that by inerting the drywells that we got out of the hydrogen problems. And Fukushima demonstrated that's not the case. And we don't have what I'd say definitive evidence of why the hydrogen got into the building, but people have been relatively imaginative in coming up with pathways which hydrogen -- and I'm wondering is not that proliferation of imaginative methods by which hydrogen could get in there enough to tell us that we need to do something about hydrogen mitigation in the reactor building?

MR. HEYMER: I think from our perspective once we've determined, or at least got a better idea of what was the path of hydrogen getting into the reactor building, I think as a long-term evaluation we should then take a look at hydrogen to address some of the thoughts that you began to introduce, Dr. Powers, as regards hydrogen and where it comes from. But I think central to that is how did the hydrogen get to where it got to to cause the explosion.

MEMBER POWERS: What I'm arguing is that they're going to need to know exactly the path, because the next accident that comes along will undoubtedly take a different path. And people have come up with gee, at various points I think I had 20 paths listed down. And presumably they'll have some probability of occurring, maybe not at Fukushima, but at some other accident.

Isn't that enough to tell us well, inerting can do it, and we should do for the reactor buildings in ones and twos the same thing we've done for reactor buildings in threes.

MR. HEYMER: I think that's something that the evaluation will take a look at, and assess as we go forward. I mean, that's something you can't ignore.

MEMBER BANERJEE: I think Dana's point that the path will be specific perhaps to Fukushima, and the next time around it will be something else, and the next time around will be something else. We know that hydrogen is a problem, whether it was in Three Mile Island or Fukushima, and we should take care of it.

MEMBER POWERS: Not only do we have a hydrogen -- we've got hydrogen detonations. And detonations are just extraordinarily hard to get. I mean, even when you do them in an experiment, you have a tough time doing a detonation because of the ignition problem. And we got them, and it just strikes me that gee, how much information do I need to know about specifically Fukushima. I got hydrogen. I see lots of ways of getting hydrogen. Go take care of it. We did it for Mark IIIs, why can't we do the same things for ones and twos. It's obvious that inerting is just not enough.

CHAIRMAN ABDEL-KHALIK: Dennis?

MEMBER BLEY: Yes, I wanted to ask you a

question about the SAMGs. First, we did talk to INPO about the same thing, and as part of your answer I'd like you to discuss a little bit about the relationship between NEI and INPO, and how you're moving forward.

But what's your view of the fact that when NRC asked people to look at the SAMGs, that from my reading of the list, I think there were only about two plants that didn't have some kind of deficiency when they reported back. Can you tell us a bit about what you guys think about that, and how fast we're heading to deal with those issues?

MR. HEYMER: Well, I think not only are you aware when we identified those issues, that was a surprise, and it's surprises like that that we can do without. And we're fixing them. The majority of those issues have been sorted out and fixed, but it's quite clear that we need to do more on training. And I think that's an awareness, and that's something that we need to work on. And INPO has taken that item and as regards the -- to see what we can do better about implementing a training program to make sure that operators and especially emergency response organization personnel are better prepared and more aware of what's in the SAMGs, and to make sure that we keep the SAMGs current, they don't just become dust collectors.

MEMBER BLEY: Is there concern in the industry about the things we had heard from the Task Force last time we met with them about the kind of mixed messages they picked up, and I think others of us have picked up about how various plants are dealing with the Command and Control issue should you have to actually start trying to use the SAMGs?

MR. HEYMER: I think Command and Control, the SAMGs, and that whole area is something that we put the procedures and the necessary controls in place. Some people are focused on it more than others, and we just need to raise that level within the industry up to where those -- I wouldn't say it was one or two, I'd say it's more than one or two have got a good handle on it, but we just need to raise that level of implementation and awareness up.

MEMBER BLEY: Is there guidance on this issue?

MR. HEYMER: There will be -- it will be developed.

MEMBER BLEY: Okay.

MR. HEYMER: I mean, we're working -- INPO is working on that. They identified it, and the Chief

Nuclear Officers were made very much aware of this is an area that we need to focus on. So, it's being addressed. It's in the Corrective Action programs, and we need to go down to make sure that we don't get surprises like that going forward.

MEMBER BLEY: Thanks, Adrian.

CHAIRMAN ABDEL-KHALIK: Thank you. We are 10 minutes behind schedule, so thank you very much for a very informative presentation.

MEMBER CORRADINI: Don't we have somebody on the lines?

CHAIRMAN ABDEL-KHALIK: No, we don't. So, at this time we will take a break for 15 minutes, and we will reconvene at five minutes to 11:00 for the next item on the agenda.

(Whereupon, the proceedings went off the record at 10:39:15 a.m., and went back on the record at 10:52:47 a.m.)

CHAIRMAN ABDEL-KHALIK: We're back in session. At this time we will move to the next item on the agenda, "Technical Basis and Rulemaking Language Associated with Low-Level Waste Disposal and Site-Specific Analysis." And Dr. Ryan will lead us through that discussion.

MEMBER RYAN: Thank you, Mr. Chairman.

Good morning to participants. I will quickly turn over the meeting to Deborah Jackson, who will make some introductory remarks. And then we will have the more technical briefings and have questions and answers from there.

So, without further ado, Deborah Jackson from FSME.

MS. JACKSON: Thank you, Mike. Good morning, members. We are here today to give you an update on the work with Part 61.

And why we are here today is were are following Commission direction. And what we were doing is proposing rulemaking limited to site-specific analysis, identifying the technical requirements of the analysis, and developing guidance outlining key parameters of assumptions. And this approach continues to protect public health and safety. It's risk-informed, performance-based. And it also provides flexibility to licensees and corporate site-specific information.

We're going to have two presenters from staff today: first, David Esh. And he will be providing a discussion on the "Guidance for Conducting Site-Specific Analyses for Part 61." And Andy Carrera will wrap up the staff presentation. And he will do an analysis of the comments received on the preliminary rule language.

So, with that, I will turn it over to David.

MR. ESH: Thank you.

It is my pleasure to be here again to talk about Part 61 and what we are doing in the rulemaking.

Next slide, please. Just to refresh your memory, I will go over what our direction was from the Commission. The direction from the Commission was that we were supposed to perform a limited rulemaking to add site-specific analyses prior to the disposal of significant quantities of depleted uranium and blended waste. And as part of that, we were supposed to identify the technical requirements that would apply to the site-specific analyses and develop a guidance document that outlines the parameters, assumptions, and those sorts of things in conducting such site-specific analyses.

The requirements I feel that we have developed are appropriate for this limited-scope rulemaking. And the bottom line to me is that they have to be able to distinguish between an action that is appropriate and an action that is inappropriate. Hopefully I'll try to convince you of that as we go along.

We weren't tasked with modifying the framework for Part 61 in this activity. That is a future activity that we could consider changing the framework. So questions about framework, we're welcome to take them, but we feel we are on pretty strong ground with not modifying the framework in this limited-scope rulemaking because the Commission did express a desire that it gets done relatively quickly; that is, relatively quickly in government terms.

So this rulemaking -- next slide, please -- what we do is we require site-specific analyses to demonstrate compliance with the Subpart C performance objectives. We identify the technical requirements for the analyses. So basically I would describe it as we have definitions of what those analyses are.

And then the two main requirements that we have changed as part of this rulemaking are the addition of the period of performance and the Intruder dose criterion.

At a higher level, the only main thing that we have changed is adding in the requirement for an intruder dose assessment to meet the 61.42 61.42 performance objective.

As part of this activity, we have

developed a guidance document -- we have briefed the Subcommittee on that at a previous meeting -- that we feel is risk-informed and performance-based. And it outlines the key parameters and assumptions in doing these sorts of evaluations.

The overall rulemaking effort, we believe, continues to protect public health and safety while providing flexibility to licensees.

VICE CHAIRMAN ARMIJO: David, just to make sure that I have it right, the Subpart C performance objectives, are they changed or not with the limited --

MR. ESH: There are four performance objectives, 61.41 through 44. 61.41 is basically protection of a member of the public. And that we have not changed. The only change to it is adding in the period of performance, which we -- it was expressed to us by stakeholders in various interactions that they wanted it in the rulemaking. They couldn't agree on a number, but they wanted it in the rulemaking.

The 61.42 performance objective is not a new objective, but the component added to it that is new is the intruder dose assessment. So the existing performance objective requires that you meet the waste classification and segregation requirements, which is done through tables in 61.55 in the regulation for radioisotopes that are listed in the tables.

What we did in this rulemaking for isotopes that are not listed in the tables, the options previously presented to the Commission were to revise the tables and add in the new isotopes, to take the approach we did with a site-specific analysis requirement to change the whole waste classification system, which is kind of what is being proposed or what is being discussed in the comprehensive rulemaking context or do nothing. I think those are the four main alternatives. And the Commission directed us to take the action that we are taking in this limited-scope rulemaking.

VICE CHAIRMAN ARMIJO: Okay. The period of performance and the intruder dose assessment are major changes --

MR. ESH: Yes.

VICE CHAIRMAN ARMIJO: -- in the performance objectives?

MR. ESH: Yes. The performance objectives have not been changed, but 61.41 has been. We have changed the -- it didn't use the performance assessment terminology before, but, in essence, it was a performance assessment. Performance assessment terminology I would say developed after the early '80s, when the regulation was developed.

What we did was modernize the terminology, but in the 61.42 performance objective, we're adding in the requirement to do the intruder dose assessment. So that's the new part of it. And then a period of performance is applied to both of those. So that is also in there.

MEMBER RYAN: That's a big change. That's changed from 10,000 to 20,000 units.

MR. ESH: Well, the existing regulation has not value for a period of performance. It's silent. The regulation is silent on what the period of performance is. And this created a lot of variance in our agreement state programs.

MEMBER RYAN: The guidance was now --

MR. ESH: The guidance was we had NUREG-1573 --

MEMBER RYAN: Right.

MR. ESH: -- guidance, which recommended 10,000 units.

MEMBER RYAN: Right.

MR. ESH: But there's no value in the regulation. And our agreement states did not necessarily all follow the guidance. They did what they wanted to in their agreement state programs.

VICE CHAIRMAN ARMIJO: But prior to these amendments, there was no requirement for an intruder dose assessment.

MR. ESH: Prior to these requirements, there was no requirement, there was no explicit requirement, for an intruder dose assessment. But the NRC basically did an intruder dose assessment in developing the 61.55 waste classification tables.

So there's one implicit in the regulation but not explicit. And what we did is we added an explicit requirement for that for isotopes that aren't in the table, basically to apply the same analyses to the isotopes that aren't in the tables as the analyses that was applied to develop the tables.

Next slide, please. So what we didn't do in this rulemaking effort, we haven't done, is update the waste classification tables. That was an option presented to the Commission. And they said not to do that. We also are not comprehensively revising the framework.

So we have had lots of questions about the framework, both from the ACRS and our various other stakeholders, on things like the performance objectives. You know, does it make sense to do an intruder assessment? What should be the institutional control period, things of that nature? And we felt in this limited-scope rulemaking, we shouldn't be revising the framework. It is certainly things that we could consider in a comprehensive effort.

And the Commission directed us to propose resources to do such an effort. Of course, those resources also have to be allocated after we proposed the resources.

So we didn't do things like remove the protection of the inadvertent intruder performance objective. But what we have done, I believe is provided some flexibility for how people can meet these requirements to allow some bringing in the site-specific nature of the problem that you're dealing with here.

So next slide, please. The proposed amendments for the site-specific analysis, as I already went over the first couple, we have a performance assessment to demonstrate compliance with protection of the general population in 61.41. I would maintain that this is not a new requirement. We have just changed the terminology. It was previously called technical analyses, I believe.

Under 61.42, as already noted, we add the requirement for an intruder dose assessment, in addition to the waste classification and segregation requirements.

MEMBER RYAN: A couple of points on that one. I think it's important for the Committee to recognize that the probability of intrusion is one and the period of performance is doubled from 10 to 20 thousand units. Those are two key facts that you need to understand.

MR. ESH: Yes. I know we have some maybe difference of opinion about the probability of intrusion because I would maintain that the intruder dose assessment, as I'll talk about in a few slides here, we're recommending a dose limit of 500 millirem for that evaluation.

The dose limit that is used under 61.41 is 25 millirem. So there's an implication in the numbers -- and the Commission stated this in both the draft EIS and the EIS, but the intruder part of the problem is unlikely, viewed as unlikely, albeit possible. So that's the justification or part of the justification for applying a higher dose limit for the intruder evaluation.

If you thought the intruder evaluation was probability one, you wouldn't really have much of an argument to choose a dose limit other than the 25 that you apply to 61.41 because why if you're drawing an imaginary line on the ground as to where the facility footprint is do you say one dose limit applies on one side of the footprint and one dose limit applies on the other side of the footprint?

Sure. Go ahead.

MEMBER STETKAR: You used the term "unlikely but probable" or something like that.

MR. ESH: "Albeit possible" is the language the Commission.

MEMBER STETKAR: "Albeit possible." If I do the math, that says there's a five percent probability, which we can argue about what is likely, but --

MR. ESH: Yes.

MEMBER STETKAR: -- it's not a 1 in 1,000 --

MR. ESH: Yes.

MEMBER STETKAR: -- possibility that we might get an intruder residing on that site for its --

MEMBER RYAN: And you could take another view to say that if you have a continue of 12 feet in diameter in the 400-acre site, you probably are hitting it at 3 times $10^{-6}$.

MR. ESH: Yes. And I hope for our talk we'll whenever we get to the guidance in a few slides here give you a better flavor for how we're recommending people develop the scenarios and the analysis, but this issue of what is the probability of that scenario and is it even reasonable to consider, right now it's very subjective.

We're trying to do some things to make it a little more objective. So there's a member in my group that's an expert in GIS. And I have him working on a project to look at disturbance maps over the country, both with space and time, and use that to try to estimate in the recent historic past, at least multiple decades. What sort of disturbance do you expect over different types of areas and into different depths? That isn't developed yet.

MEMBER RYAN: Would that be focused on licensed facilities?

MR. ESH: Well, the issue is then how durable are the additional protections that you put in for a licensed facility to prevent that sort of disturbance from occurring. So the one point you can get at easily is what is the disturbance that you observed due to development, socioeconomic activity, and everything? But the part that is much more difficult to get at is how durable are those additional controls that you put on to try to prevent those activities?

And the Commission does put controls on, as you are well-aware: institutional controls, state and government land ownership. There's a whole bunch of defense-in-depth-type things they put in place to try to prevent somebody from using the site in the future.

But they say over these long time frames that you're dealing with, durability of records, government error, those sorts of things, it's not a completely unforeseeable event that somebody could use a site, but it is probably unlikely. How unlikely? I don't really know.

MEMBER RYAN: I'm sure there's a range there, but if you look at the low-level waste sites, the radioactive material waste sites that are around, that's probably the ground you want to plow first.

MR. ESH: Yes.

MEMBER RYAN: I mean, for example, a case I know fairly well is Barnwell. And right now they're in a position where their financial resources, the interest on them is more than what they use annually to maintain the site. So it's hard to envision where they will run into a lack of ability to keep track of that for --

MR. ESH: I think that's a very good point. I think the problem becomes very difficult over long term. You get into situations like -- and this happens with monitoring of these types of facilities over long periods of time. As you monitor in the near -- in the present future after you have taken your action, if you did a good design and implemented a good design, and put it in place in the right way, you're probably not going to see anything in your monitoring program.

So, after so many years of monitoring zero so people will have the tendency to say, "Well, why am I monitoring this anymore? I'm not seeing anything out of the facility," but because of the degradation and changes to the facility over time, it's exactly as you go out in time where you might expect to start seeing something.

See, you have these complicated structures of the problem that will influence what people do with those resources that they allocate to control the site. So at some point, somebody in the realm that has some ability to do something with those funds may say, "I am going to more productively use those funds for something else."

MEMBER RYAN: That is always a risk. But I think the other part of it is, even over a long time, like a legislative period of a 100-year performance interval that has to be funded, you not only get into the monitoring, you're into maintenance. So maintenance activities I think feed the monitoring with good results. So I don't think it's a simple, you know, a given that over time people will want to take the money and do something else and present it at the waste site.

MR. ESH: I don't think it's a given either. I think it's one of the things that you could expect may occur.

MEMBER RYAN: My experience would lead me to think it's much less likely than not that they would continue on.

MR. ESH: Yes. We don't have -- because we don't have a lot of knowledge of actions that have been taken in terms of, say, people trying to dispose or isolate material -- you know, the U.S. is only about 250 years old. So you don't have a lot of information on people taking actions to try to dispose of materials and then what happens as you go forward in terms of controlling those locations and land use of those locations over time.

I don't claim to know the answer on it. All I can do is explain the logic behind the existing regulation and why that framework is in place.

VICE CHAIRMAN ARMIJO: David, just a little bit. Where did the 500 millirem come from? Was that arbitrary or --

MR. ESH: No. The 500 millirem when it was initially selected was consistent with 10 CFR Part 20 at the time. So basically they were taking this concept that the intruder was unlikely, but they also wanted to be consistent with an existing other requirement.

Of course, 10 CFR Part 20 is now 100 millirem. And we have had comments on that by stakeholders. They said, "Well, you should make it 100." We were recommending 500 because then the numbers that you're generating in the intruder dose assessment are consistent with the 500 millirem that was used to develop the 61.55 table values.

So we had to choose one way or the other. We chose to go that way.

VICE CHAIRMAN ARMIJO: A number that you used to develop the table?

MR. ESH: Yes, the same number that we used to develop the tables.

MEMBER RYAN: I think it is important to recognize that that number is -- and I don't mean this as a criticism of what you did, but it's kind of arbitrary in terms of risk. A hundred millirem, 200 millirem, 500 millirem, it's not a big variation. We can pick them --

MR. ESH: That's part of like if I think you're going to go -- my belief is you should consider some sort of tiered performance period and dose limits to handle this type of problem and the uncertainties, but if you're constrained by only considering, say, 25 millirem and 100 millirem for very long times, then what is the point of that? They aren't materially different in my mind for these types of problems and the uncertainties you are talking about.

MEMBER RYAN: That's right. Well-said, yes.

MR. ESH: Yes. And so I agree with you there.

Next slide, please. I'm sorry. Go back a second. I didn't get to the third bullet here, "Long-term analyses." That is a new requirement. And it's not -- as far as to the post-20,000 years period.

And it's to show how your facility and site have been engineered or will perform to try to limit those long-term impacts, but we aren't proposing at this time a dose limit associated with those long-term impacts.

And that we feel is consistent with a lot of what you'll see in international programs, where they recognize the uncertainties and they say, "Okay. It may not make as much sense or it may not make sense to say what a radiological impact is over those very long times." You should be able to from an engineering and scientific sense show how your facility is limiting fluxes and concentrations and those sorts of things over long periods of time.

MEMBER RYAN: To me, that can -- correct me if I am wrong. I am just trying to get the other members some examples. That's kind of the exact one. It's probably not good to put it in a river delta that is migrating toward you --

MR. ESH: Yes.

MEMBER RYAN: -- and those kinds of things, where over those sorts of time horizons, intrusion by natural processes into the disposal site is more likely than not or has -- you know, it looks like things are coming your way, for example. That would be one thing you want to avoid.

MR. ESH: The other thing I would add is that the long-term analyses only applies to when you have significant amounts of long-lived waste. It doesn't apply to all waste in all facilities. So it's only in analyses that if you say, "I have long-lived waste," okay. Show me how your facility and your site are going to act to try to reduce the fluxes and concentrations that you may have associated with that long-lived waste.

MEMBER RYAN: The old question, of course, is what is a significant amount.

MR. ESH: Yes. Well, I mean, I'll show you --

MEMBER RYAN: Okay.

MR. ESH: -- maybe some examples or at least I'll talk a little bit about it.

So let's go on to the next slide, please. So in the proposed technical requirements, we have performance assessment, which identifies the features, events, and processes which comprise your evaluation. The features, events, and processes are those components that determine that scope of your evaluation and you look at the effects of the features, events, and processes on the performance of the disposal system.

The performance assessment estimates the annual total effective dose equivalent, TEDE, to any member of the public considering uncertainties, caused by the FEPs that you include in your assessment.

And then associated with the performance assessment we have a two-tiered period of performance. The first tier is to estimate the peak annual dose that occurs within 20,000 years. So basically if you have a facility to add short-lived waste, you can show when the peak occurs, make some argument that you have captured the peak, and that's what you need to do to meet the requirement.

As I already noted on the previous slide, we have a requirement for the post-20,000 years to show us how the facility and the site are working to limit the risk from your long-lived waste.

VICE CHAIRMAN ARMIJO: How can you claim any credibility for something that 20,000 years into the future? I mean, who would believe it? Material degradation, environment changes. You know, I'm just having a real hard time understanding what we gain from regulating so far into the future when we can't really demonstrate in any credible way, at least in my opinion.

MR. ESH: Well, there are strong and diverse opinions about the credibility of those analyses over those time frames. And in some cases, I believe we -- in this sort of process, we aren't necessarily capturing all of the uncertainties that you're dealing with, especially in the societal and technology components.

So how do societies and technologies change over time? And how would that affect your decision? But if you are trying to take a disposal action, the approach that's taken, both that we're recommending here and that's done internationally, is to limit your speculation about the human component and try to address the components that you think you have a better handle on the engineered natural site behavior components.

But I believe there are large uncertainties. But the ability to reduce -- some of the uncertainties are going to certainly be epistemic that are reducible. Some are going to be aleatoric and basically unreducible.

How much of each you have is a subject of debate. And what we generally see is if you have a performance assessment and you were talking about a very long time and you're right around 25 millirem, you probably have a difficult road ahead of you in terms of convincing the decision-makers that you have met the criteria.

The uncertainties are generally large that don't allow for that sort of precision at those time frames. But it is very possible to generate calculations of those performance estimates. And in our process, what is generally lacking and what we pushed on strongly is you have to develop support for your calculations.

So this problem is a little bit different but not altogether different than some engineering problems where you're trying to estimate, say -- I'm on rotation right now through a group at research, where we're looking at piping failure and they're trying to estimate the probability of rupture or leak before break and rupture.

And basically they don't have the ability to validate those calculations in the true sense because they don't have a lot of observations of ruptures.

In this problem, we won't have observations of doses to some future population at 20,000 years. But we do still require model support to have confidence in that you generated -- you have done calculations that are reasonable estimates of if I brought some independent scientific and technical people into the room, they could sit down and go through the calculations and come to a similar opinion and that the essence of model support is you take all means necessary to develop the support for those types of calculations.

It may involve experiments, lab experiments, field experiments, natural analogs, independent expert elicitation. There is a multifaceted approach to developing support for your calculations.

I don't necessarily disagree with you about the uncertainties at these long times, but I don't know how else you manage the problem. And the approach that we're recommending is consistent with what's done out there in this community.

MEMBER RYAN: The way you describe it, though, David, that hump of -- you know, it's 25 millirem. Let's pick the number as the standard. The uncertainties are such that you can't get over the hurdle again. Why do you make a decision?

MR. ESH: Well, the issue is one of -- remember, low-level waste is the first step in the waste management food chain. And one very straightforward way to mitigate your uncertainties is to modify the inventory that you take.

So if you want to dispose of large quantities of long-lived waste and you do your assessment and you say, "I have these vast uncertainties" and I can't say what the risk is, then maybe you should limit the inventory of those components so --

MEMBER RYAN: Well, let's pick on -- the one that stands out is at $10^9$ year half-life radionuclide. And in the one case, we're concerned about low-level waste, as we discussed very well in the context of what you said.

On the other hand, we take, you know, milltailings and put it on the top of the ground, put a little topsoil on it and grow grass on the top of it.

MR. ESH: And I would say it's not the same thing. They're materially different because the milltailings are at about .2 weight percent uranium. And the depleted uranium, if you take a lot of it and dispose of it in a facility, you're talking about 80 weight percent uranium.

MEMBER RYAN: The inventory is much higher in the tailings.

MR. ESH: The inventory may be higher, but --

MEMBER RYAN: It's the fraction released from the inventory that gets to the dose.

MR. ESH: It's not just the fractional inventory in totality. It's a combination of concentration and quantity. So in the case of depleted uranium, you have large quantities in very high concentrations.

If the concentration is 500 times higher than the milltailings, -- and milltailing facilities are big, but they aren't. Some of them are massively larger than what you have for --

MEMBER RYAN: Just to pick on DU for a minute, if we have depleted uranium, which is a concentrated form of uranium, 238 mainly, and I have it in a steel container or a stainless steel container and it's buried 30, 40, 50 feet deep, the probability of getting to it is a whole heck of a lot less. It's clear the magnitude would have an explosion for the near term.

So it's not just concentration. It's probability of being treated in a way that puts whatever scenario you want. There hasn't been enough contact to create a dose of concern.

MR. ESH: The problem with depleted uranium or concentrated uranium, in particular, is it can get you in two ways. It can get you in the water pathways. And it can get you in the air pathway.

So if you don't dispose of it deeply, as the radon builds in over time, you end up with a lot of radon, even just in the atmosphere. It doesn't have to reply to the house being built above a disposal facility. You get a lot in the atmosphere.

You also depending on the geochemical conditions of your site can end up with significant amounts of uranium in the water because it's a concentrated source of uranium.

We see that in some cases now with our milltailing facilities that you reference much lower concentrations of uranium, but they have issues with uranium in the water around those facilities.

MEMBER RYAN: It's actually buried on the surface with a little bit of topsoil. Of course, you would.

MR. ESH: Well, of course, but we have research also from Craig Benson at the University of Wisconsin that shows that the resistive engineering covers, which are typically employed at these types of facilities, they undergo pretty dramatic changes in their properties over relatively short periods of time compared to the characteristics of the material in the analysis period that you're talking about here.

So it's very difficult to keep Mother Nature at bay, especially in terms of her desire to move water through the system.

MEMBER RYAN: I think you made the point earlier unless you tend to that at the front end and have an institutional program and funding and intention to manage that, which you can do and it's being done successfully at several sites --

MR. ESH: Yes. So next slide, please.

MEMBER CORRADINI: I just had one itty-bitty little question. So you said the two pathways. In my memory -- maybe I have the wrong number, but isn't the 25 here somehow linked to what EPA has for groundwater drinking in terms of it's on that order of for other chemical releases or am I remembering incorrectly?

MR. ESH: I think you're remembering incorrectly. I mean, we are considering the impacts to groundwater pathway in developing that number --

MEMBER CORRADINI: Right.

MR. ESH: -- and to air pathways. But it's not related to EPA specifically. So I guess maybe you're remembering somewhat correctly.

MEMBER CORRADINI: That's okay. I don't get hurt easily.

MR. ESH: The concepts are there. We're trying to protect all the pathways that may be involved. We're not explicitly tied to any of the EPA requirements in doing so.

MEMBER RYAN: Okay. I'm not trying to match that number, but I think the methodologies have alignment in some ways.

MR. ESH: Yes.

MEMBER RYAN: You know, it's not a merit coming up with the same number in my view.

MEMBER CORRADINI: I was trying to get at Sam's original question. Why is it that line? My only memory is that EPA for groundwater drinking has certain requirements for chemical releases that were on the order of 10,000 years.

MR. ESH: It's partly that long. Well, it's partly that long for a couple of reasons. And I'll get into them in a slide here.

MEMBER CORRADINI: Okay. Fine.

MR. ESH: We can talk about them there.

VICE CHAIRMAN ARMIJO: I don't mean to hold you up because I think eventually you are going to talk about the public comment slides. And are you going to discuss the Department of Energy comments?

MR. ESH: Yes, yes, yes. We didn't circle back to that last time with MP 1 and 2.

VICE CHAIRMAN ARMIJO: Because, you know, I want to bring that up and get that on the record when the time comes.

MR. ESH: Sure. Next slide, please. So then we also have the intruder assessment. It might be more important because we have already talked about this with you. To go by this quickly -- and I'll talk about the detailed guidance and the scenarios of how you go about doing this because I think that will address some of your concerns hopefully to -- let's go to the next slide.

All right. So technical basis for 20,000 years. We were just talking about this. There are a number of elements that we considered in developing this number. The first thing we looked about was climate change or the stability of a near-surface disposal facility.

What I want to emphasize is that we may have had an initial value of, say, 10,000 years for Yucca Mountain. And that was based on considering the stability of a geologic system. And part of the argument was if you're stable for 10,000 years in a geologic system, you're likely going to be stable for much longer.

That same logic doesn't apply in the near surface. The near surface is much more dynamic. You have to start worrying about geomorphology and all sorts of things going on, but especially at more northern locations, you have glaciation and climate effects that come into play.

So while we try to be practical about considering the climate effects, especially because how is society going to be affected when climate change does occur, we think that if you consider a period of time like this and evaluate your facility, it can allow you to make better decisions with respect to long-term stability.

So if you're considering what happens at these longer times, you're going to put waste and locations that have more favorable characteristics towards stability. And the NRC's approach to waste disposal is concentrating contain. So we feel this is in line with that philosophy.

The second element of this, of the consideration for this period of performance, was the radionuclide transport characteristics. We have talked some about NUREG-1573 and how they developed 10,000 years.

The 10,000 years that were developed in NUREG-1573 -- and I wouldn't take that number lightly by any means, and we didn't -- that was a group of experts that probably had hundreds of years of performance assessment expertise that came up with that number.

What they looked at is they said, "Well, what do I need to understand how my system is working and how changes in the engineered barrier system or in radionuclide transport through the geosphere is going to affect my problem?" And they came up with a number of 10,000 years for that.

Part of the basis of that was looking at radionuclide transport for a shallow humid site. They only looked at one type of site. In this evaluation, we looked at all types of sites, ranging from shallow, humid, to deep and arid. And what happens when you look at all types of sites, if you stretch out the 20,000 years, you'll better capture the radionuclide transport characteristics at different types of sites, as opposed to just a humid, shallow site.

So that pushed us in one direction for the radionuclide transport characteristics. And then with the specific direction that was given to us by the Commission for depleted uranium, we looked at the characteristics of depleted uranium.

Depleted uranium is much more benign when it's just disposed of than it becomes over time. Over time, the daughters grow in. And the risks from depleted uranium at 1,000 years is about 1/1000th of where it ends up whenever it reaches its peak. When all the daughters --

MEMBER RYAN: Can you just explain the basis for that factor of 1,000 increase? Because that's a construct. That's not anything intrinsic to the --

MR. ESH: No. It's the radiological characteristics of the material with the ingrowth of the daughter products.

MEMBER RYAN: It's one scenario of exposure.

MR. ESH: Well, it would apply either to anything that the daughter radionuclides can cause impacts from. In this case, it's the air and the water pathways or even direct exposure-type situations but mainly the air and water pathways because you have radon that comes in through the air pathway and --

MEMBER RYAN: To a theoretical house and

all of that.

MR. ESH: And you have --

MEMBER RYAN: You have drinking water and every kind of water pathway where it's leaching at some high rate.

MR. ESH: It will leach at whatever rate is characteristic for that particular disposal facility given the solubilities and the specific surface area of the material you have disposed of --

MEMBER RYAN: I believe the other part is -- correct me if I am wrong -- without much credit for any longer-term barrier at all, I mean, assuming for stainless steel, that has gone away at some point and on the --

MR. ESH: I'm only talking on a relative basis here. So at 1,000 years, whatever credit you take for various things, you compare the material, just its characteristics itself, to what you have at, say, two million years or a million years. You were talking about about a factor of 1,000 delta and the potential risk from that material.

Whether the risk is realized depends on the specific disposal configuration, engineered barriers, all of the other things in the problem.

When you go to 20,000 years, you're within about a factor of ten for depleted uranium. Because you have had a lot of the daughters grow in, if you're assessing 20,000 years in your regulatory analysis, you don't run the risk that you are way off just because of the characteristics of the material and its ingrowth over time.

If you stop your analyses at 1,000 years, you potentially have a factor of 1,000 still coming in the system. So say you used 1,000 years and you have the 61.42 intruder performance objective, you might be around 500 millirem or you could be at 500 millirem at 1,000 years and you end up 1,000 times more than that at some peak location.

That's a pretty big dose you're talking about. You know, what does that mean over a million years? And what should you be doing with it? That's not for me necessarily to say, but I believe this construct of going to 20,000 years handles that problem because I can make an argument that considering all the uncertainties, missing a factor of 10 for this one particular waste type if the system evolves in a certain way, I'm on relatively firm ground to make that argument.

But with most performance assessment and waste disposal problems, they set their requirements and they do their analysis based on the characteristics of the material they want to take. And depleted uranium can have another home somewhere down the food chain if you can't meet the requirements for near-surface disposal of large quantities, concentrated amounts, shallow burial depth, you know, however you wanted to solve the problem.

So that's the construct of the technical basis for the 20,000 years. And I think we can discuss it further when I get through some of these other elements here.

VICE CHAIRMAN ARMIJO: Maybe you can help me out here, David. I'm trying to understand it. If we have depleted uranium, you're telling me that way out in time, it's much more hazardous because both of these powder products.

But let's take the case of just plain old uranium, natural uranium mined out of the Earth, melted down. You have a block of natural uranium with all of the daughter products that have been building in since time zero, --

MR. ESH: Yes.

VICE CHAIRMAN ARMIJO: -- billions of years maybe, and the same block of depleted uranium. You're telling me one block is 1,000 times more hazardous or not?

MR. ESH: No, no, no. I'm saying that --

VICE CHAIRMAN ARMIJO: Go ahead. You're the --

MR. ESH: I don't want to talk over anybody else.

VICE CHAIRMAN ARMIJO: That's okay.

MR. ESH: Yes. If you take natural uranium and you concentrate it until it is basically pure --

VICE CHAIRMAN ARMIJO: And I'm talking about you just take -- you go to the mill. You dig up. You get uranium.

MR. ESH: Yes.

VICE CHAIRMAN ARMIJO: You haven't done any purification. And you create a chunk of uranium with all the daughter products that have been growing in from time immemorial. And you compare that with a chunk of depleted uranium that has gone through the enrichment process and been purified and everything else. You know, are you telling me that one of them is inherently much more hazardous?

MR. ESH: If the natural uranium is concentrated to 80 percent uranium, then the natural uranium would be much more hazardous than the depleted uranium at that time because the depleted uranium doesn't have all the daughters in it yet.

If the natural uranium is clean of the daughters and it's not concentrated, then the depleted uranium has a higher concentration. It's much higher. So the number that I was giving, about a factor of 1,000, is the depleted uranium is very concentrated in uranium but very low in daughters. And those daughters build in over time. It's about a factor of 1,000 lower at year 1,000 compared to year 1 million or 2 million, so comparing depleted uranium to depleted uranium at different times. That's the comparison.

MEMBER RYAN: I understand those equilibrium discussions. I think the other part of it to me is benefit is it also has to then fit into what is a scenario of exposure, which is a pathway to human beings in some scenario of exposure. And that can be a very complicated range of what is in play and what is not.

MR. ESH: Yes. And I'll talk about scenarios here in the guidance, especially for the intruder component, but then you also have --

MEMBER RYAN: It's not just the inventory that drives the bus.

MR. ESH: Well, no, it's not. I mean, in the performance assessment, it's inventory. It's hopefully your design and your site and also then your receptor scenarios and their characteristics. It's all of those things put together that give you the impacts that --

MEMBER RYAN: And go over institutional controls if they are there and all of those things?

MR. ESH: Yes. But if you want to talk just about the material, then make it relative to all of those things put on a normalized basis. And then you can just talk about the material characteristics.

Of course, if you're valuing the same scenario at those two points in time, then the comparison is valid. If you're evaluating different scenarios at those two points in time, then the ingrowth characteristics of a material may be worse or less by the changes in the scenarios that you apply at those different points in time.

MEMBER RYAN: So I think it's fair to say there's no real three-sentence way to summarize what's the risk from DU without considering all of these different factors in context of how you really can come up with a risk scenario for any given specific --

MR. ESH: The way the depleted uranium is similar to other sorts of things, it's not different in that it represents long-lived waste. And so what do you do with long-lived waste, especially long-lived waste in near-surface disposal.

The NRC when it developed the regulations in the early 1980s, they put limits on the long-lived waste that they thought were appropriate for near-surface disposal. Those are reflected in the 61.55 tables.

So this idea of applying analysis right now to determine on a site-specific basis how you should limit maybe long-lived waste is no different. It is consistent with what was done to develop the regulation. It's only we're allowing the licensees to do it on a site-specific basis, instead of the NRC doing it on a predetermined humid site, humid Southeastern site, and applying those results to all sites throughout the country.

I think this approach is consistent, but it's more risk-informed. But I would argue and I do argue that you have to set requirements that allow you to distinguish between an appropriate action and an inappropriate action. And if you don't have a long enough period of performance or you don't have some evaluation of possible disturbance, then I think that some materials that right now from a government policy perspective they view as unsuitable for near-surface disposal could meet those requirements.

So that tells me you need to set the requirements where those materials couldn't meet and other materials could meet it. That tells you when you're at the right place of managing the waste. And that's what we had attempted to do here.

For the post-20,000 years, we feel that the impacts can be better placed in the proper context in something like an environmental analysis. So we do require, would require, that somebody generate a dose number, but that is only to ensure transparency with the stakeholders. At this time we weren't implying regulatory requirements for that.

MEMBER CORRADINI: You've gone way beyond my understanding something, but if I understand the post and within, the 500 millirem and, as you said, the consistency with the table -- I don't remember the reference -- is within the 20,000 years.

MR. ESH: Yes.

MEMBER CORRADINI: And the post-20,000 years, if somebody were to put in a performance curve that showed everything was hunky-dory within 500 millirem and then at 30,000 years or 40,000 years in the simulation, it went from 100 millirem to a rem, I'm trying to understand what that does to you. That's just purely qualitative observation?

MR. ESH: Yes. That would not fail these requirements as we have proposed them right now.

MEMBER CORRADINI: Okay.

MR. ESH: You would take that information. In our case, we would evaluate it in our environmental analysis and see whether that analysis was too large and unjustified based on the action that wants to be taken.

MEMBER CORRADINI: It's more qualitative. You post this time period.

MR. ESH: Yes. If we have EIS people in the room, they will be offended, but EIS analyses I think are softer than the performance assessment type of analyses.

MEMBER CORRADINI: Right.

MR. ESH: We're trying to make sure that because you do have these vast uncertainties, especially over the long time frames and so this is -- but we have had stakeholders comment each way. Some feel that absolutely we should apply a dose limit at those longer times. And they have recommended values, 100 millirem, 500 millirem, 25 millirem. We should apply a dose limit regardless of the time. And then we have had others say, "You shouldn't apply any dose limit or require any analysis at that point in time."

MEMBER CORRADINI: That's fine. You helped. You helped. Thank you very much.

MR. ESH:

Next slide, please. The guidance document we talked about pretty in-depth in the Subcommittee. What this guidance document is is it provides guidance on conducting site-specific analysis to demonstrate compliance with the performance objectives.

We supplement existing low-level waste guidance. So it isn't a standard-alone guidance document. And the reason for that is primarily because this is a limited-scope rulemaking.

In a comprehensive rulemaking, we would maybe want to do something like we did in the decommissioning program and make a consolidated guidance document. That is a very big effort involving a lot of people because there is a lot of guidance, either direct or it may be ancillary, the technical guidance and NUREGs and those sorts of things. It can all be pulled together into one set of guidance that you would maybe use for this program.

So what we did is we supplemented

guidance. We filled in holes that we thought we had holes. We especially put detailed guidance into apply to what we feel is risk-informed the way that you would implement these regulatory requirements we are proposing.

The Commission directed us to propose parameters and assumptions to be used in the analyses. We took some liberty -- and hopefully they're in agreement with us -- that they didn't specifically list the hydraulic conductivity should be $1E^{-7}$ meters per second and the distribution coefficient for technetium should be one milliliter per gram.

We didn't specify particular parameter values. We talked technically about the parameter values and assumptions and gave some examples about uncertainty and variability that we wanted people to consider in choosing the value for this one and say further site-specific application.

And we can afford some flexibility where warranted. In some cases, we don't think flexibility is warranted, but we provide flexibility where we think it is warranted.

Next slide, please. So the main outline, we have an introduction, general technical analyses. So that provides some discussion of things like data uncertainty, model uncertainty, model support, integration, abstraction, kind of the basic technical building blocks that comprise a performance assessment in these technical evaluations.

And then we cover what are more process model-type things in performance assessment, such as inventory and source term release and waste containers and radionuclide transport biosphere modeling. All those sorts of things we discuss in the performance assessment modeling section.

That's an area where we felt we had some pretty good guidance in like NUREG-1573 and a few other documents. So we didn't go into great detail, but we provided details we thought might be needed to fill in some issues.

We did generate new guidance on the intruder assessment, intruder dose assessment I should say, because it wasn't required before. And we thought there might be a need for some pretty good guidance on that topic. So we have a pretty thick section on intruder assessments. And I will cover some of the elements as some examples to you in a few slides here.

We have a section on long-term analyses, the type of analyses we would expect somebody to produce that justify what they would do to compare to the 61.13(e) requirement; and then other considerations, which are like developing inventory limits, how you would go about that, how and why you might develop inventory limits.

And, then, finally we have a performance confirmation section and the use of other NRC guidance documents.

Next slide, please. So we have some guidance on period of performance. And what it basically discusses is the flexibility that can be afforded for short-lived waste or low concentrations of long-lived waste. And what we are advocating is that the primary differences are in the level of detail of the justification for the calculations.

We also provide expectations for what you would need to do for long-term analyses. So if we could go to the next slide, I'll show you an example.

There are some example boxes right in the guidance document to kind of pose questions and answers that we think people might have when they're doing the evaluation. And this example says, "Okay. I have a facility that only has low-level waste generated by commercial entities," which normally has limited concentrations of long-lived waste. The values of the waste are at or below one-tenth of the table values.

Additionally, the facility is expected to receive waste that is long-lived that are found in the table that is less than the soil surrounding the facility.

So in this case we say, "Okay. We need to do the performance assessment to meet the 61.41, .42, and .44-type requirements, but we don't have to get into all the complicated business with what's happening with climate and stability and all the things that come into play over the very long-term assessment period."

The reason why we have taken the approach to the period of performance on the intruder requirements in the regulations is legally you have to set the requirements as to what you want to be met. And then you can provide ability to demonstrate that in a risk-informed way, which is generally done with level of detail.

So you have to show that you have captured the peaking of dose within 20,000 years, but you could do that a number of ways. If I was doing it and I had a facility that was only taking short-lived waste, I would probably make an argument based on the characteristics of the waste I had and show that it's going to be all decayed by year whatever.

I also would consider just running the calculation out and showing I did a bunch of zeroes at longer times. That would be an easy, practical way to do it because once you have set up the performance assessment calculation, there is not a burden to running the calculation longer. The burden comes in as if you have to develop specialized models of what is happening at longer time and provide support for those calculations. And that is the way we think the process should work.

If you're dealing with a hard problem, you're going to be faced with a more challenging review and more information that you're going to need to supply. If you have an easy problem, you should be able to deal with it in a more straightforward way.

MEMBER RYAN: Just a question, David, on the example 2.3. What if I have some not small but not horrendous quantity of uranium and I say, "Okay. Well, I'm going to make that so that it's about the same as resting in the natural soils in the surrounding facility by mixing it with a whole bunch of dirt"? What do you make of that?

I mean, I don't think it's all that -- I'd much rather have one container that's at a robust container buried 50 feet down than meet that goal.

MR. ESH: Yes. We did a blending requirement or we have requirements about basically dilution. So you can mix waste streams --

MEMBER RYAN: Yes.

MR. ESH: -- in order to manage the disposal of those waste streams, say, by mixing a class B waste with an A waste and get it all down to A waste.

MEMBER RYAN: I mean, the point is that --

MR. ESH: You can do what you need to do under the technical position on concentration averaging to stabilize your material and take action such as that, but you can't artificially dilute your material by, say, mixing clean soil in with waste.

MEMBER RYAN: So it's all in the matter of definition. If I'm blending waste for the purpose of stabilizing what I have, which I could be doing with a chunky uranium and other kinds of soil waste that have a little bit of cobalt or whatever, okay.

MR. ESH: I think it's --

MEMBER RYAN: You try and judge intent there, which is very interesting to think about how that happens.

MR. ESH: That's existing in the regulation right now that you can do things to manage your waste streams. But generally you can't -- I mean, if the philosophy is concentrated and contained, they don't want you doing dilution. Dilution is not the solution to pollution, even though from a risk analyst perspective, it is in many cases. You are most confident that the risk is low when it is diluted.

And that's what happens in these performance assessments many of the time is that you are trying to assess how much dilution and dispersion you get out of the system. That's a --

MEMBER RYAN: These longstanding principles may be right or may be inappropriate or not useful.

MR. ESH: It may be, but that's not for us to do within especially this rulemaking and maybe not even within the comprehensive one. We can discuss it, but those were decisions for Commission policy to set how they want to manage waste, how they want to set waste disposal and the framework for it.

MEMBER RYAN: I guess it's my view and I'll express it for the rest of the members. I think you're hamstrung by the fact that you are in a very limited rulemaking circumstance right now. I think that is something that we need to think about. This is very limiting to what we can or can't do to try and move the ball in a positive direction.

MR. ESH: I mean, this is brain surgery, but it's not lobotomy. So, I mean, I think we are delving in and working on the part that we need to work on, but we aren't taking a dramatic action in how we're trying to change the system because --

MEMBER RYAN: But you are only given a vice grip and a screwdriver --

MR. ESH: Would have given us a hammer when we needed a screwdriver, but so be it. And we have had those comments from stakeholders that have said, "Look, the system works. Don't break it." We're certainly not trying to break it, but we have been given direction to change it to deal with specific waste streams and problems. And that's what I think we did.

Let's talk about the intruders now. I think that would be useful for you. The guidance on the inadvertent intruder assessment, as you are well-aware, most of you, probably boils down to scenarios.

What our guidance says is that we want to evaluate or want people to evaluate reasonably foreseeable scenarios resulting in the greatest dose for compliance. You can consider site information. You are going to have flexibility to identify what the reasonable foreseeable scenarios may be in the near-term.

For longer time frames, you get into this issue, though, of future human behavior. In those cases, what we are recommending is, just to keep it simple for yourself, it made you look at the default scenarios.

The default scenarios limit speculation. We can argue they are conservative, how conservative they may be. They have a rich history of use in practice, both from within the NRC and in some sites that have done intruder evaluations. They are usually looking at default scenarios. So there is a basis or there is a history of usage for the default scenarios at least.

If we go to the next slide, I'll show you some more details on this. The default scenarios that were considered, just to refresh your memory, they were in intruder construction, discovery scenario.

You have the issue of whether waste is recognizable or not. If the waste is recognizable when the construction occurs, then they stop construction. And the exposure time is much more limited. If the waste is unrecognizable when the construction occurs, then they build a house and somebody lives there. And the exposure times are much longer, and the pathways are much more involved.

For deeper waste, then, you may also need to consider drilling. So somebody puts in a well, for agricultural or domestic use, and look at the impacts to the crew that puts in the well or the impacts to somebody that lives and uses the water from the well after it has been put in.

They are all hypothetical regulatory constructs. They aren't meant to be "This is exactly what we think would happen." But we do believe they provide reasonable bounds to do a regulatory analysis and they limit speculation about human activities because when you talk with stakeholders about human activities, their views are way more diverse than they are about even something like period of performance.

Somebody can come up with very complicated scenarios that they can justify "Well, my Uncle Joe does this exact thing. Therefore, you should evaluate it" without the context of "Well, not everybody has an Uncle Joe that's crazy."

So this limits speculation about the human activities, and I think it's appropriate. It may not be appropriate at all sites, though. You need to consider what's happening out at a particular site.

So if we go to the next slide, please --

VICE CHAIRMAN ARMIJO: David, just before you go --

MR. ESH: Yes?

VICE CHAIRMAN ARMIJO: -- in your default scenarios, do you specify the number of people who were involved in this intrusion? Is there a maximum number?

MR. ESH: It does not specify the number, but it's generally thought to be, say, one family or one residence. It's not a whole community, for instance. The evaluation is not that a town gets built but that a house gets built, which we think is much more consistent with the idea that you are trying to put controls in place to prevent something from happening. And if something bad happens, it is likely to be more limited to an extent than comprehensive. Maybe that's not a good assumption, but that's that assumption to --

VICE CHAIRMAN ARMIJO: Okay. I just wanted to know what the number was.

MEMBER BROWN: It just hit me based on what you said. So construction people coming in, this assumes, then, that these are not barriered sites. These are open field after the disposal has been done. Is that after some period of time or is that --

MR. ESH: Yes.

MEMBER BROWN: Is it 100 years? It is 10 years or is it the 10,000-year point?

MR. ESH: It's after the institutional control period, which is up to 100 years. So it's after that time. During that time, there are active controls, like fences and security and --

MEMBER BROWN: The factory gets torn down. And then the fences go away and the --

MR. ESH: Yes. And you can imagine if -- well, the other thing is, say, for instance, if you're dealing with companies, how many companies in the S&P 500 are 100 years old? It's only a handful of them that are that old. We start dealing with companies that come and go over long time periods.

MEMBER RYAN: David, I'm not trying to rush you, but I want you to maybe move along a little bit.

MR. ESH: Yes.

MEMBER RYAN: I think we have covered this one point.

MR. ESH: All right. Fine.

MEMBER RYAN: We need to keep going.

MR. ESH: All right. So the next slide, then, is the site-specific scenarios. This is the other aspect that we're bringing into play in the intruder assessment is we want people to be smart about it.

So, Dr. Ryan, you talked a lot about "Well, does it make sense to assume that somebody builds a house and they are eating a steam generator" or whatever, you know, some sort of metallic component that is obviously still metallic at 100 years? No, that doesn't make sense at all.

Sure, you can do it for your regulatory analysis if you want to be conservative and you show you can meet the requirements. Why not? But you don't have to do that.

MEMBER RYAN: I sure wouldn't do it.

MR. ESH: You can make an argument that, "Look, this waste is recognizable. So my scenario is limited to scenarios that would happen when the waste is recognizable."

So we feel that we allow people to bring in the physical information and then also cultural information. So if a waste disposal facility is located in an industrial area and it's been an industrial area for some time, it's likely for, at least the immediate future, to remain an industrial area. Maybe you can look at industrial-type scenarios, instead of a residential-type scenario, after the institutional control period.

But the ability to do that over very long periods of time starts getting limited. So we do ask for people to consider changes over time, either to the physical information, like maybe you have waste that's not potable today you need to look at "Is that a robust configuration? Does it remain unpotable?"

MEMBER RYAN: Just as another example, I think our previous conversations touched on the depth of burial.

MR. ESH: Yes.

MEMBER RYAN: If I'm at a site where I can go, let's say, 100 feet down, houses aren't going to put basements 10 stories down.

MR. ESH: Absolutely no.

MEMBER RYAN: I think there's a way to think about, "Well, how do I get it out of reach of the intruder? And if my site allows that, bingo." And I think that's a positive way to move forward.

MR. ESH: Well, that is a very good way to try to reduce the likelihood of interaction with the material and disturbance of the material by natural processes. That's why high-level waste is desired to go in a geologic repository, to eliminate the instability associated with the near surface and the potential human interaction.

So it's a concept that is applied universally worldwide. The further you can isolate the material from the people and the environment, the better off you will be over these long --

VICE CHAIRMAN ARMIJO: You can't get away from the imagination of the assessors. I recall a Department of Energy document that I saw on Yucca Mountain where the intruder was drilling 1,000 feet down through Yucca Mountain, through the drip shield, through the waste packages, and into the fuel, and, of course, exposed, causing exposure and release.

I mean, so these are open-ended. You can go in these fine frames and open strengths. You just can't close on the problem.

MR. ESH: That's why, especially in this area, we want to kind of constrain speculation and limit speculation to a few scenarios that have been used in the past or to consider that this type of information on slide 20 that we have right here, especially in the short term, to be smart about it because for short-lived waste, these sorts of considerations can make a very big difference.

The long-lived waste, we think they make lots of a difference. So when you're in the long-lived waste box, then you probably want to be more simple and pragmatic about the uncertainties and the solution and you try to mitigate those uncertainties.

MEMBER RYAN: And I guess it would be helpful if, at least in guidance, if not in the regulation changes you are proposing themselves, we address this very point that Dr. Armijo and you just talked about.

MR. ESH: I believe it is. I mean, we would love your feedback on that guidance document, on this guidance document. The intention is that it's going to go out for public comment with the proposed rule, we'll get feedback on it.

MEMBER RYAN: We haven't seen it yet. So --

MR. ESH: Yes. I would say it's like 95 percent there, maybe even 99 percent there. It's getting pretty close.

MEMBER RYAN: Okay. Well, we would be happy to schedule a briefing whenever you are ready.

MR. ESH: Yes. Next slide, please. So conclusions, and I'll pass off to Andrew to go over public comments quickly. We feel we followed and addressed the Commission direction, the proposing rulemaking, limited rulemaking to site-specific analyses.

We do identify what requirements we believe should be associated with those analyses. And we have developed a guidance document outlining the key parameters and assumptions and all the technical information to go with the analyses.

The approach we believe is protective of public health and safety, it is risk-informed and performance-based. And we do provide flexibility to licensees when warranted.

So Andrew?

MR. CARRERA: Thank you, Dave.

My name is Andrew Carrera. And for the next couple of slides, I will just briefly go through the comments that we received on this rulemaking, go through the language and how the working group came out of pursuing those comments. And then we still go back to Dr. Armijo's questions with regards to the

Department of Energy's comments. And then I'll proceed with the path forward.

So the NRC posted the proposed rule on regulations.gov and requested early public comments. And we also had a public meeting on May 18th to discuss this document.

The comment period ended on June 18th. We also heard some of the comments from stakeholders during the previous meeting.

And at the end of the comment period after the staff reviewed 15 comment letters from this group of stakeholders, industry, government organization, and grouped them into these 9 issues. And Dave has previously talked about these issues in the comments regarding these issues already.

In the end, the working group sees comments as being both supportive and critical for what we are proposing in the formal proposed rule language. And in the areas where we see the comments leaning one way or the other, we went back to the preliminary proposed rule language and made revisions to address those issues.

Those revisions are included in the background slides. I don't know if you want to go over that now.

The working group is comfortable with the direction that the revision is taking us. And we are comfortable with the current path that we are on with the rulemaking.

Stakeholders will have another chance to comment on the proposed rule language when it goes out officially for an official comment period on the proposed rule.

MEMBER RYAN: When do you think that will be released for comment, just roughly? Is it this year or first of next year?

MR. CARRERA: It would be next year.

MEMBER RYAN: Okay.

MR. CARRERA: The package, the first review package, is scheduled to be delivered to the Commission at the end of January 2012.

MEMBER RYAN: Okay.

MR. CARRERA: And then the Commission will review and vote on it. And I don't know how long that process will take.

MEMBER RYAN: Okay.

VICE CHAIRMAN ARMIJO: Yes. I'd like to make a comment that I had hoped you would provide more detail on the Department of Energy comments because I thought they submitted very detailed and well-thought-out comments.

You know, I won't go into all of their reasoning and everything they said, but basically they wind up with a period of performance of 1,000 years.

MR. CARRERA: Yes.

VICE CHAIRMAN ARMIJO: They address the issue of intruders with some constraints. Reasonable people will behave in the future pretty much like they behave today. And they come up with something that looks practical and workable. And 1,000 years is far different than a 20,000-year assessment and certainly easier to believe that you understand what is going on as far as materials, environment, and even people. You know, the country may not exist in 1,000 years, but let's hope they do, we do.

I can't reconcile two government agencies, responsible agencies, Department of Energy already disposing of low-level waste, including depleted uranium, and NRC regulating the disposal of the same materials, having two radically different conclusions on periods of performance and how you do intruder assessment and whether -- so I just think that this has got to get resolved.

And once the -- you know, I can understand the DOE approach much better. And I could believe that they can support their arguments for 1,000 years.

MR. ESH: I can talk to that. We work with the Department of Energy on a number of projects, especially down to processing reviews. And in those projects, they don't use 1,000 years. They use 10,000 years, and they look beyond 10,000 years. So when you're looking at the 1,000 years, you're looking at the requirements in order 435.1 that they're applying for maybe what they call their low-level waste disposal facilities, where I believe they limit -- they develop waste acceptance criteria but they limit the concentrations of all long-lived isotopes that they take in those facilities, as they need to on a site-specific basis.

Let me talk about intruder area first. In the intruder area, I don't think we're in misalignment with what the Department of Energy does. They do an intruder assessment. They look at what they think are reasonable scenarios. We may differ as you go out in time how much we think the relevance of -- how much recency bias comes into play. So they believe because the Department of Energy is there now that it's always going to be there. And if it's an industrial-type activity now, then they can use an industrial-type activity indefinitely into the future in some cases.

In other cases and problems that we review, they don't take that approach. They analyze an intruder very similar to what we would do, but they apply a 100-millirem dose limit, instead of 500. That's one of the main differences.

And they separate it into a chronic and acute case. They look at acute exposures and chronic exposures and make a distinction between them. So we're not in misalignment in the intruder area.

In the area of the period of performance, where they choose 1,000 years, I'm not aware of the basis for or the document that describes why they came up with the 1,000 years. Basically they have 1,000 years, and they have used it. And in the material they submitted to us or the comments that they made at our public meeting, it was basically, "Well, we have used 1,000 years for a long time," but they don't say why they picked 1,000 years or why it's appropriate for the problem.

And I would argue for the direction the Commission gave us, especially for depleted uranium, 1,000 years is not appropriate. It just does not capture enough of the characteristics of the material. You are way off on the ingrowth characteristics of the material to make an argument along those lines.

If you have some sort of socioeconomic argument about what is going on in society in the future in evolution and technology to justify a shorter period of performance and how other societies should deal with the long-term risk, that's a different story, but we don't have that analysis. And I'm not aware that the Department of Energy has that analysis.

And in practice, when we do the reviews, independent reviews, of what the Department of Energy does, they project impacts, say, even past 10,000 years, but they, to our knowledge, don't take them seriously or take any action on it.

So it's a little bit disingenuous to say, "Yes. We have some line in the sand that we draw at 1,000, but then we also consider what is going on after that" because in practice, when we are doing our independent reviews, they aren't taking action on what is going on after that. They are just drawing the line in the sand and saying, "That is where we draw it."

And I don't think you can draw it there both from a depleted uranium radiological characteristic standpoint or from a radiological transport characteristic for most of these problems because you're dealing with a situation where an isotope does not get out in 1,000 years but may arrive in 1,500.

And you might have zero dose for 1,000 years and 5 rem at year 1,500. But that doesn't make any sense that just because where you wanted to draw the regulatory requirement, it's a dramatic pass or a dramatic fail.

So that's kind of my thoughts on it. I do realize we have some differences there. But we tried to develop a technical basis for it. And considering what we see in practice of the way they do it, we understand exactly how they run their problems and how they do their analyses. We don't necessarily agree with them, obviously.

VICE CHAIRMAN ARMIJO: Well, you know, it's clear that they're different. They are different. You say that you don't have a basis or they haven't shared their basis for their 1,000 years.

They did share their documents on what their rules are and their processes are. And they address the intruder assessment and, for whatever reason, think 1,000 years reasonable and practical. And that's where they draw the line.

MR. ESH: Yes.

VICE CHAIRMAN ARMIJO: And I just can't see the federal government having two agencies, both responsible for disposing of the same thing, having two different views.

One could argue and say, "Well, look. We're going to be tougher on the private sector. We're going to make them worry about stuff for 20,000 years. But the Department of Energy government property, we just will do it for 1,000."

Something is wrong here. And I just find it believable and practical that 1,000 years is plenty of time, even though you can -- you know, I understand your radiological arguments, but do we have a duty, moral, ethical, legal, to protect a family 20,000 years out into the future? I don't believe so.

MR. ESH: That's the issue. It's like "Well, what is the" --

MEMBER RYAN: We've probably --

VICE CHAIRMAN ARMIJO: I'm not talking --

MEMBER RYAN: Let others have a chance for some questions.

VICE CHAIRMAN ARMIJO: Okay.

MEMBER RYAN: Okay. Jack? Okay. Dennis?

MEMBER BLEY: No more. Thanks.

MEMBER RYAN: Okay. Dana?

MEMBER POWERS: I was at the Subcommittee meeting.

MEMBER RYAN: Okay. Bill? Back to you.

VICE CHAIRMAN ARMIJO: I'm finished.

MR. ESH: One thing I would add is that what I was trying to say is that we set the requirement. So we think certain materials would pass that we think are appropriate to pass. And other ones that aren't appropriate wouldn't pass.

If you set a period of performance of 1,000 years and say, "Did away with the intruder performance objective," I believe that defense high-level waste would meet those criteria for near-surface disposal and probably even commercial spent nuclear fuel as long as you've got a shielding barrier on top of it to take care of the high-activity short-lived stuff. And that's a dramatic move from the policy of the Commission right now as to how they think you should manage certain materials.

So in my mind, the requirements have to be able to distinguish -- it has to get the right materials in the right boxes. And I think these requirements do that.

MEMBER RYAN: One thing, David, I hope you'll agree is that 19 -- I don't know whether it was first written in '61, in the '70s -- the best calculator you could was a card Wang calculator that would do a really simple calculation in about a day.

MR. ESH: Yes.

MEMBER RYAN: And now we confuse ourselves silly with a desktop portable computer and do differential equations until the cows come home.

So the ability to calculate is so powerful that I think we need -- my own view is this is -- performance assessment is a victim of "Well, let's just calculate everything without really thinking it doesn't make any sense."

I mean, so we can calculate impacts to any species in between the waste and the cosmos. Because we know where they are, we can run a differential equation to do it. And I think sometimes we need to think about what makes sense --

MR. ESH: Yes.

MEMBER RYAN: -- to do. I mean, where are the limits of this? I think Dr. Armijo is trying to address in his mind a very important point about where are the limits of where these calculations make sense or can we defend it? And it gets into the uncertainty.

It's not uncertainty analysis of the

parametric uncertainty.

MR. ESH: Yes. I understand that, yes.

MEMBER RYAN: It's the uncertainty and what do we know or don't we know. So I think that's part of what you're hearing a little bit from the Committee. And during the Subcommittee meetings, we have touched on this.

So, with that, I don't think we have any other questions. I'll go around once more. Anybody else have any questions or comments?

(No response.)

MEMBER RYAN: I do want to thank David and Andrew and Debbie for not only supporting this meeting but for the two very detailed and very productive Subcommittee meetings that we had with other participants.

I want to thank the other staff from the Low-Level Waste Branch that are here in the audience who are, as I said many times, probably the most talented group of folks in performance assessment I have seen put together in one group. And I appreciate your time. And so I thank you all for coming and for being here and for your participation.

Are there any other comments from members of the public?

MEMBER POWERS: I would just echo your comment. The presentation at the Subcommittee meeting was a tour de force, very professional, well-done.

MEMBER RYAN: Thank you, Dr. Powers.

Is there anybody on the bridge line who wishes to make a comment?

(No response.)

MEMBER RYAN: So if the bridge line is not closed, we can close it now. With that, Mr. Chairman, I will turn the meeting back to you. Thank you.

CHAIRMAN ABDEL-KHALIK: Thank you.

Before we break for lunch, I would like to welcome our newest member. Gordon Skillman is now an official member of ACRS. And we welcome him.

MEMBER SKILLMAN: Thank you very much.

(Applause.)

CHAIRMAN ABDEL-KHALIK: Let me just give you a brief bio on Mr. Skillman. Mr. Skillman has over 45 years of commercial nuclear power experience. He has served on nuclear safety oversight boards and engineering councils for many years and has been directly involved in design consultation or oversight actions at many of the currently operating plants in the United States.

Mr. Skillman earned his reactor operator's license and senior reactor operator's license from the U.S. Atomic Energy Commission in 1967 and 1969 and served on the nuclear merchant ship NS Savannah as a reactor operator.

He later joined the Babcock and Wilcox Company, where he contributed as an engineer and manager for B&W's Nuclear Power Generation Division.

He was an immediate responder to the TMI 2 accident and served for seven years on the stabilization and cleanup of TMI 2 from GPU Nuclear. Mr. Skillman subsequently served as Manager of Recovery Support Engineering and Manager of Defueling for TMI 2.

Following his employment with GPU, Mr. Skillman has provided consultation and oversight services to the nuclear industry. In his consulting capacity, he has been involved in a variety of activities, including the response to the Davis-Besse head event and design and construction of the national enrichment facility at Hobbs, New Mexico.

Mr. Skillman received his Bachelor of Science degree in marine engineering from the United States Merchant Marine Academy in 1966. And he is a registered Professional Engineer in Pennsylvania and Virginia.

Welcome aboard.

MEMBER SKILLMAN: Thank you.

CHAIRMAN ABDEL-KHALIK: Okay. Thank you.

At this time, we will take a break for lunch. And we will reconvene at 1:15.

(Whereupon, a luncheon recess was taken at 12:13 p.m.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

1:14 p.m.

CHAIRMAN ABDEL-KHALIK: We're back in session.

At this time, we will move to the next item on the agenda, Safety Evaluation Report Associated with Revision 19 of the AP1000 Design Control Document Amendment. And Mr. Ray will lead us through that discussion.

Harold?

MEMBER RAY: Thank you, Mr. Chairman.

As you just said, the agenda item is entitled Safety Evaluation Report Associated with Revision 19 but actually what exists is the final Safety Evaluation Report. It's dated August 5th and it includes Revision 19 to the AP1000 DCD Amendment.

The AP1000 Subcommittee met on August 16th, ten days following the issuance of the Final Safety Evaluation Report for the entire amendment, including Revision 19 to review the changes that were made just by Revision 19 as we had, of course, reviewed through Revision 18 at the end of last year.

This review was facilitated by the staff providing us with an extract from the Final Safety Evaluation Report, which addressed just the Revision

19 changes. I guess I'm not sure if the ACRS has previously reviewed changes to an application after issuance of the Final Safety Evaluation Report. But in any case, that's what we're doing now.

Most, but not all, of the changes in Revision 19, which had been submitted June 30th, 2011, are editorial or conforming for the issues previously identified by staff and which are now being closed out. An example of such an item is the inclusion of certain structural details in the enhanced shield building as Tier 2*.

In regards to the enhanced shield building structural design, there was a change made at NRC staff request to combine extreme ambient thermal loads in safe shutdown earthquake loads. Associated with this change, the Subcommittee pursued at the August 16th meeting the effect of solar radiation in potentially causing even higher loads. This is referred to as the solar gain effect.

To explain a reason for including the additional enhanced shield building structural detail as Tier 2*, let me quote from the final draft rule, which explains the reason for most of these revisions to the DCD Revision 19.

"These revisions were to the DCD wording about the design but were not actual design changes. The purpose was to ensure that sufficient information was continued in the DCD to provide a clear licensing basis for the future and to ensure that key details about structures, example materials, reinforcement details, were subject to increased regulatory control with Tier 2*.

"Because there are no consensus standards applicable to the modules, the NRC concludes that some information about this unique design warrants Tier 2* regulatory controls."

The most challenging area for the Subcommittee to resolve in the time since the FSER was issued August 5th involves the various aspects of the containment evaluation methodology. The most important of these is the calculated peak accident pressure. But this is not the only one.

As stated in the Draft Final Rule, the design changes within the scope of the amendment with respect to the containment vessel are the calculated accident pressure to correct a number of errors, one of which was identified in the ACRS letter dated December 13th, 2010, and the balance of which were identified by the Applicant and addressed in an update to the shield building design report dated June 15th, 2011.

In response to a comment from a member of the public, the Subcommittee has also sought to determine if there is a nonconservative error in the containment evaluation methodology associated with the conduct of what is called the large scale test initially performed in support of the AP600 design. Such an error would be related to the effect of solar heating of the facility, which was located outdoors.

At the August 16th Subcommittee meeting, and in preparing for this full Committee meeting, I've had been greatly assisted by Bill Shack and Sanjoy Banerjee in their respective areas of expertise. We've been asked to issue a letter on Revision 19 at this full Committee meeting if at all possible. Therefore, in the interest of time, I will ask that Bill and Sanjoy lead with any questions they have in their areas.

Finally, I want to note that I believe a concern pursued by Sam Armijo regarding materials testing related to the rad coolant pump flywheel has fully resolved by the Applicant and is satisfactory.

Therefore, I would like to allocate most of the time, to the extent that I can, to achieving closure of matters related to the containment evaluation methodology as the first priority for our discussion. And with that, the agenda will -- we'll proceed to follow the agenda, which involves presentations by the Applicant. Over to your, Rolf.

MR. ZIESING: Okay. Thank you, Mr. Ray, Chairman. Appreciate the opportunity of being here today to address your questions.

In the interest of time, I think Mr. Ray summarized what I was going to summarize. So I don't want to repeat myself. We do have the slides. They are provided for your information and for the record. And we are prepared to focus on what we understand to be the primary topics of interest, namely the internal pressure and the questions on the structures.

We did have the structures folks lined up here first, but if you'd like to talk internal pressure, we'll get them.

MEMBER RAY: I put them first, too, Rolf, but I will say you do whatever you think is best. Both Bill and Sanjoy, I think, are prepared. So go ahead as you planned.

MR. ZIESING: Okay. We'll stick to that.

So I really don't intend to go through each of my slides in the interest of time. The details will be covered in following presentations.

But I do have just an intro remark or two to make.

The DCD is today, for all practical purposes, the same DCD that was subject to your prior review only better. And I mean that seriously.

Since the time in which you completed your review to Revision 18 and our issuance of Rev 19 and the following issuance of the FSER, the Final Safety Evaluation, we've been through an exhaustive review by NRC following through on known confirmatory items. Many inspections and audits to run the confirmatory items to ground.

As a result of that thorough review, the design was validated. Certainly there were some analyses that changed and supporting information was updated. But the design was validated through that effort as documented with the issuance of the FSER.

And I said it is better. By that I mean that at a high level, the design remains the same. But I believe the document is improved in terms of clarification. It is important that the licensing basis, you know, be as clear as possible. And there were edits made as a result of the confirmatory reviews, the audits, inspections, and meetings that we had, many of those were public, to ensure there was no ambiguity around key licensing basis-type language.

And it was significantly strengthened from a regulatory control standpoint with the identification and addition of Tier 2* designation to existing information or, in some cases, some supplemental information such that future design changes, you know, are more tightly controlled with regard to the regulations that apply.

So it represents a design that has been the subject of years of review. And the regulatory basis, in my opinion, has been strengthened through the confirmation review process and the inclusion of Tier 2*.

So with that -- those are my intro remarks. I do think it is important to preserve the balance of time to get through the technical issues and answer any questions you may have. So with that, I'll turn it over -- we do have the Structures folks lined up first. So we'll go ahead and address that topic first. Mike?

MR. CORLETTI: Sure. Good afternoon. My name is Mike Corletti. I'm Director of Engineering at Westinghouse. With me we have Leo Tunon-Sanjur, Structural Manager, and Tod Baker, Engineer in Structurals area, who are going to be speaking today with regards to the structural analysis changes that are included in DCD 19, the differences between what was in DCD 18 and what was in DCD 19.

The two key topics we're going to speak to today is -- one is what we term the seismic and thermal load combination issue. And included in that are any responses to two questions that were raised in our Subcommittee meeting, at the Subcommittee meeting held three weeks ago, one associated with the welding requirements, which I think at that meeting, I think we answered the question -- read it into the record.

I think we have it our slide here, specifically where the welding requirements are captured in the certified design, in the DCD, or in other topical reports that are referenced in the DCD.

The other topic under seismic and thermal load combination we will speak to is the effect of solar gang. There was a presentation made by a member of the public last -- three weeks ago. We would like to explain the effects of solar gain on the structure and the importance of that. So -- and I think we have a slide on that to speak to that question.

The second topic is with regards to the PSC tank analysis that is presented in the DCD. And there it really is the -- what was included in DCD 18. And now what is now included describing that analysis in DCD 19. Those are the topics we'll speak to.

First of all, with regards to the load combination issue, the issue essentially is that for ambient thermal conditions, when we do -- when Westinghouse had performed the design in accordance with ACI 349, we did not explicitly combine the loads from ambient thermal with a seismic event. And that is in line with, I think, a practice that has been done by Westinghouse in the past and in other AEs that have done nuclear structures design.

However, I think the staff basically had asked us to quantify that effect -- really quantify that engineering judgment. And Westinghouse has performed a series of calculations that shows that effect. And have included the results of those calculations in the DCD Rev 19.

So next slide. Again, to validate the existing shield building design, we updated those calculations for not only the shield building but we also included an update for all of the Nuclear Island structures. As I said, this has been our past practice for the ambient thermal that we did not explicitly combine that. We really cited provisions in the ACI Code that allowed that. However, we have updated the calculations to explicitly include that now.

The revised calculations really demonstrate that there is not change in the structural design. The amount of reinforcement, it has not changed. And really, the effect with respect to the margins is fairly small.

The DCD text changes were included in Rev 19 to really clarify the licensing basis. In the DCD, we include details of load combinations for the structures, including the critical sections. And the staff, as part of the review under Part 52, does a review of the critical sections.

And those methods that are applied for those critical sections, then will be applied by Westinghouse in the design of the entire structure. So this really sets the licensing basis for the calculations that will be done, the detailed calculations that will be done for the Nuclear Island structures.

MEMBER SHACK: Now when I looked at those calculations, those were done basically with a kind of effective -- those were done with the ANSIS model, not the detailed one where you explicitly included the tie rods and all the stuff and sort of following a standard global.

But back in the earlier part of the shield building report, there was a discussion of thermal gradients within the composite. And there, there was sort of a statement that it was modeled -- I think it was not the seismic plus thermal but was thermal only was modeled on a detailed basis.

I could find a quoting of the result, which was that there was a 700 psi stress. And it introduced a small amount of cracking, which is addressed in the ACI by reducing to -- but I didn't see those calculations explicitly in the shield building report.

Are there in there somewhere? And then I just missed them? For the localized thermal gradient and the detailed result where you had the tie rods, the steel --

PARTICIPANT: We can look.

MR. CORLETTI: But the results are included in the shield building. I believe in our seismic -- I don't believe -- in our seismic plus thermal load combination calculations, they were detailed in the last appendix.

So if you recall the previous version of the shield building report, that load combination was not included in the body of the report. We had largely left the body of the report untouched. And included in that last appendix the detailing of our seismic plus thermal calculations.

MR. TUNON-SANJUR: But his question is more for the localized thermal.

MR. CORLETTI: Oh, okay. Localized thermal.

MEMBER SHACK: Yes, no, I certainly -- the seismic plus thermal --

MR. TUNON-SANJUR: It exaggerated the thermal gradient. So it is in the appendices, Chapter 3.

MEMBER SHACK: Okay. The result is in Chapter 3. But I couldn't find any detail of the analysis anywhere.

MR. TUNON-SANJUR: The description of the analysis, there were calculations made.

MEMBER SHACK: So it was done with an ANSIS modeling?

MR. TUNON-SANJUR: Yes. It was done with actually an ABACUS model --

MEMBER SHACK: ABACUS, okay.

MR. TUNON-SANJUR: -- which captures the leading aspect of the thermal. So the thermal gradients were exaggerated. And so we came up with a very steep thermal gradient, especially close to the studs and the plate. And then ABACUS showed the results to be about 700 psi.

MEMBER SHACK: Okay.

MR. CORLETTI: Yes, I think a lot of time we present the results and I think the staff has done audits of the calculations where maybe they would review those audits. So I think the body of the calc is not included in the report. Okay?

MEMBER SHACK: Yes, okay.

MR. CORLETTI: Okay. On this next slide, there was a question at the Subcommittee with regards to what are the shield building weld requirements. And is it adequately captured in the licensing basis.

And the purpose of this slide really is to -- I think we read this into the record at the last meeting but really it is to identify that the weld detailing requirements for the SHIELD BUILDING REPORT structures do follow the AISC N690 code. And it is specified in two documents.

And we mentioned that there was a proprietary document that's referenced in the DCD, APP-GW-GLR-602, which includes some of the details of the shield building that the staff had believed was the most important, that Westinghouse could not change without coming back to the staff, that becomes certified as part of the design. And so some of those requirements are included in that document as well as other portions of DCD Rev 19.

This slide really outlines in design in the steel-to-steel and steel-to-concrete we'll follow AISC N690 or the ACI 349 codes as appropriate. And this really outlines some of the requirements that are included in those two documents.

MEMBER SHACK: Okay. One requirement that you did miss here is for the tie bar welds to the plate, which again is a nonstandard kind of weld. And you've addressed that by a performance requirement, which seems to me adequate.

I did have a question -- and I don't know whether this gets into proprietary information or not -- you use mechanical couplers in some cases. And it says those mechanical couplers -- and, again, those mechanical couplers have a performance requirement, which seems appropriate -- but it says they've been used elsewhere. And I was just wondering where the experience is in their use.

MR. TUNON-SANJUR: The mechanical couplers are used sometimes for tying the rebars together.

MEMBER SHACK: Even in a standard

reinforced concrete structure.

MR. TUNON-SANJUR: Right. Even in standard reinforced concrete.

MEMBER SHACK: Okay. So it's just a --

MR. TUNON-SANJUR: Yes.

MEMBER SHACK: -- it just adapted from the conventional reinforced concrete structure?

MR. TUNON-SANJUR: That's correct.

MEMBER SHACK: Okay.

MR. CORLETTI: Next slide. So this next slide is really to address -- to give the ACRS members a feeling on the magnitude of the effects of solar gain, solar beating on thermal loading. And calculations -- Westinghouse has actually -- we spoke to it last week -- or three weeks ago that this load is typically not considered explicitly. And it's a very small effect. I think the ACRS said please show me. And so we've come back to try to show you that.

First of all, the ACI code equations in load combinations really build in margins. And so with respect to the thermal cases, where we look at thermal dead and live load, a factor of 20 percent is increased to the thermal load to address maybe uncertainties associated with small effects.

For the case of seismic and thermal when it is combined, the seismic load is on the order of 80 percent of the overall load due to seismic. And the thermal would be in the order of 20 percent.

And for that case, we looked at very extreme delta Ts as in our standard plan. The range of temperatures that we -- the ambient temperatures that we design to range from minus 40 to 115 -- minus 40 in the winter and 115 in the summer. And that design is the design that we applied to the plant at Vogtle and the plant in Georgia and the plant in South Carolina.

And we'd look at both the winter condition and the summer condition. And you will see here -- this slide is showing that the winter -- the delta T across the structure, across the wall, for the winter condition is the most limiting. And it is 110 degrees across the structure, 70 degrees on the inside of the shield building and minus 40 degrees on the outside.

For the summer case, we look at the delta T as 45 degrees out and 70 degrees inside and 115 outside. And so you see our limiting case is the winter condition.

When we looked at the effects of solar gain -- and we can go into how we came up that -- we followed the ASHRAE standards that really provide the equations of how to predict the temperature effects of solar gain. For our shield building wall, those calculations show a surface temperature of 129 degrees for an ambient condition of 115.

So when you look at that, that would really increase. And that's looking at -- I believe 115 day and night?

PARTICIPANT: That's correct.

MR. CORLETTI: So assuming day and night, which is a pretty bounding effect -- the delta T for that summer case would go from 45 to something like 59 degrees. Still bounded though by the winder condition of 110 degrees.

So the effect of solar gain in the wintertime would really, in effect, lower that delta T -- lower the 110 degree delta T.

VICE CHAIRMAN ARMIJO: To get that 129, is that for a painted surface with high reflectivity? Or is it for --

MR. BAKER: A light colored surface.

VICE CHAIRMAN ARMIJO: Light colored surface. Okay. So you plan to paint this coating that's on it.

MR. BAKER: Right.

VICE CHAIRMAN ARMIJO: Okay.

MR. CORLETTI: So really when we do these calculations, we really show that for the AP1000 shield building, the design calculations that we've already done really bound any effect of solar gain that we could have envisioned.

We did also look at radiative cooling. So we have thought about that. And we have looked at that.

Tod, do you want to speak to that?

(No response.)

MR. CORLETTI: Okay. So with respect to the radiative cooling, in the wintertime, the surface temperature is on the order of -- on a minus 40 degree day -- jump in if I'm wrong -- it's something like minus 30 degrees.

So the effective emissivity due -- in that cold condition would be a couple of degrees. So it would be one or two degrees in the range of -- on the factor of --

MR. TUNON-SANJUR: It would be a small factor -- 22 for the cylindrical wall, the industry standards say that emissivity, that radiative cooling is negligible.

PARTICIPANT: For a vertical surface.

MR. TUNON-SANJUR: That's right.

MR. CORLETTI: For the vertical surface, I'm sorry, thank you, Tod.

So basically the ACI standards, it would say you take no panel before for emissivity. So the limiting delta Ts is still the 110 F that you did the calculations for.

(Chorus of agreement.)

MR. CORLETTI: We did perform additional calculations just to see what was the impact on the stresses for the summer case, for the limiting summer case with that 129. And it was -- it's on the order of a couple percent increase in the stresses due to the effect of solar gain on the summer case, which again was the non-limiting case.

The next issue that -- and the final issue in the structural area was on the issue of the PCS tank. And I think this, to explain, what the issue here was is that the analysis that was described in DCD 18 did not reflect a commitment that Westinghouse had made to the staff to address an issue as part of the shield building report.

The shield building report has identified how the design -- the hydrodynamic loads to the PSC tanks should be accounted for in a certain way. And that did not get reflected in the DCD. And we've subsequently updated the analysis and provided those results in DCD 19. I'll give you a little bit more explanation.

Just to digress a bit, in the hard rock certification that was included in DCD 15, Westinghouse performed equivalent static analysis, applying maximum acceleration for time history analysis for the structure, including the PSC tank. And that was what was certified.

Next slide please. When we went to the extension to soft soil, we did change our analysis method to use a response spectrum analysis using what we call the NI05 global model. In that and in the DCD, we identified that we would use the NI05 model to design the structure, including the PCS tank.

However, in portions of the roof, that was a more complicated structure that maybe was not adequately represented in that global NI05 model, we did retain an equivalent static methodology with a more detailed model. And we applied those results from that equivalent static method for the air inlet ad tension ring region. And that was what we had described in the DCD Rev 16 through 18.

Next slide. In the review of the shield building, I think the staff really asked us to perform the design of the PCS tank using that more detailed equivalent static model not only for the air inlet and tension ring but also to apply it to the PCS tank.

And we self identified after we submitted Rev 18 that we had not included those results from that equivalent static method that we applied for the air inlet and tension ring to the PCS tank. So what we did is we subsequently updated the analysis results in DCD 19 to use -- to reflect the more detailed method of the equivalent static method not only to the air inlet and tension ring but also to the PCS tank.

So essentially DCD 19 is really the same methodology as was done in the certified hard rock site of DCD 15. And that is now all included and the job site is now better. This is one of the areas where that licensing basis has clearly then identified in the DCD.

MEMBER SHACK: But that required no changes in the actual design itself?

MR. CORLETTI: That resulted in no changes to the reinforcement or to the structure or to the design. We did do updated calculations using that method. But as far as results or as far as the physical structure, it did not change.

That ends the structural portion of the presentation unless there's questions from the members.

MEMBER RAY: If nothing else, we can come back. Your guys aren't going to run to the airport are they?

MR. ZIESING: Nope, we'll be here.

MEMBER RAY: We'd better move on to the containment.

CHAIRMAN ABDEL-KHALIK: On Slide Number 6, you made the argument that when you include solar radiation, the outside surface temperature increases to 129 degrees so the delta T in the summer increases but is still sort of limited by the -- or smaller than the 110 degrees.

Does the sign of the gradient matter at all? Whether it's a positive gradient or a negative gradient in the radial direction?

MR. TUNON-SANJUR: Yes, we designed the structure as a symmetric structure both the reinforcements, whether the stresses are on the outside or the inside. The signs do matter in that there will be -- in the summer condition there will be more tension in the outer plates versus the cold condition in the winter.

Those are more of a localized stresses. The delta T was emphasized by Mike Corletti because the overall wall, the delta T dictates the bending of that wall.

In the localized area, those things do matter. However the study that we did for the thermal cycling, we actually have a much higher gradient than this 59 degrees of solar gain there. So answer to your question, yes, it does matter. That localized stress area had already been analyzed and accounted for for a different reason than thermal cycling using just --

MEMBER SHACK: But I think he was asking even in the overall structural response, which is what you're really doing in this particular case, you know, does the fact that you've got the delta Ts going different ways make a difference.

MR. BAKER: And we looked at both cases. And the envelope considers both cases.

MEMBER SHACK: Yes, I mean the statement was even though you -- with the 129, it was still smaller. You actually did the calculations. And the winter delta is still the limiting one. So they did -- they actually did the calculations.

CHAIRMAN ABDEL-KHALIK: Okay, so it's not just a simple argument that the delta T is small then the case for the winter. And therefore, it should be okay.

MEMBER SHACK: The smaller delta was where we were, I think, at the Subcommittee meeting. This now essentially so it verifies what you sort of expected with the rather are difference in the delta T, it's okay.

MEMBER BLEY: But just to follow that up because I'm curious, the bending is going to reverse directions when you change that. And the points were that while it connects top and bottom, it must behave very differently whether you're bending this way or that way. So is there something of an additive effect in summer or winter? And the opposite in -- one of those must be worse.

So you've done the calculations. So which one of those is worse and kind of why just to inform me.

MR. TUNON-SANJUR: The winter condition, it's -- we designed both sides of the plate symmetrically. And so we take the worst thermal, in this case in the inner portion, the winter condition would be worse, add it to SSC --

MEMBER BLEY: I didn't ask it right. If

you had the same delta T --

MR. TUNON-SANJUR: Yes.

MEMBER BLEY: -- summer and winter because the bending is reversed, which of those cases would be the most troublesome if one were in troublesome?

MR. TUNON-SANJUR: I would say summer would be for the solar gain.

MR. CORLETTI: No, I think he said at 110 in winter versus 110 in summer, which is the worst case. In our thermal cycling study, I believe the reason we presented it in the thermal cycling case, that 110 degree delta, because we showed it as a winter case was the winter results were a little bit worse. Do you agree with that?

MR. TUNON-SANJUR: The seismic changes sides in both directions.

MEMBER BLEY: Okay.

MR. TUNON-SANJUR: So it really -- so for us, whether the inner plate or the outer plate is worse, it's interesting but we -- like I said, we take the worst condition of either one of those two plates and assign both plates the same.

MR. BAKER: But we have combinations that consider both sides of seismic and both sides of thermal.

MR. CORLETTI: And we combine it. It's because they're looked at when we combine it with seismic.

MEMBER CORRADINI: Okay. Did you get your answer?

MEMBER BLEY: Not quite. I think I know what they're saying but I'm not sure.

So I think from what you just said that the problem area is the plate itself. So it doesn't matter whether it's bending one way or the other.

MR. TUNON-SANJUR: The winter conditions say the inner plate.

MEMBER BLEY: It's not the connection points.

MR. TUNON-SANJUR: Right. Both are designed symmetrically. In winter condition, the inner plate combined with SSC would be worse. However, we designed the outer plate just the same.

MEMBER BLEY: For the same loading.

MR. TUNON-SANJUR: And then for the same. And then in the summer condition, the outer plate would be worse. It would be the same. The signs would be reversed. And then we designed it. I would say the winter condition in general would be worse because you would have an additional effect of buckling of those plates instead of shrinking.

MEMBER BLEY: That's what I was trying to get to. Yes, okay. Thank you.

MEMBER SHACK: But it is a hypothetical anyway because the delta Ts --

MEMBER BLEY: Yes, I got it.

(Laughter.)

MR. ZIESING: Are we ready to move to the containment vessel pressure? Or are there more questions for these guys?

MEMBER RAY: I'd like to get on with containment evaluation.

MR. ZIESING: Okay. Thank you very much. And don't feel slighted.

MEMBER BANERJEE: So some part of this is open and some of it is closed? Or what?

MS. McKENNA: This is Eileen McKenna from the staff. We're going to try to proceed with this session as open as possible. It is possible that to answer fully some of the questions, we may need to go to a closed session. And we'll climb that if it arises. And that's what we'll have to do because we want to make sure your questions do get answered.

MEMBER RAY: Eileen, so that we don't go back and forth, I guess we will have to save those things to make sure we've got them all if we implement a proprietary session.

MS. McKENNA: Right.

MEMBER RAY: Okay.

MR. ZIESING: Let's go guys. It's like a hockey game. Fresh lightning here now.

PARTICIPANT: Just don't fly them in on a Yak-42.

MR. ZIESING: Okay. So we're going to lead discussion on the questions related to the containment pressure analysis. We have Tom Kindred, Rick Ofstun, Brad Carpenter up here. And I think Kent Bonadea is over in the wings if we need him.

And I think, Rick, you're going to lead discussion here?

MR. OFSTUN: Yes.

MR. ZIESING: Okay. I'll drive.

MR. OFSTUN: Okay. Good afternoon. I guess you already introduced us all.

This is essentially the same presentation that was made three weeks ago. However, we tried to address some of the questions and concerns that came up during that meeting.

First just a brief history of where we are with the containment pressure analysis or how we got to where we are. Back in DCD Revision 18, we had a peak pressure of 57.8 psi gauge. ACRS member questioned the scaling of our time to establish steady state water coverage.

We found that that needed to be corrected. And made that more conservative. And as a result, that increased our calculated peak containment pressure to 58.1 psi gauge.

That happened around the February-March time frame this year. At that same time, we discovered or we became aware of several generic issues that are related to the containment analyses and the calculation of the LOCA mass and energy release inputs.

And so we were requested to make some additional input changes to our LOCA mass and energy release model and containment model inputs to address those issues. And those changes --

MEMBER BANERJEE: How did those issues come to light? Did the staff do an audit? Or --

MR. OFSTUN: No, internal -- Westinghouse internally, we just discovered we had not selected as conservative inputs as we could have. And so --

MEMBER BANERJEE: For the mass and energy release?

MR. OFSTUN: For the mass and energy release calculations.

MEMBER BANERJEE: And what was missing there? Just remind me. Was it some structures inside?

MR. OFSTUN: Yes, there were some -- I have a list here. Steam generator secondary pressure -- we used the pressure in the steam line rather than in the tube region of the steam generator. We hadn't realized that we were doing that.

The steam generator pressure in the tube region is about 30 psi higher. And as a result, the initial stored energy in the steam generator is higher.

MEMBER BANERJEE: I'm really interested to understand what was the process that you went through to find this. Did it just happen by accident? Or did it happen --

MEMBER SHACK: Did you do an internal audit? I think that's what --

MEMBER BANERJEE: Yes, was it an audit? Or when this issue arose, did you --

MR. ZIESING: I think there's -- I'll try to address this at first. There's no single reason for the variety of input changes. As part of design finalization, auditing, you know, just the different looks that occur.

There's various reasons that identified the minor discrepancies. And as part of our corrective action program, they are captured in our correction action program.

And any time any one of those is identified, the impact is evaluated and actions are identified. And up to that point in time, each of the discreet issues had been evaluated to be minor and were basically queued up to be put into a correction at some later date, okay?

MEMBER BANERJEE: So they had accumulated over a period of time?

MR. ZIESING: So some of them had accumulated over time and they were in our corrective action system. We knew about them. Maybe there was not situational awareness, you know, of them until this issue with the steady state film coverage came to bear and we started looking at updating the calculation.

And that caused people to -- as part of updating those calculations, you look in your corrective action program. And there's also just, you know, knowledge that people have to say hey, there's these other factors out there. What do we do?

And so internally, they sought guidance from Licensing. And we had some consultation with the staff. And it was decided that the right thing to do is to go ahead and sweep all these things into this update.

MEMBER BANERJEE: But just -- the staff is not going to appear in front of us because they've finished their final SE of course. And we're reviewing this after the final SE.

So -- but just from -- to get some clarity, did the staff come and do an audit or something of this mass and energy release at about this time? Or what happened?

MR. ZIESING: No, we self identified the issue. These were generic issues so they effected all Westinghouse plants. And we informed the staff. And I can't -- do you remember? Was that February or March time frame?

And of the -- there were a number -- there five to six issues that were generic that were discovered. And of those, two impacted the AP1000 design.

MEMBER BANERJEE: And you discovered them yourself?

MR. ZIESING: I didn't discover them but other people within Westinghouse did, yes. And as a result, obviously then we asked ourselves, you know, is there anything else. What's the extent of condition? And we did our own independent assessment of extent of condition.

Customers formed a team as part of the design center working group, came in and took a look at, you know, our CAPS program, make sure we didn't miss anything. And then there was also an AIA inspection that the staff conducted that the scope of that inspection was expanded to include a review of our corrective action program.

And so, you know, it was looked at to some degree in that context as well. So if you're asking because, you know, is there anything else out there and are we going to change it again -- I think we shook the tree pretty hard --

MEMBER BANERJEE: Okay.

MR. ZIESING: -- to make sure that we captured everything that we needed to at this point in time.

MEMBER BANERJEE: That was part of the question obviously.

CHAIRMAN ABDEL-KHALIK: But from a generic standpoint, do you have any way of checking for latent errors? Not just related to this particular calculation.

MR. ZIESING: Could you elaborate on your question a little bit?

CHAIRMAN ABDEL-KHALIK: Well, there may be some other areas for some other calculations. Is there a QA program where you periodically do --

MR. ZIESING: Yes.

CHAIRMAN ABDEL-KHALIK: -- sampling checks to make sure you don't have any latent errors in your documentation?

MR. ZIESING: The answer is yes. We do have a program that looks at that. Our corrective action program is a very comprehensive program where we set a very low threshold for identification of issues that first should be identified and put into CAPS -- into our corrective action program.

Each item goes through a weekly screening review of a cross section of the business experts so we can levelize the issues. And periodically there's trending done to understand, you know, are there a series of small order issues that are looking like a trend that we have to, you know, take a harder look at to understand. So --

MEMBER RAY: Rolf, I think the issue here, you referred to it as situational awareness -- was there some lesson learned from the fact that these things were known but had not yet been incorporated that based on that lesson learned, you feel that that situation doesn't exist or won't exist in the future in which there are recognized problems but they are accumulating before you issue a revision?

I mean this is a common thing to have happen, a backlog of corrective actions. But that I think is what we're asking about here. Not so much that there's an error that you haven't discovered but there's not timely action taken in the event that --

MR. ZIESING: I feel confident that our system is sound and protects us against that type of thing.

Some of the nuances with this particular issue, you know, we're -- there were some judgment calls made in terms of, you know, what is the significance of this. And it was, you know, we wanted to be transparent and, in fact, I'll say initially there wasn't alignment within the staff on the need to deal with this, okay?

And we probably, you know, lost a couple of months in terms of being able to jump on this and put it to bed because initially we thought that these small errors didn't need to be included at this time because they were not considered to be significant.

But because -- then it was realized it is related to a tech spec and there was some legal involvement that, you know, it's really important as we certify the rule, if we have any known knowledge of a tech spec being in error, that we didn't want to have any uncertainty associated with that.

And so, you know, we went ahead and made the correction. But technically it was viewed as insignificant. But it was a matter of principle, you know, and setting the right standard for the tech specs. It was something we decided we were going to correct.

And we don't think we have -- I'm not aware. We've looked, okay, broader. I'm not aware of any similar situation. And if we did encounter something like that, then we'd have to identify it and do the right thing.

MEMBER BANERJEE: Sure. It has sort of strong legal implications once you go into rulemaking, right?

MR. OFSTUN: We didn't want an question regarding the tech spec requirement for the pressure test, you know, to come up and cause a wrinkle in the rulemaking process.

MEMBER BANERJEE: Okay. Let's go on. Sorry. At least you've clarified that.

MR. OFSTUN: Thank you.

So after making all those changes to the model, our final result here is that our peak pressure for DCD Rev 19, that's reported in DCD Rev 19, is 58.3 psi gauge.

The approved modeling methodology that is applied in the LOCA mass energy release and containment response evaluation models is conservative. I think we had a question the last time on whether we're using a best estimate method or a conservative method. It is a conservative method.

We try to select conservative input values to bias the initial stored mass and stored energy in the system for the mass energy release. And we try to bias the mass energy release so that we dump the energy out as quickly as possible.

We also try to select conservative input values to bias the containment pressure calculation in an upward direction. And those conservative input values would be things like that would reduce the condensation rate on the inside or the heat transfer rate to the outside.

MEMBER BANERJEE: But as far as I know, you are using correlations which you multiply by some number.

MR. OFSTUN: Yes.

MEMBER BANERJEE: But the number seems to me to be just one standard deviation lower than your best estimate.

MR. OFSTUN: Yes, that is what it is.

MEMBER BANERJEE: Yes, so it is not particularly conservative.

MR. OFSTUN: It's more conservative than nominal, yes.

MEMBER BANERJEE: Yes. But --

MEMBER CORRADINI: There's no methodology for containment analysis the way there is for peak clad temperature if that's where you're going.

MEMBER BANERJEE: Yes.

MR. OFSTUN: Right.

MEMBER BANERJEE: So it's not an evaluation model in the usual sense of what we do for peak clad temperature? Okay. So it is a little conservative, not completely.

MR. OFSTUN: Okay.

MEMBER RAY: There's no claim that it is

bounding in other words.

MR. OFSTUN: No, it's not bounding.

MEMBER BANERJEE: It's not two or three derivations.

MR. OFSTUN: No, it's only one standard deviation on those multipliers, yes.

So in addition to the changes to the mass energy release model inputs, we made changes to the containment model inputs. And those changes were either corrections to make the calculation more conservative or they were to reflect updated plant design information.

After making those changes, we found that our containment peak pressure was too high. And in order to maintain it within the design basis, we had to take credit for existing heat sinks that are in the plant and in the model but not turned on normally. And I guess our other goal is to try to maintain about the same amount of margin that's reported in the DCD Rev 18 in this new model.

MEMBER BANERJEE: Could you just elaborate a little bit on this? If I understand it, since you are trying to shave this peak pressure, you need heat sinks which have a fairly rapid response. So things like the grating clearly do because they're there. So they are short term, so responding -- quick-responding heat sinks -- long-term responding heat sinks.

Did you use most of the short-term responding heat sinks that you could?

MR. OFSTUN: No.

MEMBER BANERJEE: Okay. So what other short-term responding heat sinks are there other than these gratings?

MR. OFSTUN: We used grating that we knew were --

MEMBER BANERJEE: Rapidly responding.

MR. OFSTUN: -- well, that we knew that we had data for that we were confident was not going to be changed.

MEMBER BANERJEE: Okay.

MR. OFSTUN: So we selected the gratings that were in the CMT compartment, for example. There's a big --

MEMBER BANERJEE: Right.

MR. OFSTUN: -- floor in there that's a large heat sink for us. We hadn't included these heat sinks previously because the design had not gotten to the point where it was certified for construction.

And so we were instructed don't include the floors, the gratings, that kind of thing because they may change in the final design -- or the properties may change.

MEMBER BANERJEE: So what else is there potentially?

MR. OFSTUN: Well, so we used the grating in the CMT compartment. We used some gratings in the accumulator compartments. We used some gratings that were above the operating deck as well. But I believe there's more gratings that we aren't -- haven't credited yet.

MEMBER BANERJEE: Are they deeper down?

MR. OFSTUN: No, there's -- and there's some additional heat sink above the operating deck that we haven't credited yet.

MEMBER BANERJEE: In a reasonably well mixed region.

MR. OFSTUN: Yes, in the reasonably well mixed region. That would be, for example, the HVAC ductwork.

MR. KINDRED: The HVAC ductwork is a galvanized metal. None of the cranes are credited, only the girder on the polar crane itself. The hoist on the polar crane is not credited. The gip crane is not credited. The fuel-handling crane is not credited.

In reality, these were easy -- geometrically, the gratings were easy to represent. A as far as trying to geometrically represent the effective heat transfer service area of a crane or a crane hoist, that's a little more complex.

MEMBER BANERJEE: Of course it's hard to do heat transfer calculations on gratings. But when you did that, you sort of just took the vertical surfaces in the grating, did a sort of slab type calculation. Is that what you did?

MR. OFSTUN: We did a slab calculation. We calculated --

MEMBER BANERJEE: Has this been done before? Have other people done this? Or have you done it for other Westinghouse plants?

MR. OFSTUN: In our standard analyses, usually we have a lump parameter, single volume containment model. And there are ten to 12 heat sinks. So I'm not sure if some of the gratings are included in one of those ten or 12. But most likely they are but I can't say for certain.

MEMBER BANERJEE: So WGOTHIC, when you -- was authorized in some way to handle this? Mike is nodding so he knows this stuff.

MR. OFSTUN: There's a -- the validation

report for WGOTHIC and for our AP600, AP1000 containment models is WCAP 15846. And in there it discusses how we conservatively model the effects of circulation and stratification. And those effects on the condensation heat mass transfer inside the containment.

MEMBER CORRADINI: So just one thing on that. When WGOTHIC has been validated, this is the lump parameter version, not the distributed parameter version.

MR. OFSTUN: That's right. This is --

MEMBER CORRADINI: You've not gone through the validation of the other version of GOTHIC where you essentially saw more of a CFD formulation.

MR. OFSTUN: That's right. We -- I think we started down that path and then we switched to the lump parameter path when we were working --

MEMBER CORRADINI: I thought so. I just wanted to make sure. Okay.

MEMBER BANERJEE: Yes and so the methodology is accepted by the staff --

MR. OFSTUN: Yes.

MEMBER BANERJEE: -- and has had previous applications to --

MR. OFSTUN: Yes.

MEMBER BANERJEE: All right.

MR. OFSTUN: Yes. And the modeling methodology for the containment was compared to test data.

MEMBER BANERJEE: Okay.

MR. OFSTUN: At least for GOTHIC code, for a number of different --

MEMBER BANERJEE: So the gratings now become the --

MR. OFSTUN: Yes, and that's the next bullet there. That those heat sinks have been added as a Tier 2* item.

MEMBER BANERJEE: Can we -- are you going to visit this question of the accumulator that arose during the Subcommittee meeting and the effect of whether isothermal or adiabatic and potential effects, if any at all on the containment pressure?

MR. OFSTUN: Yes, Tom's looked into that.

MEMBER BANERJEE: Could you just make a statement for the record on that?

MR. KINDRED: Could you -- could I ask you, Dr. Banerjee, to elaborate your question just a little bit? What exactly --

MEMBER BANERJEE: Well, the reason I'm asking it is that there was an issue about whether the discharge from the accumulator was presumed to be under adiabatic conditions or isothermal conditions. And there was some discussion about under what conditions the density should be taken.

MR. KINDRED: Okay, yes, Dr. Banerjee, I understand.

MEMBER BANERJEE: If you recall --

MR. KINDRED: I recall it.

MEMBER BANERJEE: Yes.

MR. KINDRED: Dr. Wallis, I think, brought that up when he reviewed the report.

MEMBER BANERJEE: Right.

MR. KINDRED: He noticed that when we calculated the expansion of the accumulator, when we determined what the mass flow rate was, we looked at the variance and volume. And we said okay, if we push this much volume out, to convert it to a mass flow rate, you have to know the density.

So you assume the density at 120 degrees Fahrenheit as opposed to minus 140, which is what we calculated the final gas temperature to be. So at minus 140, of course the density of the gas is going to be much larger than it would be at 120. So he wondered if that was an error or a, you know, something that we should have considered more conservatively.

I redid the calculation and we stated -- we did both calculations in the analysis. We did an isothermal and an adiabatic.

The isothermal yielded a much larger volume expansion into containment than the adiabatic heat up did -- 2,300 cubic feet as opposed to around 70 cubic feet -- 2,300 being the isothermal volume expansion of the containment, 70 being the adiabatic volumetric expansion and containment.

However, the 2,300 cubic feet volumetric expansion was performed at 120 degree Fahrenheit. If you did the volumetric expansion at minus 140, your total volume expanded in the containment would be about 376 cubic feet, which would yield a mass flow rate of 6.15 pounds per second for both accumulators as opposed to 20.8, which I believe was used in the analysis.

So it was very conservative to assume the isothermic. Even regarding the density. And it was not erroneous because 120 degrees Fahrenheit was consistent with the assumptions of the isothermic calculation methodology.

MEMBER BANERJEE: And what is the effect on containment pressure in terms of if you made it additive or not? Is it a small amount like .01?

MR. KINDRED: The intensity of the psi. And that's with the overly conservative calculation.

MEMBER BANERJEE: Two-tenths of the psi. All right. Fine. May we put that to bed.

There was another related to the accumulator but I don't know where we what to consider that, which was the question of the temperature.

MEMBER SHACK: The effect of the temperature on the pressure boundary?

MEMBER BANERJEE: Yes, well on the DVI line in particular.

MR. OFSTUN: Yes.

MEMBER BANERJEE: So in particular, Bill was going to discuss that? Or do you want to ask those questions? Or do you want me to do it?

MEMBER SHACK: Well, we have the thermal hydraulocists up now. We should have had the structures people -- the question is whether you've considered the thermal loading on that pipe and whether it would have significant effect.

MR. KINDRED: I can answer this.

MEMBER SHACK: The load temperature, yes, go ahead.

MR. KINDRED: Actually if you look at it

logically, your gas initial or thermal inertia, the amount of energy that the gas can impart when compared to water for instance, if you compared the mass of the gas in the accumulator with the water, at a minus 140 degrees, the energy that the gas would have to -- if the gas imparted all of its energy to heat the water back up to 120 degrees, if the gas imparted all of its energy to heat the gas back to 120 degrees Fahrenheit, it could only change the mass of the water in the accumulator by one degree -- less than one degree -- a half of a degree.

MEMBER BANERJEE: But that's all the water right? But --

MR. KINDRED: That's correct.

MEMBER BANERJEE: -- if you put a thin film of water on the surface, it would freeze.

MR. KINDRED: Right. You have considerations regarding, you know, localized effects. What happens at the gas liquid interface? What happens at the discharge of the accumulator?

So a simple simulation using the GOTHIC, this is different from WGOTHIC.

MEMBER BANERJEE: But GOTHIC is a lump parameter, right?

MR. KINDRED: Actually, a simple model was made with an accumulator tank, nodalized to contain a blanket of nitrogen gas with liquid benefit at 120 degrees Fahrenheit. The LOCA accumulator injection flow rates from the calculation for the limiting temperature decrease associated with accumulator expansion was used. And pulled the liquid and the gas out of the accumulator.

The DVI line -- a five-foot section of DVI pipe was modeled just at the discharge of the accumulator line. And in reality, the temperature -- the surface temperature of the inside of the accumulator tank was approximately 115 degrees after -- at the end of injection or about a -- I let it run for 150 seconds after the end of injection to allow the gas to expand into the DVI line to ensure there would be no pronounced thermal gratings associated with the gas.

The DVI line itself, surface temperature decreased to approximately 110 degrees. The DVI line is very thin, approximately .312 inches. I don't know if I can get into that detail in an open session however the DVI line is thin. It easily promotes a rapid response with regards to convective cooling.

MEMBER BANERJEE: Could we take the detail up in a closed session because there are a number of questions here we need to pursue. First of all, of course the applicability of GOTHIC to a situation like this where you can get cold gas on top of hot gas. So you can get curious effects with GOTHIC that are hard to defend.

Secondly, you know, these are transient effects and the heat transfer proficiencies on the inside of the line and the natural convection outside --

MEMBER SHACK: I realize you have a great interest in the thermal hydraulics of this. But from a structural point of view, if we have some thermal stresses on this pipe, it's, you know, one cycle of perhaps some plastic stress. This is not going to fatigue. You know, it's not a broken material. You know, it's going to yield.

MEMBER BANERJEE: I'm happy to hand this over to you.

MEMBER SHACK: If we did this once a year, we might have a problem over 60 years.

MEMBER RAY: Let us -- we're just now beyond halfway in our time. So let me do suggest that Bill engage any discussion here or provide his assessment. And then we'll see if we can move on.

MEMBER SHACK: Yes, I mean that's my -- my argument is that, you know, whatever questions you have about the thermal hydraulic analysis and the temperatures, it would have no impact on the structural. That, you know, we could take the whole temperature drop, calculate it as conservatively as you want.

MEMBER BANERJEE: Well, I think that's the issue. If it's the bounding face of minus 140 or whatever --

MEMBER SHACK: Right.

MEMBER BANERJEE: -- and if you can live with, then it doesn't matter.

MEMBER SHACK: Now Graham, he had a thermal shock picture in mind. And you just don't thermally shock stainless steels. They take plastic string at any temperature you want to give it to them.

And so from a structural point of view, I don't think there's any problem here. And, you know, we probably ought to pursue the thermal hydraulics as an --

MEMBER BANERJEE: But we don't need to.

MEMBER SHACK: Yes, okay.

MEMBER CORRADINI: I can concur.

MEMBER BANERJEE: But I'm only doing it because you don't seem to want to pursue it.

MEMBER SHACK: I don't really trust it but --

MEMBER BANERJEE: Yes, all right.

MEMBER CORRADINI: And I think what we did commit that this piping, the structural design of the piping is part of the piping DAC. It's not part of the certification.

So you're absolutely right. The thermal hydraulic trains that gets characterized for this transient, this isn't a condition 2 event. It is a condition 4 event, which we don't do fatigue evaluations. So we would look at the stresses to meet condition 4 events. And that documentation will be included one way or another as part of the piping DAC, the final piping DAC.

MEMBER RAY: Okay. But from our standpoint, we would -- because we don't necessarily agree with the temperatures you'd be using, it would be better if we could simply bound it and say it is not significant rather than to say we will do it and keep track of it.

MEMBER BANERJEE: Or do something which if you need to get the transient -- my suggestion would be not to do it with GOTHIC. But that's up to you.

MR. KINDRED: I will say, Dr. Banerjee,

that I did benchmark the model to the isothermal expansion case. And the model did very well predicting what we predicted with the isothermal expansion. And it is interesting that the nitrogen injection, those were benchmarked to the Spazenosa test. I mean so that was -- those were prototypic nitrogen injections. And they did agree with what they predicted in an isothermal expansion case.

MEMBER BANERJEE: Okay.

MR. KINDRED: But prior to adding -- and all I did that after that, after I benchmarked to the isothermal case was add the thermal conductors to simulate heat sink or heating to the environment, heating from the sensible heat of the accumulator metal and --

MEMBER RAY: Again, insofar as what Dr. Shack talked about, I think it is better at this point if we bound it and conclude that from our standpoint it is not -- we don't need to pursue it or make the assumption that you have proven it to be true.

MEMBER BANERJEE: Or it will be dealt with elsewhere.

MEMBER RAY: Well perhaps.

MEMBER BANERJEE: Yes.

MEMBER RAY: As long as there is not -- I just don't want to get into trying to make sure we agree with the last statement made here, because that will take us forever and we won't achieve our aim.

MEMBER BANERJEE: Okay. Well I think it is fine. Let's go on.

MR. OFSTUN: Okay, the next plot shows a comparison of the DCD Rev 19 to the DCD Rev 18 containment pressure response. And the reason for this plot originally was to show that they are very similar and that the containment pressure increase early in the event is what caused the peak to be higher at about 1200 to 1500 seconds.

We were asked about this plot to find out why the pressure response on the DCD Rev 19 falls below DCD Rev 18. That was the question. And so we looked into that by doing some sensitivity studies and found out that the reason is that the new mass and energy releases shift or shifted toward the earlier in time with the conservatisms that we have added and they move earlier in time. And as a result, that plus the fact that we have included some additional thin metal heat sinks that absorb that energy early in time and don't give up very easily, that the curve shifted and crossed over the other curve.

MEMBER CORRADINI: So let me say it

different to you so I get it right, since I wasn't here. So you are saying in your energy budget, what you release is the same but it comes out earlier and some of it is sucked up in your heat sinks that you have now included.

MR. OFSTUN: Yes, our energy --

MEMBER CORRADINI: And they don't give it back up to later than --

MR. OFSTUN: Right.

MEMBER CORRADINI: -- to where the red line is.

MR. OFSTUN: Right. But our energy budget wasn't exactly the same because we had added some energy for this new generator pressure correction.

MEMBER CORRADINI: Excuse me. Okay, excuse me. I'm sorry. That's right.

MR. OFSTUN: So it is still a little bit higher than what we started with. We just, we do push it out earlier because we changed our equilibration value.

MEMBER CORRADINI: Okay.

MR. OFSTUN: So at the last meeting, the ACRS requested further review concerning the impact of solar radiation heating on our larger scale passive containment cooling test results and how that information is applied to our containment evaluation model.

The primary modes of heat removal from passive containment are condensation on the inside surface of the shell and evaporation from the outside surface of the shell.

We looked at all the test data. Only two tests, the large-scale test and the small scale test were performed outside in the sun or in the environment. We did not use any of the data from the small scale test facility for anything. But for the large-scale test, we did look at the data in terms of the condensation, heat-mass correlations and the convection heat transfer correlation.

Again, we used the multipliers that we are talking about for the condensation and the conduction correlation and we don't use the convection correlation in our model at all, actually.

When we looked into this, we found that the solar radiation did not have any impact on the large-scale test data that was used for validation of the condensation heat mass transfer correlation. And this was because the large-scale test is fairly well instrumented and so we knew temperatures and heat fluxes around this vessel, around the perimeter of this vessel and on top of the dome. And when we did the heat balance, the heat in from the steam was approximately equal to the heat that was going into the containment or into the steel shell of the large-scale test facility.

MEMBER BANERJEE: Actually, you had more than that but carry on.

MR. OFSTUN: Okay.

MEMBER BANERJEE: Finish off.

MR. KINDRED: Not for the condensation test.

MR. OFSTUN: The convection tests they did. We did see a difference there.

MEMBER BANERJEE: No, no. I'm saying even for the condensation tests that you did with the water film, you had three heat balances if you look at of when you are reporting contained.

MR. OFSTUN: Right.

MEMBER CORRADINI: To your credit.

MEMBER BANERJEE: So but you have a heat balance based on how much condensed and you have a heat flux meter in the wall? Then you have a heat balance on the air and water stream.

MR. OFSTUN: Yes.

MEMBER BANERJEE: Right? And you compared all three heat fluxes.

MR. OFSTUN: I didn't compare the heat flux on the water stream and air on the outside of the vessel.

MEMBER BANERJEE: You have a figure in the report 331 if you check it.

MR. OFSTUN: Okay.

MEMBER BANERJEE: You will see that they are also there.

MR. OFSTUN: And that is in the large-scale test data report?

MEMBER CORRADINI: The big monster report.

MR. OFSTUN: Okay.

MEMBER BANERJEE: Yes, 331 compares that.

MR. OFSTUN: Okay. I haven't looked at that for a long time.

MEMBER CORRADINI: We recommend you might. One of the engineers.

MEMBER BANERJEE: Who were the people who did this test? Were you involved with this?

MR. OFSTUN: No, I was not involved with those tests.

MEMBER BANERJEE: They are very nice experiments, by the way, but the internal velocity measurements didn't work worth a damn.

MEMBER CORRADINI: Yes, the turbine meters were crappy.

MEMBER BANERJEE: Exactly. But they do show a lot of interesting things. Because I agree, by the way, with that first statement. I looked at it myself in some detail.

MR. OFSTUN: Okay.

MEMBER BANERJEE: So you have independent corroboration but I wanted you guys to say that as well.

CHAIRMAN ABDEL-KHALIK: Okay. Let's say, granted you may have extracted the correct data out of the large-scale test facility, in doing the actual calculation for the actual steel containment and shield building, the incident solar radiation part of it makes its way to the inside surface of the shield building. If you are looking at it on a steady state basis. Right? And therefore, that heat flux has to be removed by the natural convection air that is ultimately used to remove decay heat through the film. And therefore, there is an increased heat load on the liquid film.

Is that accounted for in your calculation?

MR. OFSTUN: No. We do not model the solar heat flux on the outside of the shield building and the effects of that through the shield, as it conducts energy through the shield building and into the air.

CHAIRMAN ABDEL-KHALIK: Would that have an impact on the heat load? I mean, you know, the incident solar radiation on the shield building can be as high as a few megawatts. And part of it --

MEMBER RAY: Of course, we're no longer talking about the large-scale test. We are talking about the real world.

CHAIRMAN ABDEL-KHALIK: Correct.

MEMBER RAY: Up until you asked that question, we had been talking about the large-scale test.

CHAIRMAN ABDEL-KHALIK: Correct. And I started my statement by saying granted, you may have extracted the correct data out of the large-scale test facility and now you are using that data to calculate the containment pressure and the effectiveness of the film in cooling, in removing decay heat essentially.

So we are saying that incident solar radiation on the shield building, part of it, will make its way to the inside surface of the shield building and, therefore, will make its way to the natural convection air that is used to remove decay heat from the liquid film. And if that is the case, this is effectively the same as increasing decay heat.

Has that been accounted for?

MR. OFSTUN: I have to think about that. As I said earlier, we do not model solar heat flux in the containment model. We don't add a heat term to the outside of the shield building. It would be a variable over time. So, it might be the other way and during the day it is in.

CHAIRMAN ABDEL-KHALIK: Right. You know, you can't assume when the accident is going to happen.

MR. OFSTUN: That's right.

CHAIRMAN ABDEL-KHALIK: But being a pessimist, the accident will happen during a time of the day when the heat flux is maximum, you have a lot of heat being conducted across the shield building to the inside surface.

MR. KINDRED: Dr. Khalik, there is a film of water on the exterior containment --

CHAIRMAN ABDEL-KHALIK: I understand. I understand. Look at it globally.

There is heat coming in that is being removed by the downward flowing air current on the inside surface of the shield building. And that air is going to make it back up, removing the heat by evaporation from the thin film.

So you have essentially hotter air that is being used to cool the film.

MEMBER RAY: It would be like an increase in the ambient air.

CHAIRMAN ABDEL-KHALIK: Correct. Has that been taken care of?

MR. CORLETTI: Can I try to answer part of the question before you do that?

We presented to you the surface to the solar gain on an increase of 14 degrees on the outside plate. That gradient does not work this way all the way through the structure.

So the inside wall, inside structure -- What's the increase?

CHAIRMAN ABDEL-KHALIK: Whether it works its way all the way through the structure or not, there is some finite heat flux on the inside surface of the shield building.

MR. CORLETTI: So I think the answer is we did not account for that increase on the inside temperature. It is less than one or two degrees. It is on the order of one or two degrees on the inside.

CHAIRMAN ABDEL-KHALIK: It is not a matter of how high the temperature is. It is a matter of what is the inside surface heat flux and what that contributes to the heat load.

MEMBER RAY: As we said, it is equivalent to increasing the ambient air temperature, in a sense.

MEMBER BANERJEE: Let them answer this.

MEMBER RAY: Okay. I'm just trying to avoid the argument that it is only a degree or two because the wall is so thick.

Actually the air flows from the outside to the inside.

MEMBER BANERJEE: Right.

MEMBER RAY: And the issue is if you heat the outside, what effect will that have not just on the inside surface of the shield building but also on the air that is flowing into the space.

MR. OFSTUN: That would be probably higher.

MR. KINDRED: And I will say that --

MEMBER RAY: Of course it would be.

MR. KINDRED: -- in the evaluation of the enhanced shield building design for Revision 18 of the DCD, the air in that area was reduced by approximately 40 percent. I don't know the exact numbers there, but it was reduced significantly, which would have caused a significant decrease in the airflow you are talking about.

That significant decrease in that airflow did not result in an impact to the pressure valves.

CHAIRMAN ABDEL-KHALIK: But these are all sort of qualitative arguments.

MR. KINDRED: Well you had mentioned the air temperature. And the air temperature is important but so is the airflow. So is the air velocity. In that region you decrease the air velocity, decrease the amount of mass airflow in that region and still have no impact because the primary mode of cooling is the evaporation of the film, due to conductive heat from the shell not from what the air is doing to the outside of the film.

CHAIRMAN ABDEL-KHALIK: Now at 1300 seconds, is 1300 seconds is the time at which you reach roughly the peak containment pressure. At that point, decay heat is how many megawatts?

MR. KINDRED: I don't know off the top of my --

CHAIRMAN ABDEL-KHALIK: Roughly two percent.

MR. KINDRED: Two percent?

CHAIRMAN ABDEL-KHALIK: Right. Two percent that means what, 60 megawatts.

So what would be the effect of increasing decay heat by a few megawatts?

MR. OFSTUN: The decay heat's very small impact at the time of peak pressure, most of that energy that is due to the heat coming out of the steam generators and not of the RCS metal. I don't have the numbers in front of me but the decay heat will come out continuously. But it is after about 10,000 seconds, all the energy is decay heat in our model and none of it, because we dump everything else out into the containment atmosphere from the RCS.

MEMBER BANERJEE: I guess he is asking how much decaying heat are you putting out.

MR. KINDRED: He's asking what is the contribution of decay heat at the time of peak pressure.

MEMBER BANERJEE: No, not decay heat. Solar radiation.

So let's say the solar radiation is a couple of megawatts, two to three at most. I mean, my calculation shows actually, depending on the angle --

MR. OFSTUN: On the real containment?

MEMBER BANERJEE: Yes, it is not that high. But let's say it is a few megawatts, two or three megawatts. But you are dumping what? How many seconds or whatever? That is really the question he is asking you.

MR. OFSTUN: How much we are evaporating at the time of peak pressure?

MEMBER BANERJEE: No. How much heat are you dumping inside of containment that you have to take care of. Or what is the heat you are losing? What percentage of this would be the solar insulation?

MR. OFSTUN: Oh, okay.

MEMBER BANERJEE: It would be one percent, 105 percent, 1005 percent? What is the number?

MR. OFSTUN: I would need to know the total and I don't have that off the top of my head either. Is Bob Jakub on the line?

MEMBER BANERJEE: Around the maximum peak. I mean, really what we are after is can it affect the peak pressure significantly at all. That is the question. That is what they are after.

MEMBER RAY: To the extent that it is equivalent to raising the ambient temperature, I don't see how it could not. But I keep coming back to this is a problem of basically equivalent to raising the ambient temperature. I don't want to try and answer for you beyond that.

MEMBER CORRADINI: I mean, you are asking a quantitative question. Unless you have exact quantitative things you are not going to get an answer for it.

My quick estimate is the solar flux is no more than about one or two megawatts out of 70.

CHAIRMAN ABDEL-KHALIK: But the problem is the peak containment pressure is, the margin is so small and that is why these questions keep coming up. What is the effect of the incident solar radiation on the peak containment pressure, even though it is indirect heating?

MEMBER CORRADINI: But the heating is not -- The heating is affecting the inlet air temperature. It is not affecting what is appearing on the evaporative surface of the containment shell. Right?

CHAIRMAN ABDEL-KHALIK: You can look at it anyway.

MEMBER CORRADINI: But I mean, that is what is effecting. So my question would be, have you considered the effect of the inlet air temperature and how it effects the pressurization inside? That is the parametric I would do. Because if you vary the inlet air temperature, how do you change the peak pressure inside containment?

MR. OFSTUN: It is relatively insensitive to that because evaporation is the key heat removal.

MEMBER CORRADINI: During that time period.

MR. OFSTUN: Yes. We run cases, sensitivities to air temperature and they are documented in the WCAP 15846 and I think it is in section ten.

MEMBER BANERJEE: Well that would be helpful, I think, to refer to that.

MR. OFSTUN: But again, I don't have this in front of me.

MEMBER CORRADINI: My way of interpreting at least in my mind is that is the question to ask. If I am uncertain about the inlet air temperature due to essentially whatever is happening on the outside of the building, how does that affect peak pressure? If the answer is it doesn't affect the pressure more than a tenth of a psi, then you need to know a quantitative, you have got to be pointed to some quantitative place to look at that.

MEMBER BANERJEE: I think that is a fair way to look at it, what Mike is saying.

MEMBER RAY: Okay, in the interest of time, and given that we have the staff and a member of the public to hear from also, can we table this and ask you to come back with it at a time the chairman will fix hopefully yet today and resume the discussion? Otherwise, we are just going to burn up time here that we can't afford to do.

MEMBER BANERJEE: Have we dispositioned the effect of solar radiation on the correlations that are used? Because the question that was asked was specifically since you used the large-scale test for validation of your correlations, did solar radiation affect the validity of the validation process of these correlations?

MR. OFSTUN: And our answer is that it didn't affect the condensation correlation.

MEMBER BANERJEE: And that is the only one you used?

MR. OFSTUN: And that is the only one that I used the large-scale test for.

MEMBER BANERJEE: Now moving on to the convection case, what did you find? Even though you did not use it, since you brought it up, now you have to. How did you find it affected it?

MR. OFSTUN: Well what we found is that we either thought that the impact of it of the solar radiation on the dry convective heat transfer test caused the outer temperature to be higher than what it would have been otherwise. And what we saw when we compared the heat rates from inside the vessel through the steam and the heat flux times area in the shell, that they did not balance. That that heat flux was lower than it should have been.

MEMBER BANERJEE: Which was lower?

MR. OFSTUN: The delta T.

MEMBER BANERJEE: Which is what you would expect. Right?

MR. OFSTUN: Yes.

MEMBER BANERJEE: So in which direction did the solar radiation take it?

MEMBER RAY: Conservative or non-conservative?

MR. KINDRED: Conservative because it would have under-predicted the measured body of the heat transfer of the convected heat transfer coefficient.

MEMBER BANERJEE: Can we put that on the record? We agree with you.

MEMBER CORRADINI: This is, as he said, the convective tests? I'm sorry, the convector test?

MR. OFSTUN: Yes, the dry convective test.

MR. KINDRED: It is the impact of solar radiation on the measured convection heat transfer coefficient would have been to bias the measured heat transfer coefficient in a conservative direction.

MEMBER BANERJEE: Right. There's a good -- I mean, if you do the math, you can show that.

MR. KINDRED: Absolutely. I mean, the result of the solar radiation impedance of solar radiation or solar flux is going to be to heat the shell. If the shell temperature, your Q equals HA delta T, the delta T is smaller. Therefore, your convective heat transfer coefficient will be smaller, which is conservative.

MEMBER BROWN: It will do what? The convective heat transfer coefficient will do what, H?

MR. KINDRED: No, the convective heat transfer coefficient simply is Newton's law of cooling Q equals HA delta T, where delta T is the surface temperature of the containment vessel as opposed to T infinity or the surface temperature of the air.

The effect of solar radiation would be to heat the shell, the shell temperature, thus reducing the delta T in the equation HA delta T. And you would have, thus, you would measure a lower heat rate coming out of containment, as opposed to a predicted which would be conservative because you would have measured a lower value.

So when you did your measure to predict it and developed your mean and standard deviations, that would have resolved itself as a greater standard deviation because it would have created a greater variance --

MEMBER BROWN: On the qualitative part, not on the standard deviations.

MEMBER BANERJEE: Unfortunately the argument he is making is qualitative but you can actually do the sums. The equations --

VICE CHAIRMAN ARMIJO: The words on the charts say the heat flux data were adjusted to account for this impact. So that must have been done quantitatively. Right?

MR. OFSTUN: Yes, we tried to do that.

VICE CHAIRMAN ARMIJO: So if you have done it, you probably have some numbers.

MEMBER RAY: Let's bear in mind we are talking about the -- not talking about the evaporative cooling. Right?

VICE CHAIRMAN ARMIJO: No, I'm talking about the second to the last sentence there. Solar radiation and convection heat transfer correlation, heat flux data were adjusted.

MR. OFSTUN: They were factored into our

data evaluation.

MEMBER BANERJEE: Yes, so what you did is you corrected the data so that you could actually get the right correlation. Otherwise, you would have found the correlation was too conservative.

MR. OFSTUN: Yes.

MEMBER BANERJEE: Right. Let's put it this way. You didn't use that data.

MR. OFSTUN: I didn't use that data.

MEMBER BANERJEE: You didn't use the correlation. But if you did use the correlation, the data would have been conservative.

MR. OFSTUN: Yes, probably. Now hindsight is 20/20, I probably would not even have used that data.

MEMBER BANERJEE: Right. Okay. By the way, that data seems to be for a heavy water reactor, from what I can see.

MR. OFSTUN: Yes, the large-scale test facility was originally was the heavy water reactor test facility. And that design did not use evaporative cooling. It is air only cooling.

MEMBER BANERJEE: Okay. Can we -- There were other anomalies which we won't go into right now, the variation in heat flux, things like that.

MR. OFSTUN: Uh-huh.

MEMBER BANERJEE: But I think that was due to your plume rising and --

MR. OFSTUN: It could be internal or external.

MEMBER BANERJEE: Fine.

MEMBER RAY: Conclusions. Something I have been looking for.

MR. OFSTUN: All right. Model input changes were made there were input changes to address the items that affected the peak containment pressure that is reported in the Tech Specs. We made no changes to the plant design. Our calculated peak pressure remains just under 59 psi gauge.

The NRC has reviewed the modeling changes and requested additional information and found that the changes and their responses to their questions were acceptable.

With regard to solar radiation, we found that there was no impact on the validation of the condensation correlations on the large-scale tests and that the impact from the convection correlation which isn't really used, was addressed through the data evaluation.

MEMBER RAY: Any further questions? We

will have Westinghouse come back with a discussion on the effect -- to see what the data suggests the effect would be of solar heating on the airflow that is drawn in to the shield building annulus.

But at this point in time, I think, Mr. Chairman, we should move on with the staff and have an opportunity for our member of the public to speak to us as well. Anything else you wanted to say?

MR. KINDRED: Yes. A ten degree increase in the outside air temperature results in a 500th of a psi increase to peak pressure. So of course, by 100 degrees would result in a half of a psi. So if you heated the air by 100 degrees, you would increase the peak pressure by approximately a half of a psi.

MEMBER RAY: If you could still -- You have gotten that very promptly and we appreciate it. If you could give us facts or by some means give us something that we can all look at, rather than trying to peer over your shoulder at your BlackBerry, I think that would be appreciated, too, if you can do that.

Okay, with that, Eileen, come up here and change places.

MS. McKENNA: Okay, as he said, I am Eileen McKenna. I will have my staff colleagues introduce themselves.

MR. PATEL: Yes, my name is Pravin Patel, NRO. I am a structural engineer in the structural engineering garage.

MR. DROZD: And my name is Andrzej Drozd. I will address containment issue, containment peak pressure issue.

MS. McKENNA: In the interest of what appears to be the committee's interest, I thought we might start with the containment issues, rather than the structural issues because that seemed to be that that was generating greater attention.

So as soon as we get the slides up.

MR. BUCKBERG: My name is Perry Buckberg. I am doing the slides.

MS. McKENNA: Sorry. That's my mistake. I thought it said NRC. Here we are.

MR. BUCKBERG: I'll introduce the staff. The staff has introduced themselves. I am a little off base here but we have two presentations. We have containment pressure that you just heard from Westinghouse. We are going to give the staff's opinion, the staff's views and analysis on that, a very brief presentation and entertain your questions as well. And we will follow that with a brief structural presentation.

MEMBER RAY: Thank you. Please proceed.

MR. DROZD: Okay, again my name is Andrzej Drozd. And we did all the WGOTHIC calculation as well as assumptions. And we went through the revision of mass and energy release as well as the additional heat sink added to the modeling.

And we don't have any issues with using either revised mass and energy release as well as added heat structures but we did want do our independent confirmatory calculations. We used MELCOR as was developed by Sandia for research two years ago to analyze revision, I don't remember, 16 or 17. And we modeled accordingly.

We added the heat structures to the model as well we revised the mass and energy release. We performed a number of parametric studies on the model, as I will show a couple of slides down the road.

Let me give you the result, the summary of our results. The heat pressure that we had, let's call it originally with the old mass and energy release and old heat sinks, give us surprisingly high safety margins of almost four pound gauge. Using a revised mass and energy release, decreased that safety margin to 1.6 as we can see. And then this margin increases as we added the heat sinks, additional heat sinks. And the margin, according to our calculations, will be or is 2.2 pound gauge. That is consistently higher margin or the pressure is consistently lower than the one calculated by GOTHIC and we can discuss why is it.

MEMBER BANERJEE: Well before you go on, Andrzej, maybe this is the time to discuss why is this.

MR. DROZD: What is that? Oh, it is and you will see a couple of slides below GOTHIC is using a very conservative heat transfer coefficient of the type of Tagami and Uchida, while MELCOR well for one reason or another, the research in Sandia decided not to implement directly Uchida and Tagami.

MEMBER CORRADINI: Because it's wrong.

MR. DROZD: That is one of the arguments.

MEMBER CORRADINI: That is not an argument. It is wrong.

MEMBER BANERJEE: But I thought they were validating these.

MR. DROZD: The way MELCOR is being used for design basis analysis is based on studies of containment pressure transients comparing to contained, which uses Uchida and Tagami.

MEMBER CORRADINI: It is a heat mass

momentum analogy.

MR. DROZD: Analogy. But then contained was qualified kind of based on comparing to contained, very ancient code which does mass and energy balance, rather than calculations.

MEMBER BANERJEE: But WGOTHIC was validated against the large-scale experiments.

MR. DROZD: Yes and --

MEMBER BANERJEE: I mean, it must be right. Right?

MR. DROZD: We never said they are right but they are accepted.

MEMBER CORRADINI: Just one clarification for Sanjoy because I want to make sure I understand. So the 58.3 is with the modification where they essentially did an automatic reduction in the multiplier, is my understanding.

MR. DROZD: That is for Westinghouse calculation.

MEMBER CORRADINI: The Westinghouse calculation.

MEMBER BANERJEE: One standard deviation.

MEMBER CORRADINI: One standard deviation. But it does have that effect in there. That's what I was trying to understand.

MEMBER BANERJEE: Yes but what they did is for the one standard deviation for the inside is a fairly substantial reduction by .28 so it is around wherever. But outside is less. What did you do on the outside with MELCOR?

MR. DROZD: Outside is a default convective heat transfer calculated by MELCOR. I don't know the name of this particular correlation. It is a correlation.

MEMBER BANERJEE: But this is with evaporating water in the chimney?

MR. DROZD: Yes.

MEMBER BANERJEE: But it was not tuned against any data?

MR. DROZD: No.

MEMBER BANERJEE: All right.

MEMBER REMPE: Could you talk a little bit about the additional heat conductors? Did you just go with the assumptions provided by Westinghouse? Did you audit them?

MR. DROZD: We audited the choice of heat structures and there was a list of eight or nine heat conductors that were added. And what I was given was surface area and volume.

So what I did is I surface weighted

thickness based on those volumes which turned out to be roughly a quarter of an inch and that sounded reasonable to me, to us after discussion, because grating would be just about two millimeters. So we used that as a representative added structure.

So the added structures are 6.77 millimeters thick covered with epoxy paint and located in a couple of different places that I will show you.

MEMBER BANERJEE: Let me ask you a question which sort of has been in the back of my mind. When you really look at these large-scale data, there is a very wide variation around, depending on wherever they are sitting and all sorts of things. And has there been any analysis done of the scaling of this? Because even those the large-scale facility is fairly large, the real system is much larger.

MR. DROZD: Much larger.

MEMBER BANERJEE: Okay. So in fact, I am wondering if that sort of averaging which is done actually has any validity on such a large-scale. Is there some evaluation being made of this?

MR. DROZD: The simple answer and short answer is yes. We had a contractor, if I recall, from Idaho. Many years ago they went through the scaling analysis. He had some issues but eventually the scaling numbers were accepted by us.

The averaging of heat flux evaluation of heat transfer coefficient were always subject to uncertainty. But what I believe convinced us was that we can accept the model was the test that Westinghouse performed with half of the shell being dry.

MEMBER BANERJEE: Right.

MR. DROZD: So the asymmetry with the heat transfer turned out to be not such a big effect. Somehow internally the condensation appears to take place, regardless whether it is this half or the other half wetted.

So we thought although uncertainty definitely exists, we thought that since we have on one side the amount of condensate on an inner surface and another vibration on the outer surface, these two roughly gives you the idea how much heat can be rejected.

MEMBER BANERJEE: So for example, even in this containment, the heat fluxes vary by almost a factor of two.

MR. DROZD: Yes.

MEMBER BANERJEE: Right and maybe even more. So yes, it is sort of reassuring that even when you have cooling on one side, it takes care of it in some way. But without a good physical understanding of why that happens, it seems that the scale is much, much smaller to sort of put your half on this happening on a grand scale needs a little bit more than that.

MR. DROZD: That is correct. However, other applications of codes in general like MELCOR for other cases show that the heat models that uses local value of heat transfer coefficients are decent enough and predict at least trends if not pretty good qualitative values of pressures and temperatures that we accept those definitely imperfect lump parameter models and mass and energy analogy, mass and heat analogy to a heat transfer based correlation to be used in design basis.

MEMBER BANERJEE: That's fine when there are big margins and this is not your ultimate heat sink and all sorts of stuff. I mean, you can do that.

Here, we are sort of appealing to this as taking care of our -- You know it is a much more critical component here.

MR. DROZD: It is. It is. And what gave us --

MEMBER BANERJEE: It is not pressure that matters. It is how much heat have you lost that matters.

MR. DROZD: That is correct. And there is sufficient uncertainty about the peak pressure that raised a lot of concern with first with 8600 and 81000. And as we decided that adding a non-safety spray system is sufficient to cover the as we call residual uncertainty with the issues that you raised. And that is on the top of many layers of conservative assumptions to begin with.

MEMBER BANERJEE: Well I would agree. Because of the non-safety spray that you have but Harold will maybe argue that you cannot think of it quite that way. Right?

MEMBER RAY: Not with the staff having only having one minute to go.

(Laughter.)

MEMBER BANERJEE: He would like to stay on schedule. Okay. That's okay, Andrzej.

MR. DROZD: Okay. We have very briefly in those remaining 35 seconds, I have three slides to cover.

This is the model that we used, nothing -- very few notes. And the location of the added heat structures are marked with those stars. We pick out the low end of then ends modeled to minimize the effect, the potential effect. And the location is volume four, which is south stimulator produced a little lower peak pressure than the heat sinks in the volume three, which is core makeup tank.

And here is the effect of a revised mass and energy release. The red one and the blue one are equivalent. The red one and the greenish is a kind of an added fringe benefit parametric study. I didn't notice when I received the input that this data was used for various parametric studies. And at first I was running it as if it was a best estimate heat transfer coefficient rather than default value. So here you see how MELCOR given all equal the conservative heat transfer ranges of the peak pressure.

The revised mass and energy release moved as in the case of GOTHIC up from the peak pressure and raised another couple of pounds.

And the final one is, the next one please, is given the revised mass and energy release, the location of those heat sinks whether it is in the control volume or calculation of volume four or three, gives slightly different results, according to engineering judgment.

We did many more parametric study changing heat transfer area or heat transfer coefficient by ten percent plus minus ten percent. The results just follow engineering intuition when you increase heat transfer and heat sinks, you decrease peak pressure. It is just as simple as that. These given all the uncertainty, at least trends are calculated.

So that is what we did and I don't think there is much more to be done about the peak pressure.

MEMBER RAY: Thank you. Eileen, you have got more to say?

MS. McKENNA: Only that if there are any questions about the structural aspects, we have our structural reviewer here. But I will defer to you whether there is questions and you want presentation or you want move on.

MEMBER RAY: All right. Bill, anything you want to direct to the staff?

MEMBER SHACK: No. We know they found it acceptable. And I figure you are just going to tell us that again.

MEMBER RAY: Yes, I mean you and I have talked about the fact that what appeared Tier 2* appears to me at least to be a judgment of what is needed. And people can differ on that judgment. You have made a judgment. And I guess I should ask any reason that you would conclude now that there is anything more that ought to be made Tier 2* in the same manner?

MS. McKENNA: I will speak and then I'll let the OCD people. I think we did make a judgment of what we thought were the most important values, parameters, dimensions, materials, that we would want to have that applied to, particularly where as we said and as you quoted, where we didn't have the code to give us the fall back, if you will, on how you would judge any differences. We were aware of some of the issues that the consultant raised but I don't think that the staff had a different opinion after seeing that information. But I will see if there is --

MR. PATEL: Yes. Something I think what I will insert is that I won't be adding some more to that. And I think like said here, it is a matter of analysis to have some of the matter of analysis that question those data. Also we consider this data Tier 2*.

Then also we made it some of the critical sections, some items like rates and other stuff that we are attempting to include in Proprietary Report 602.

We did do an audit and looked at all the tables they provided some of the parameters like the coil and provided reinforcement issues that we want to control that we have the design margin maintained up to the construction and installations.

And also we will check the ITAAC to make sure that the ITAACs are also see items are supporting ITAAC and Tier 2* also supporting ITAAC.

So that is what we did at while we did the audit a couple of times.

MEMBER RAY: Okay, well as Bill mentioned in his remarks, you have performance criteria. Well perhaps somebody would like to see it, a design specified under performance criteria.

The thing that I think I was glad to see was that you recognize that Tier 2*, at least for the items that you thought were necessary provide something that merely being included in the current design doesn't provide. And that is the whole point.

Okay. Mr. Chairman, we are about five minutes late in terms of I perceive you may want to provide the opportunity for a public comment at this time?

CHAIRMAN ABDEL-KHALIK: Yes, please.

MEMBER RAY: So may I have -- Shall I turn it back over to you for that purpose?

CHAIRMAN ABDEL-KHALIK: No.

MEMBER RAY: All right. We have been advised and I think everybody has received at their place a written statement with some slides by a member of the public who I will now ask, hoping that the line has been opened so she can respond to us, if Dr. Sterrett is on the line and prepared to provide us the oral comments.

DR. STERRETT: Oh, can you hear me?

MEMBER RAY: We can, indeed. Thank you. Go ahead.

DR. STERRETT: Okay. I just joined about a minute ago so I don't know what you have been talking about.

MEMBER RAY: Almost everything. But it doesn't matter because we are now attentive to what you would like to say to us.

DR. STERRETT: Oh, okay. So some of the things I have to say may be things that I really do not need to emphasize. I don't know.

So let's see, I didn't give you slides for what I was going to present today. The slides that I would have given were from the presentation to the committee.

MEMBER RAY: Yes. Yes, and by the way, I

believe you had estimated you would need not more than ten minutes. Is that correct?

DR. STERRETT: I didn't say but I think that should be sufficient for today.

MEMBER RAY: All right. Well we are running a little late. So if you would please proceed.

DR. STERRETT: Okay. All right. So I am saying this, I didn't know how much you talked about it so I will just give the written text that I have prepared.

All right. This is Susan G. Sterrett. I am at Carnegie-Mellon University. And there is some noise on the line. I wonder --

MEMBER RAY: I don't believe we can do anything about it. We have experienced it before and it would be best if you just proceed.

MEMBER SHACK: You are clear. You are quite audible.

MEMBER RAY: You are clear. There is noise on the line. I agree.

DR. STERRETT: Okay. All right. So just to introduce myself prior to my academic structural mechanics including systems design. I did some work on Westinghouse passive plant design but I never worked specifically on the AP1000. So the information I have is just the information available to the public through the NRC's website.

To summarize the presentation last time, there were two issues. The first one was radiation on the concrete chilled buildings that wasn't accounted for in the analysis. And I said that because looking at the temperatures that were considered, they only considered the temperatures to be the same as ambient air; whereas I pointed out that the range will be wider. It will be colder in the ambient air or can be and can be significantly higher than the ambient air when the sun is shining.

The second issue was the large-scale test and actually the small scale test, too, that were used in WGOTHIC were outdoors in the sun. And the thing is that the main effect these were not scale model tests in the normal sense. They were meant just to understand certain effects. And one of those was the coefficient representing evaporative losses. The sun aids in evaporation and the test result was the main way that this was being carried out was through evaporative losses.

So I would like to just say a few things about each of these and they may be moot by now but I guess it doesn't hurt to have the reasons down.

The first one was the response that was given previously, hopefully not today, was that normal thermal loads don't need to include this extra 30 or 40 degrees, that somehow you would only worry about that if there was some sort of extreme heat wave that only occurs once in a great while. These are everyday things. Surface temperatures in the sun and the ambient air temperatures and ones at night can be lower than the air temperature.

The other thing was that some people just felt that the effect would be negligible. And I had pointed out to the subcommittee there were a vast number of cases, not just a handful, but many in the news about this year there is concrete roadways, bridges, ramps, and other structures, have buckled. Now in those cases, the risk to public safety isn't large because they closed down the highway. They demolished the old buckled portion and they replaced it. But of course, a shield building is different. You can't use the same standard of acceptability. It is a water tank. It forms a passageway to the airway needed for heat removal.

So that is why I felt that it couldn't be ignored that the attitude well what we are doing in the AP1000 with the SC models conforming to normal practice for concrete use in these other industries, that to me is not an acceptable response because it is different, even if it is true. I didn't check it was true.

So the technical cases that I cited in my long letter, I think the eight-page one, shows that that attitude of complacency that if we need you know the sort of the way that concrete is normally designed with respect to the temperatures we consider, is already not the norm at the other federal agencies and institutions. So I found papers that came out Oak Ridge and out of the National Institute of Standards in Technology to illustrate this. Okay and I said I wanted to say that if you have trouble getting those, I can send you a copy.

The second thing regarding issue two about the large-scale test, there were several remarks that seemed either puzzled by the concerns or missed it because of the intuition that surely if the sun is shining on the physical model, wouldn't that be unhelpful in providing cooling. And I do understand that argument but it is first of all kind of complicated. But second of all, Westinghouse was always saying that their analysis using WGOTHIC which was validated by this test was that worst case was cold and if they counted in extra heat from the sun, it would help. So it is hard to see how you could accept what Westinghouse says the results of WGOTHIC is and yet have the intuition that sunlight is going to make evaporation worse. So I wanted to say that it shouldn't be dismissed on that basis.

I personally think that no generalizations about whether a certain increase or decrease in any single factor is going to reduce containment or not, I don't see how that can be made. And the reason is that -- So I don't make a statement either way because containment cooling involves humidity and other factors that affect conduction through the shell. Radiation is only one of the mechanisms.

So the thing is that if all you were doing was measuring temperature and if what you were doing is measuring temperature in the large-scale test, I mean, it is going to matter what the humidity is and what the sunlight is. If you have intense sunlight and low humidity, that is going to be very different from the case of no sunlight and high humidity, even if they are exactly the same temperature. That is why I don't see how you can really draw too much if all you have and I don't have access to the detail that you ACRS members do, but it looked like they were just measuring temperatures. I don't see how you can make any conclusions and correlate cases on the basis of temperature. And I think if you understand the review on the basis of heat transfer, you have to agree with that.

And so the problem I am wondering, and again I don't have access to the data, but just what people wrote in discussing how they applied it to WGOTHIC, but if what they have is just temperatures, then I would worry that the test is measuring the things that you need to make the inferences to cases that are not exactly like the actual large-scale test.

So what I said or meant to say is that if they are going to use the large-scale test to determine the coefficients of evaporative effectiveness then whether or not it is in the sunlight does need to be taken into account because into sunlight would aid evaporation. I hope by now no one considers that an objectionable statement.

Secondly, I point out the purpose of the large-scale test is limited to certain aspects of mass and heat transfer effects. And here I am going to quote from the FSER. I think it was stated at some point that Chapter 21, which is about the test and validation of the computer codes has not changed since the 2004 FSER and here is quote from that.

"The experimental large-scale test is designed to induce similar containment dome heat transfer processes and circulation stratification patterns. However, it is not meant to simulate specific AP600 accident scenarios. The large-scale test data is used to validate WGOTHIC computer code, which will be used to analyze the containment."

And I note that the main conclusion of the test is and I quote, "evaporation was the primary mode of heat removal from the outside of the vessel; approximately 75 percent of the total."

So it looks to me like the situation is this, that because the test, the large-scale test is not, and I guess the large-scale test did not separate out heat of solar radiation which was present in the large-scale test but will not be present in the AP1000 leaded steel containment from the effects of ambient air temperature and humidity of air, we just don't know. And I don't know how you are going to figure out how to do that from the data if the data didn't include humidity and solar radiation.

Now you might say well let's run some WGOTHIC. Well you can't use WGOTHIC to answer that because that would be circular.

And the test data, I am just wondering if you have enough there if you didn't measure solar radiation. Now you might ask how do you measure solar radiation. And the way meteorologists do it is by using evaporation. They should have done that when they ran the LST if they were doing it outside. But I don't see any indication that they did. So I am wondering if the data isn't there, I don't know what you are going to do.

The test concluded that most dominant factor is cooling via evaporation but assumed it was the same whether the equipment was in the sun or in the dark. So it looks to me as though WGOTHIC uses coefficients for evaporative loss based on the test performed in the sun for which the data is not available on how much of the evaporation was due to the sun. So that is just conveying the problem.

So I have a lot more I could add but I am assuming that the time is limited. So let me just add one more thing. That why this has to get done before design cert is granted is because that is it. I don't think there are checks and balances until real nature comes along, the real challenge in nature would come along. And that is a concern, that there would be no check and balance on it, no check on it or checks of it until the real challenges comes in nature.

And why would I worry about this? Because as far as I know, the ITAACs are not going to check this error. And here is my worry, that they don't test for actual heat removal capabilities in the containment by this PCS, per se. The ITAAC criterion is whether or not certain system parameters like flow rates and so on, the flow rate of water being delivered over the steel containment dome and such things.

Now if you think about it, the claim of adequacy of heat removal from the containment, that is going to be based on this error. And it is really, really important in the AP1000 and 600 because unlike in any other operating plant, this is the ultimate heat sink. It means every other system performing post-accident heat removal, all it is doing is collecting the heat and then passing it on to the containment so that the passive containment can remove the heat.

So the validity of conclusions about the effectiveness of those systems in removing decay heat is going to be based on these calculations performed using WGOTHIC, too. And the WGOTHIC analysis calculations about evaporative heat losses are exactly what are in question by this error about forgetting about the sun.

And I am going to stop there due to time.

MEMBER RAY: Thank you. Yes, you've used the time and I think I would just say this to you. Can you hear me all right, Dr. Sterrett? Evidently we have been muted, although Dr. Sterrett hasn't been. So she is not able to hear us in response.

MEMBER BROWN: We were told the mute was on a little while ago.

MEMBER RAY: Yes, I know. Is there any way to un-mute it before she hangs up? Can you hear me Dr. Sterrett?

DR. STERRETT: I'm sorry. I can't hear anything. Is the connection good on your end? Can you hear me?

MEMBER RAY: Evidently we --

MEMBER BROWN: We are all nodding our heads.

MEMBER RAY: Our control room operator went for coffee or something.

DR. STERRETT: I can't hear anything.

MEMBER RAY: Dr. Sterrett, can you hear us? We will try one more time here.

Okay, well having heard nothing then, Weidong, please get a hold of Dr. Sterrett. Tell her that we heard all of what she had to say and that we would ask her to -- and we appreciate her input very much -- to consult the transcript of the meeting today as well as the letter that we will ultimately write. And we believe we have received her input and included it in our deliberations accordingly.

So try and give her a call as quickly as you can. We did hear the mute set, as Charlie mentioned. And since it didn't mute her, we had to assume it was muting ourselves.

MR. HACKETT: Harold, it was apparently on her end. We have confirmed.

MEMBER RAY: That is very odd. We were able to hear her so she should be informed of that.

Okay. Well with that now that we had a last thing which was, let me just check with Westinghouse and see. Are you going to provide us those data that we were asking for, which would give us some visual sense of the effect of ambient temperature on containment peak pressure?

MR. CORLETTI: Yes, they are preparing a slide next door.

MEMBER RAY: All right.

MR. CORLETTI: Did you want to do that --

MEMBER RAY: So we will do that later, then if it is not ready now. Anything else you want, Eileen?

MS. McKENNA: No, that's fine.

MEMBER RAY: Okay, back to you, Chairman.

CHAIRMAN ABDEL-KHALIK: All right. Thank you very much. At this time we are scheduled to take a 15-minute break. So we will reconvene at 20 minutes to 4:00.

(Whereupon, the foregoing proceeding went off the record at 3:24 p.m. and went back on the record at 3:38 p.m.)

CHAIRMAN ABDEL-KHALIK: We're back in session. At this time we will move to Item No. 5 on the agenda, Draft Final Revision 2 to Regulatory Guide 1.115, "Protection Against Turbine Missiles." And John Stetkar will lead us through that discussion.

MEMBER-AT-LARGE STETKAR: Thank you, Mr. Chairman. And in the interest of time I'll make my remarks short.

This is for the Committee's information. Another of the reg. guides that have not been updated in quite a while, I think the last update to this one was in 1977. We heard from the Staff regarding a prior version of this update back on October 4, 2010. So luckily we made it under one year before we brought it to the Committee.

The Staff has made some changes to the reg. guide in response to some of our discussions during the Subcommittee meeting. And I think with that I'll turn it over to the Staff.

MR. LABINSKY: If I could, this is John Labinsky. I'm the Deputy Director of Component Integrity in NRR. And I would just like to do a brief introduction as well.

As stated, we are here to talk about the reg. guide on protection against turbine missiles. We appreciate the opportunity to address the full Committee today.

I'd like to start by saying this has been a collaborative effort over multiple offices and multiple divisions. Both NRR and NRO have been working on this update to the reg. guide.

As mentioned, we did have a Subcommittee meeting last October. We did revise the reg. guide in response to comments provided and questions during the Subcommittee meeting. Based on those changes, we also decided to reissue the reg. guide for public comment again. We had done that before the last meeting. So we did address changes in response to those public comments as well. Today we'll provide an overview of the proposed final reg. guide and how we addressed both the ACRS Subcommittee comments as well as any comments we received from the public.

So with that what I'd like to do is turn to our presenters today, Simon Sheng from Division of Component Integrity NRR, Steve Jones from the Division Safety Systems NRR and John Honcharik from our Division of Engineering in NRO.

Gentlemen.

MR. SHENG: Okay. Good afternoon. I am Simon Sheng of Division of Component Integrity NRR. And this is a presentation on the proposed RG 1.115 entitled "Protection Against Turbine Missiles " summarizing the effort of Division of Component Integrity, Division of Safety Systems of NRR and Division of Engineering of NRO with comments from Division of Safety Systems and Risk Assessment of NRO. The second slide.

For completeness, we are going to go over the main subjects that we went through --

MEMBER-AT-LARGE STETKAR: We're a low budget operation. I have to run your own slides.

(Laughter.)

MR. SHENG: Yes. That we went through in the Subcommittee such as the GDC 4 requirements, the current NRC position on protection against the turbine missiles, the enhancements in the proposed RG 1.115 and the rest. However, this time we are going to focus on the resolution of the Subcommittee's comments and the industry comments on the RG which incorporates the Subcommittee's comments. Next one.

And now let me summarize ACRS Subcommittee comments. The first is to clearly define the structure, system and components to be protected and then consider non-nuclear power plant experience, consider risk-informed approach, provide turbine missile risk goal for new reactors. And the fifth is clarify use of Table 1 in RG and the use of barriers in the RG. And the sixth, clarify when Table 1 in the RG is applicable. And the last one is expand RG to include detailed technical guidelines.

And except Item 5 and Item 6 which we have provided much better explanations in our RG, we don't think that it requires further discussion here. And each of the remaining items will be addressed this afternoon. Next one.

(Off the record comments.)

RG 1.115 is based on GDC 4 which requires structure, systems and components important to safety be appropriately protected against the effects of missiles.

And the current NRC -- Number five, okay. The current NRC position on protection against turbine missiles offers three options. The first one is by turbine orientation. And the second one is by control of turbine missile generation frequency. And the third is by missile barriers.

And the positions of using orientation and barriers were stated in RG 1.115 since 1977. However, the position of controlling turbine missile generation frequency was only stated in the Hope Creek SER of 1986. In year 2007 when the NRC revised the entire SRP and we took the opportunity at that time to revise the SRP section on turbine missiles to include this position on missile generation frequency. Next one.

The objections of the proposed RG 1.115 is to assure that the turbine failure is a negligible contributor to risk. It makes the RG self-contained including all acceptable protection methods against turbine missiles and clarifies the structure, system and components to be protected from turbine missiles.

And ACRS comments wanted us to do even a better job in this area. Basically, the SSCs to be protected from turbine missiles includes safety shutdown functions, for example, like makeup water, heat sink and long-term decay heat removal. And also these SSCs excludes functions necessary only for other unlikely design basis events, for example, high-head safety inject ion and containment. And our objectives of the proposed RG 1.115 also include assesses operating experience since 1977.

MEMBER-AT-LARGE STETKAR: Simon, before you go to the next slide, I think we had some discussion at the Subcommittee meeting regarding as you mentioned a couple of bullets on this slide. And one I recognize you've clarified the scope of SSCs that need to be evaluated backing off from safety related to important to safety so that we capture the notion of non-safety equipment but important to risk elements for new reactors.

The first bullet is something we did indeed have some additional discussion. It says "Assure turbine failure is a negligible contributor to risk." Now the analyses require that we have confidence that damage to SSCs important to risk occurs at a frequency of less than $10^{-7}$ per year.

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: How does that

specific numerical value for damage to SSCs important to risk give us assurance that that damage is a negligible contributor to overall risk when risk assessments for new reactors are publishing total core damage frequencies on the order of two or three times $10^{-8}$ for a factor of three to five lower than that screening criterion? So how do we have assurance that's negligible and negligible doesn't mean 10 percent. It means a very small fraction.

MR. SHENG: Right. I see. We are going to address that in a later slide.

MEMBER-AT-LARGE STETKAR: Are you? Okay. Thanks.

MR. SHENG: Okay. Thank you. So next one.

This RG also reviews operating experience since 1977 which is a year that we published the first RG 1.115. And before the existence of NUREG-1275, it is safe as our effort in that area because that NUREG basically summarizes the operating experience before 1995.

However, for after 1995, we reviewed the Licensee Event Reports (LERs) and International Incident Reporting System and INPO Significant Event Notifications and basically we wanted to see whether there are important precursors or any reports which we think is significant. So that we need to revise the current $P_1$ and $P_4$ criteria. And I'm going to define the $P_1$ and $P_4$ in the next slide.

MEMBER-AT-LARGE STETKAR: Before you do that, do you have any sense of the number of turbine operating years that are included in the dataset that you have on this slide here? Is it a 1,000 turbine operating years? Is it 10,000 turbine operating years? Is it 100,000? Is it a million?

MR. SHENG: Do you mean for the one that we went through, the LERs, and what's available in the system we did not have tabulated the number of reactor years?

MEMBER-AT-LARGE STETKAR: Okay. Well, in the U.S., if we have 100 units we accumulate given each unit has a couple of low pressure turbines or maybe three 200 to 300 turbine years per year.

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: That ball park.

MR. SHENG: Okay.

MEMBER-AT-LARGE STETKAR: So since 1995 15 years would give us a couple of thousand.

MR. JONES: NUREG-1275 included an assessment, you know, a rough estimate of about 1,000 operating years before that time.

MEMBER-AT-LARGE STETKAR: But that was obviously conventional, primarily conventional, units. Right?

MR. JONES: No, that was nuclear.

MEMBER-AT-LARGE STETKAR: Those were only nuclear?

MR. JONES: Right.

MEMBER-AT-LARGE STETKAR: Okay.

MR. JONES: 1995 there were -- Some plants had operated for 20 years.

MEMBER-AT-LARGE STETKAR: Yes.

MR. JONES: Other plants only just a few years.

MR. SHENG: And I'm going to -- After the definitions of $P_1$ and $P_4$ we're going to present the results, the summary of our evaluation of, our surveying of, the operating experience.

First, let me define $P_1$, $P_3$ and $P_4$. When turbine missiles are controlled by limiting the turbine missile generation frequency the ultimate concern is the probability of failure of an essential system caused by turbine missiles. And we call it$P_4$. And basically $P_4$ is equal to $P_1$ times $P_2$ times $P_3$.

And $P_1$ is the probability of turbine

missile generation which is the emphasis of the current NRC practice. And $P_2$ is the probability of ejected missiles striking an essential system. And $P_3$ is the probability of the struck essential system losing its safety function. Next slide.

After this digression, let's refocus on the review of turbine operating experience and summarize our findings. And we found that an event in 1997 which give the point estimate of $1E^{-3}$ per turbine year for destructive turbine overspeed event. We also found that the turbine operating record has improved in general during the past 15 years.

However, from this, we also found that we have an unignorable number of events resulting in scrams, shutdowns and outage delays per year. But no major damage has occurred except a throwing of blades. And based on this summary, we conclude --

CHAIRMAN ABDEL-KHALIK: What does unignorable mean in this context?

MR. SHENG: Unignorable means that we have several events a year which will cause scrams, shutdowns and outage delays per year.

MEMBER CORRADINI: Are those overspeed events or?

MR. SHENG: No, that is debatable. You

can say that these are precursors to overspeed. But you can also argue they are not.

MEMBER CORRADINI: Can you give me an example what you mean by a precursor to overspeed?

MR. SHENG: Precursor means that if --

MEMBER CORRADINI: I know what precursor means. But can you give me a specific example so I understand your point?

MR. SHENG: Okay. What I mean by precursor is that if all the mechanisms fail designed to function -- it failed. Supposedly failed, its function and the other situation go on without stop. Then eventually you would develop into an overspeed scenario.

MEMBER CORRADINI: So some kind of control function failed. But if you were to do a what it would have carried you to an overspeed event.

MR. SHENG: Right. But it means everything put in place works.

MEMBER CORRADINI: Okay.

MR. SHENG: That's why it didn't go from step one to step four.

MEMBER-AT-LARGE STETKAR: Simon, we had some discussion in the Subcommittee about these numbers and those sort of qualitative assertion that everything is improving and that we have documented experience to demonstrate that improvement. It's not clear to me that if we have some evidence in 1991 that the frequency might $1E^{-3}$ or ten times higher than your $1E^{-4}$ limit. That primarily nuclear U.S. operating experience for the last 15 years gives us a lot of information to have confidence that that's somehow an absurd anomaly.

And there's a quote I keep hanging up on in the reg. guide itself. And I won't read the whole paragraph. I'll just excerpt this last sentence. "Many destructive overspeed failures that occurred in recent years were caused by the failure of turbine steam valves to close and to stop the flow of steam even though a trip signal was generated."

And I don't care about the forensics. I care about the phrase "many destructive overspeed failures that occurred in recent years." That tells me that there is some operating experience of many destructive overspeed failures.

And I'm curious where the basis either for that statement which causes me some concern about this $10^{-3}$ or $10^{-4}$ per year frequency. If you have evidence to support the phrase "many destructive overspeed tests that have occurred in recent years" I'm not sure how confident I am in these frequency estimates.

So I'm really at a quandary in terms resolving that phrase with this notion that "Well, we really haven't collected a lot of data, but we know things are getting better and $10^{-4}$ is an okay frequency for us to target because that's sort of consistent with actual operating experience."

MR. SHENG: Okay. Thank you for quoting that sentence to me. Okay. Because in this round of effect we paid attention to your comments and we did not read RG very carefully about the language that you quoted. I believe that that quote probably was from the NUREG-12 --

MEMBER-AT-LARGE STETKAR: It doesn't make any difference where it's from.

MR. SHENG: I understand. I said it may be a direct copy from that NUREG 1275.

MEMBER-AT-LARGE STETKAR: It indeed is from the text of the reg. guide.

MR. SHENG: So basically that means it's prior to 1995. Yes. Because in recent years it implied in the last five or ten years.

MEMBER-AT-LARGE STETKAR: That's what got my attention.

MR. SHENG: Right. That wouldn't be

appropriate. So I reexamine that the wording to make appropriate changes.

MEMBER-AT-LARGE STETKAR: Thanks. And it is something by the way that we discussed during the Subcommittee meeting because I'm if nothing else pretty good about keeping notes. And my notes from 10/4/2010 note that I quoted the same quote at that Subcommittee meeting. So maybe you didn't read the transcript.

MR. SHENG: Yes. Sorry. When we put that summary together we missed your then notion.

MEMBER-AT-LARGE STETKAR: Okay. Thanks.

MR. SHENG: As I said, we're going to revisit that.

MEMBER-AT-LARGE STETKAR: The other -- Dr. Abdel-Khalik's term is unignorable is not a very quantitative term.

MR. SHENG: Yes. I believe there's a better word.

Okay. So let me keep going on our presentation. Continue our presentation. Let me make a note.

MEMBER-AT-LARGE STETKAR: It's in the section that talks about destructive overspeed analysis.

MR. SHENG: Okay. And so based on our survey we conclude that we consider that the nuclear power plant experience only. But that's also the ACRS's comment to include the non-nuclear units. However, when we revisit this issue we found out that the nuclear operating practices, maintenance, testing and inspections changed after the Salem 2 event. That's a result that we don't believe that these changes made by nuclear utilities and nuclear power plant insurers and turbine manufacturers have been completely implemented by non-nuclear power plants who are not involved in the effort.

MEMBER-AT-LARGE STETKAR: What's the basis for that belief? Because I suspect that if I'm a large conventional power plant and I have 1,000 megawatt electric turbine out there I suspect my insurance companies and my investors are pretty interested in keeping that large expense income-generating piece of equipment intact. And I might do everything in my power to try to make sure that it stays intact.

So it's not clear to me why there isn't the same attention placed on testing and maintenance of conventional plant turbines, large conventional plant turbines, as there is to the nuclear industry simply because we may have codified some requirements for testing.

MR. SHENG: Yes. As I said, our argument is that because the non-nuclear power plants were not involved in the joint effort by the utilities, NRC, insurers and the turbine manufacturer at that time. So they may implement -- I would say that they may have implemented something, some recommendation, by the turbine manufacturers.

However, those guidelines provided by the nuclear power plants insurers are strictly for nuclear power plants. Whether they also implement some recommendations to the non-nuclear power units are really hard to find.

MEMBER-AT-LARGE STETKAR: I guess the general question is you're discounting any operating experience from large conventional plants or any quantitative assessment of international nuclear operating experience based on the assertion that "Well, we have special rules in the United States. So therefore only our turbines under our rules are valid in our dataset."

MEMBER CORRADINI: I would expect that you have potentially a database of ten times more experience.

MEMBER-AT-LARGE STETKAR: That's the whole point or more. Much more.

MEMBER CORRADINI: Conservatively.

MEMBER-AT-LARGE STETKAR: If I just take 700 megawatt electric and above.

MEMBER BLEY: And from some of the people we've talked with and asked about their experience with the monoblock rotors, that sort of thing, they refer to very broad experience in the conventional power plants. That's where they started because of the expense. There's got to be a big --

MEMBER-AT-LARGE STETKAR: International.

MEMBER BLEY: Yes.

MEMBER-AT-LARGE STETKAR: Yes. That's right.

MR. HONCHARIK: Well, I guess. But there are those manufacturers that like you said are going to monoblock for the nuclear components. Basically they do have separate turbines for nuclear applications. They actually have separate classifications for nuclear turbines.

CHAIRMAN ABDEL-KHALIK: That's because we run on lousy steam. They have to design around it.

MEMBER-AT-LARGE STETKAR: But if you go back to the observation that I'll leave out the quote "many" that turbine destructive overspeed failures are due primarily to failures of steam stop valves to go closed and things like that. It may not be all that sensitive to monoblock rotors. I mean that's obviously an effect of the materials and things like that. But the reliability of the turbine protection trip steam shutoff systems which are primarily the contributors to the calculated $1E^{-4}$ frequencies if you look at the analyses it may not be that sensitive to material property requirements for nuclear qualified steam turbines versus any other large steam turbine that the people are producing.

MR. HONCHARIK: Well, I think like Simon said that phrase about the many of the destructive overspeed I think that was from the original meaning previous to 1997. There were some destructive overspeeds caused by that.

MEMBER-AT-LARGE STETKAR: I'm aware of a destructive overspeed that happened in South Africa. When was it, Sam? Earlier this year or was it last year?

VICE CHAIRMAN ARMIJO: Within the last couple years.

MEMBER-AT-LARGE STETKAR: Within the last couple of years. Indeed the steam stop valves didn't go closed.

VICE CHAIRMAN ARMIJO: Yes.

MEMBER-AT-LARGE STETKAR: I don't know whether it was a monoblock rotor. But it probably didn't matter.

MEMBER SIEBER: Well, governor valves do close. They're independent, but they're slower by about a second which makes a big difference peak. At coal fire plants --

VICE CHAIRMAN ARMIJO: Is the issue here, John, that the population is needlessly restricted?

MEMBER-AT-LARGE STETKAR: The issue here is that there's a general acceptance that the frequency of destructive failures of turbines on the order of $10^{-4}$ is acceptable and consistent with operating experience. And the assertion is that we have operating -- Despite the Salem event that was cited that we have operating experience that shows that that $10^{-4}$ frequency is reasonable to use. It's sort of a fundamental precept of this entire notion of why we emphasize the frequency of turbine missile generation that $P_1$ number in Simon's equation there as opposed to the integrated $P_1$ times $P_2$ times $P_3$.

Essentially all of the regulatory guidance is based on $P_1$.

MR. SHENG: Up to now, right.

MEMBER-AT-LARGE STETKAR: Up to now. This allows some more flexibility which is an important extension of this revision.

So the reason is if there's evidence to support that notion that not only analyses but actual operating experience say that there's no reason to disbelieve something on the order of $10^{-4}$ is reasonable, that's fine. If there's evidence for some reason to show that $10^{-3}$ might be more reasonable that sort of throws into question a little bit of the difference and the emphasis in terms of the guidance and the level of detail of analysis that might be required to justify that nominal $10^{-7}$ degree of assurance.

So that's the whole reason of trying to look at additional operating experience to give us confidence. Because looking at ten years of operating experience of just the U.S. nuclear industry only gets us a couple thousand turbine years, if that.

MR. JONES: But we do have evidence from the U.S. operating plant experience that they are better at testing the solenoid valves in particular that initiate the trip cycle. Also there are operating procedure requirements to periodically test the steam emission valves and cycle them that I don't think happen as frequently or nearly as frequently at fossil units.

MEMBER-AT-LARGE STETKAR: Yes, the one at South Africa came apart because they were doing the test. So you have to be a little bit careful about making assertions.

MR. JONES: During which tests? The overspeed protection system test?

MEMBER-AT-LARGE STETKAR: Apparently they were. I don't have all the details.

MR. JONES: Salem 2 is the same situation.

MEMBER-AT-LARGE STETKAR: Yes, that's right.

MR. JONES: Bypassing one trip to test the other in that circumstance.

MEMBER-AT-LARGE STETKAR: The whole point is not to microanalyze individual events. The point is to kind of probe these assertions about what is the operating experience, what do we learn from that. And if there are assertions that things are getting better, do we actually have quantitative evidence to sort of support that notion? Because $10^{-4}$ is still a small number. And one or two events in 25 or 30 years might throw into question our confidence in that very small number.

MR. SHENG: Yes. As I said, we made a decision based on qualitative judgment. I think that regardless of whether you have nuclear unit or non-nuclear unit the intents of design and materials I think it would be reflected in both sides of the turbines.

However, the only thing that we emphasize that we didn't use a large database, but use a smaller database purely because we believe that there are lot of things which have been changed in the nuclear operating practices, maintenance, as I said, the testing frequencies and the requirement of the quality of the EHC oil and all these things and the inspections and all these things that we think that the nuclear units are better maintained. That's why we better use -- It is as I said based on qualitative judgment.

MEMBER-AT-LARGE STETKAR: Okay.

MR. SHENG: And based on that qualitative judgment that we think the operating experience is consistent with the turbine failure rate of 1E-4 per turbine year and also result we maintain the current criteria of $P_1$ and $P_4$. We did not change it. We changed it slightly. I'm going to elaborate on later slides.

MR. JONES: Also I think it's important to point out what we're really saying is operating experience supports probabilistic type of analyses performed by the turbine vendors that estimate that turbine destructive overspeed frequencies are lower than that number.

MEMBER-AT-LARGE STETKAR: I can also turn that around and say limited operating experience does not refute those analyses.

MR. JONES: Right. That's a better way.

MR. SHENG: Now slide 11. Now let's shift gears to the risk-informed approach and this RG allows applications conforming to RG 1.174 be considered on a case-by-case basis and directly addressing ACRS Comment 3. So in the previous version of the RG, we kind of had an active tone about using the risk-informed approach. But considering your comments that we think we would like to entertain that the risk-informed approach.

However, one of your comments also said that whether the risk goal should be redefined for new reactors. And after a lot of internal debate and discussions and reviewing several revisions of the language finally we decide to say the risk goal is not defined for turbine missiles for new reactors. However, currently we'll use the SECY Paper 10-0121 entitled "Modifying The Risk-Informed Regulatory Guidance for New Reactors" to compare to our review.

MEMBER-AT-LARGE STETKAR: I understand the rationale and that's hopefully as best as we can hope in the context of this reg. guide.

MR. SHENG: Yes. It's simply because I think the responsible branch did not want their hands to be tied. They wanted more freedom to do the review.

CHAIRMAN ABDEL-KHALIK: But just back to the point of nuclear experience versus fossil experience, do we have any idea how many turbine overspeed have occurred in fossil plants over the past ten years?

MR. SHENG: No. I did not do the investigation. So I did not know.

CHAIRMAN ABDEL-KHALIK: So you have no idea about whether the probability or the experience base for the fossil side of it is any different than the nuclear experience.

MR. SHENG: Right.

CHAIRMAN ABDEL-KHALIK: So I'm not sure why the argument that we should limit the database to only data from nuclear operations.

MR. SHENG: Yes. As I explained before, it's based on our qualitative --

CHAIRMAN ABDEL-KHALIK: It would seem to me that the investment protection on the part of the people in the fossil business would drive them towards equally high standards.

MR. SHENG: However if you do increase the testing frequency or maintain a certain quality of the control system that it would require money. For instance, like one nuclear unit, right, they even refused to adopt the insurer's recommendation after this Salem 2 event.

The nuclear operating -- nuclear insurance company issued guidance that says you have to follow. But one unit refused to follow and then paid higher premium because they think their system is fine. Certain, not all guidelines, guidelines.

So all I'm saying is that I do believe that once we issue so many guidelines. Right. And the nuclear units followed. And they don't follow them completely. So if the non-nuclear plants were not affording the effort and they will follow all these guidelines rigorously, that I just don't -- I find it hard to believe. That's why the reason that based on the quality assessment.

CHAIRMAN ABDEL-KHALIK: But absent data this is all conjecture.

MR. SHENG: I understand.

CHAIRMAN ABDEL-KHALIK: It is quite possible that when you actually collect the data you'll find that the failure rates are the same and maybe you're doing too much testing that is not necessary because it doesn't impact the failure rate.

MR. SHENG: Right.

MR. JONES: We do have earlier operating experience that did indicate problems with inadequate testing especially if the individual components were not individually tested. There was a problem missing existing failed components and then having a subsequent failure that resulted in negative impacts. And that contributed to the Salem 2 overspeed event.

So I think that particular piece of operating experience we know is infiltrated in the operating practices of the nuclear units. And that has a big effect on that. But I understand your point regarding fossil units may indicate we're --

MEMBER-AT-LARGE STETKAR: Or international nuclear units. I mean if the notion is that nuclear people do better on these things because they do better on these things --

MEMBER SIEBER: Safety culture issue.

MR. JONES: Right. A lot of that is.

MEMBER-AT-LARGE STETKAR: Anyway I think we talked about the frequency.

MEMBER SIEBER: There are differences between coal-fired and nuclear units. For example, coal-fired plants generally have two pole generators. So they turn at 3600 rpm compared to 1800 rpm per nuclear.

Nuclear units have longer blades. And that's because somebody said lousy steam. That lousy steam is the right answer to that. You've got to get every piece of horsepower out of it and the way to do is high moisture content on the tailend, large blades, do as much expansion as you can.

The performance records that I'm aware of are probably worse for fossil units at least in the companies that I've worked for in the past. And because the insurance company will make them do an overspeed check but there's multiple paths to get the trip and the one they paid most attention to was the moving slug in the trip. And so they would not test all the methods.

I think there's something to be learned

from fossil units. But I'm not sure I would rely on their record. Just establish the probability of failure.

MEMBER-AT-LARGE STETKAR: Without speculating on what the data might show, I think that when you collect the operating record -- I mean we're hopefully not looking at 10,000 turbine failures. If you're looking at a couple of hundred failures and examine the root causes for them and I'm sure that that documentation is available because these types of events actually catch your interest and people are probably interested in looking at the causes. If you compare the causes of those to the designs and testing and maintenance that's performed on the nuclear units you might have justification to say "Well, that particular type of event is not applicable to a nuclear unit turbine for the following reasons." Or you might find that it might be applicable.

But until you actually have the operating experience in front of you and you can examine the event records, a lot of it is just speculation. It might be better. It might be worse. We just don't know. And if we're trying to predict numbers that were one in 100 that's a little bit different. We're trying to predict numbers that are a magnitude lower than one in 100.

MR. HONCHARIK: But I guess also I think -- I understand. Yes. To see whether or not some of the fossil plant failures can be applicable to nuclear. But also with the I guess to see whether or not the frequency is the same, that would need to have not only what the failures are but what the operating experience years and everything for each of the units.

MEMBER-AT-LARGE STETKAR: In many of these cases, the desire to be precise to six significant figures is less important than to be accurate to within an order of magnitude or so.

MR. HONCHARIK: Right.

MEMBER-AT-LARGE STETKAR: So having a precise estimate of the number of turbine operating hours might be less important than to say we took data from the following set of large units and we know roughly that each of those units has operated X number of years. That information should be readily available.

MR. HONCHARIK: That's if they haven't replaced rotor blades.

MEMBER-AT-LARGE STETKAR: Accuracy is good. Precision is not necessarily required for these types of -- After all, this is not a precise data assessment. It's an evaluation of operating experience to derive confidence that indeed these $10^{-4}$ numbers are not contrary to actual experience. And as you said people who do analyses calculate those numbers. But maybe they're missing something in their analysis also that they haven't thought about.

We've beaten the number I think to death here. Simon, I think you can go on.

MR. SHENG: Yes. Let's move onto slide 12 and here I want to summarize the enhancements in the proposed RG 1.115. The first is that we provide the guidance for high-trajectory missiles. And then we define SSCs to be protected. We clarify the current NRC emphasis on $P_1$ and permit the approach of considering $P_1$, $P_2$ and $P_3$. And we validate operating experience since 1977. Slide 13.

And in regards of provide high-trajectory missiles, we did -- Basically I think we can neglect this one. The only thing I want to mention is that in the equation you can see that the P $_{10}$ which is the probability of overspeed protection system protection system failure. And this is a significant contributor to the entire $P_1$.

And the first P $_{1p}$ which $P_{1f}$ is the probability of disk failure based on Probabilistic

Fracture Mechanics considering stress corrosion cracking. So you did all these kind of fancy analysis to a general number. But in the end your probably overspeed system failure really is a big number compared to that. They are comparable, but you can't ignore either of those.

MEMBER-AT-LARGE STETKAR: Simon, just one question about this regulatory position 2B does discuss high-trajectory missiles and in particular it says "As the preferred option for unfavorably oriented turbines limiting the turbine missile generation..."

MR. SHENG: Excuse me. You're talking about slide 14. Right?

MEMBER-AT-LARGE STETKAR: Yes. Okay. I'm sorry. I'll let you go to 14. I'm sorry. I didn't read far enough ahead.

MR. SHENG: Slide 14 that we clarified -- Slide 14. Yes. We clarified the current emphasis on $P_1$ and we provide guidance for the favorably oriented turbines and for the low trajectory and high trajectory.

Mr. Stetkar, you can raise your question.

MEMBER-AT-LARGE STETKAR: I'm sorry for breaking in. I didn't read far enough ahead in the slides. The concern and I think we voiced this at the

Subcommittee meeting is that the actual words say "As the preferred option for unfavorably oriented turbines," the lower part of your slide 14 here.

MR. SHENG: Okay.

MEMBER-AT-LARGE STETKAR: "Limiting the turbine missile generation frequency $P_1$ for trajectory missile to a value of less than 1 times $10^{-5}$ per year."

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: "The evaluation for high-trajectory turbine missiles is not needed because the turbine missile generation frequency for low-trajectory missiles is bounding."

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: And I think we raised the question of why is the turbine missile generation frequency for high-trajectory missiles different and bounded by the turbine missile generation frequency for low-trajectory missiles. The frequency $P_1$ as you noted on the previous slide is driven primarily by failures of the overspeed system. So it's not --

MR. JONES: We shouldn't say bounding. It's more restrictive.

MEMBER-AT-LARGE STETKAR: It's -- I don't want to put words in your mouth. But I think during the Subcommittee meeting we had a discussion that said the combined likelihood of missile generation frequency times $P_2$ times $P_3$ may be bounded by the combination of those three factors for low-trajectory missiles.

MR. JONES: Right.

MEMBER-AT-LARGE STETKAR: And yet the guidance in the regulatory guide still focuses on simply a frequency argument which doesn't seem to make any sense. It seems that the frequency of high-trajectory missiles would be the same as the frequency of low-trajectory missiles. If I parse my turbine up into four equal circumferential segments or something like that, it might be a half if I don't care about missiles that go down through the main condenser.

But just to say that the frequency of the turbine missiles, you don't need to do it because $P_1$ for low-trajectory missiles bounds $P_1$ for high-trajectory missiles doesn't seem the right notion.

MR. JONES: I think the intention is to say that that's a more limiting criterion for acceptability. And that's based in part on the $P_2$ portion of that.

MEMBER-AT-LARGE STETKAR: And I think in

the sense that the last time that this reg. guide was updated was 34 years ago. Sometimes the intent of the justification is important to document because people will make inferences from the words. And if the intent is to say that the combined damage from high-trajectory missiles, there's reason to believe in some basis for that, is bounded by the low-trajectory missiles, then it would seem to make sense to elaborate a bit on that because otherwise people will just say that NRC accepts the fact that I don't need to look at high-trajectory missiles because I know for some reason the NRC says that the frequency is less. And it's not a strict ejection frequency argument. It's the overall damage.

MR. JONES: I guess there is a -- For a typical plant arrangement, there is a slightly lower number for high-trajectory missiles that could still land on the sight footprint compared to low-trajectory missiles. There's a lot broader band exit direction, if you will, that will hit or strike an essential component for a direct path as opposed to a lob.

MEMBER-AT-LARGE STETKAR: The product of $P_2$ times $P_3$ is less.

MR. SHENG: Well, $P_2$ I think particularly.

MR. JONES: Right.

MR. SHENG: $P_2$ yes. I think the language is there. Okay. Maybe modified a little bit because when we say responding actually if you read it literally that means that we're talking about $P_1$ only.

MEMBER-AT-LARGE STETKAR: That's right.

MR. SHENG: But here the implication is that we are actually considering the $P_2$ of the high-trajectory missile and we did not say so clearly in our argument.

MEMBER-AT-LARGE STETKAR: That's right. That's the whole point of the comment.

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: Because one of the -- The reason -- You know it sounds like a minor point. But the reason is to increase the notion that not only $P_1$ but $P_2$ and $P_3$ are factored into both regulatory, the scope of regulatory reviews and decisions that you might make about the potential risk from turbine missiles.

MR. SHENG: I made a note that we need to modify the language.

MEMBER-AT-LARGE STETKAR: This is a case where you're actually making arguments with regard to $P_2$ and $P_3$.

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: $P_2$ let's say about why the staff believes it's not necessary to look at high-trajectory missiles in this case. It should be just elaborated a bit.

MR. SHENG: Yes. Your point is well-taken.

MEMBER-AT-LARGE STETKAR: Because it sort of fits the mold of where you're eventually going into something that you may get to in these slides.

MR. SHENG: Right. And we can go directly to slide 16. As I said, the current NRC approach is emphasis on $P_1$ and as a result all the plant-specific applications is focused on $P_1$. But now that this RG actually permits the approach of considering $P_1$, $P_2$, and $P_3$. So as long as your $P_1$ times $P_2$ and $P_3$ is less than $1E^{-7}$ then we will consider it.

The features of these applications that we retain the RG 1.115 criterion of $1E^{-7}$ for the probability of failure of an essential system caused by low-trajectory missiles. And by doing so, we also relax -- To address the point of your earlier comment, we relax the current $P_1$ criterion for an unfavorably oriented turbine from 1E-5 to 1E-4 when $P_2$ and $P_3$ are also considered. So basically I think if the applicant has a way to control the $P_2$ to a small number then we can relax a little bit on the $P_1$.

MEMBER-AT-LARGE STETKAR: And we had some discussion about this also in the Subcommittee meeting. If ultimately the criterion is a frequency of damage to risk important SSCs of less than $1E^{-7}$ per year if I'm an applicant and I can provide an analysis that gives the staff reasonable assurance that the product of $P_2$ times $P_3$ is less than $10^{-6}$ why do I also need a turbine missile ejection frequency that must be less than $1E^{-4}$? In other words, why do the criteria that are imposed under this particular regulatory position 2C require both the product of the missile ejection frequency to be less than $10^{-4}$ and the product of our ultimate protection frequency to be less than $10^{-7}$? Why isn't it just a total less than $10^{-7}$ if I provide a detailed evaluation of my plant specific geometry and analyses to quantify $P_2$ and $P_3$ rather than just taking the accepted regulatory guidance values for those two parameters?

MR. SHENG: Right. Theoretically you are correct. However I believe that even we do so, okay, the licensee probably will not do that because that means the turbine design according to the $P_1$ or $10^{-2}$. That means their turbines is going to fail much more frequently. And it will cause a lot of cost on their side.

MEMBER-AT-LARGE STETKAR: Okay. But you know I take risk with my money. I got to Las Vegas. I invest my money. I lose it. That's my investment risk that is not risk to public health and safety from the damage to nuclear safety related equipment.

MR. SHENG: I understand.

MEMBER-AT-LARGE STETKAR: I would argue that if indeed that $1E^{-4}$ addresses utility investment risk that's not something traditionally that the agency tries to regulate.

MR. SHENG: I understand that. As I said, we already -- In the second bullet basically we already increased the criteria by an order of magnitude. And we would like to see more as I said operating experience to get an even bigger number of the criteria for $P_1$.

But right now it's just how far we want to go at the moment. And as I said that if a licensee have a different approach using a very small $P_1$ number at their own risk, then we'll consider that at that time.

MEMBER-AT-LARGE STETKAR: But when you say very small, you mean very large.

MR. SHENG: Yes, very large.

MEMBER-AT-LARGE STETKAR: That still though in the regulatory guidance and in not only the text of position 2C but also the numerics in Table 1, it tells me as applicant or a licensee that you will not consider a $P_1$ that is greater than $1E^{-4}$ despite the fact that my product -- You allow me do a detailed analysis of the product $P_2$ and $P_3$. But if I can show that that product is $P_2$ times $P_3$ is $10^{-4}$ let's say.

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: And I therefore can justify a $P_1$ of $10^{-3}$ you won't consider that. That's what the regulatory guidance says.

CHAIRMAN ABDEL-KHALIK: But doesn't $P_1$ in and of itself impact worker safety?

MEMBER SHACK: Yeah, I mean I think there's a defense-in-depth argument here. We really don't like turbines coming apart.

MEMBER POWERS: Have you ever seen it happen, Bill? It's so much fun.

MEMBER-AT-LARGE STETKAR: We also don't like LOCAs, but we accept certain frequencies of core damage from LOCAs.

MEMBER SHACK: But it's a readily achievable goal by modern turbine standards. I think it would be criminal to relax it would be sort of my reaction.

MR. HONCHARIK: And I guess -- I wasn't here way back when they were doing these $P_2$ - $P_3$. But I think previous to the Hope Creek some were using that $P_2$ - $P_3$ criteria and there are many different ways of doing it. There are very different opinions on the assumptions and such that there is such a wide spectrum that it was very difficult to handle. And I think that's why in '86 they went to $P_1$ criteria.

I think that also needs to be taken into consideration of whether or not -- how reliable are those $P_2$ - $P_3$ calculations.

MEMBER-AT-LARGE STETKAR: I think there are obviously differences of opinion. This is a change to the regulatory guidance. This says that the regulatory guidance now says the Staff will consider analyses that does a refined evaluation of $P_2$ and $P_3$. But it very, very narrowly restricts that evaluation.

And regardless of the ability of a particular licensee to provide an analysis that gives the Staff assurance that their analysis of $P_2$ and $P_3$ is reasonable that they've looked at all of the parameters and done a reasonable analysis, the question is should we presume -- Suppose they have the ability to do a perfect analysis and justify a $P_2$

times $P_3$ product of $2E^{-4}$. So I could have a $5E^{-3}$, 2E -- I can't do the math in my head right now. But you get the notion that I could have a $2E^{-4}$ turbine missile generation frequency. This says the Staff won't consider that even with a perfect analysis.

MR. SHENG: I think this --

MEMBER SHACK: That's what we call a hypothetical. Right?

MEMBER-AT-LARGE STETKAR: No. People --

MEMBER SHACK: Perfect analyses.

MEMBER-AT-LARGE STETKAR: Well, I'm not trying to presume. A particular licensee may not adopt this option because they may judge that it's too difficult to do an acceptable analysis of $P_2$ times $P_3$. But that's their judgment.

And the question is if they want to try to do that analysis and get the Staff to accept it and believe by doing that analysis they could get a factor of relaxation in their $P_1$ why ought they be restricted from trying that?

MR. LABINSKY: If I could address that to some extent. John Labinsky. As you said, the examples you brought up, I think you started with the Staff would not even address that or not even consider that. You know we are talking about reg. guide.

Under the regulations, someone could come with an exemption that we wouldn't ever consider.

In this case, if someone were to come in under an extreme circumstance, we would look at this as our initial guidance in doing that review. We would look at the guidance that we've used for addressing $P_2$ and $P_3$ and doing that evaluation. And if we felt that it had the credibility and had the sophistication, we would consider that clearly on a case-by-case basis. And that would be the entire reg. guide. But we don't want to put out there that that's something that we would want people to get margin by looking at those numbers and trying to get away from $E^{-4}$ for the initial turbine failure.

Because again we do think having that defense-in-depth and the initial turbine failure being very low is important. So we do want to put out there that we believe that's our initial position. If someone can really prove that to us in $P_2$ and $P_3$ we would have to look at that on a case-by-case basis. But we've not -- I don't think we'd want to put that into the reg. guide at this point. Let someone else come and ask us that when the situation presents itself.

MR. SHENG: Thank you. Okay. Slide 17.

And I want to review the industry comments that basically the proposed RG considers the pathway for high trajectory missile, provide a way to do that. And robust rotor designs. New rotor designs within current regulatory process. Credit for existing structures as missiles barriers. Sites with multiple units. Applications -- Up to the above it can be reflected either in $P_1$ or $P_2$ calculation because this reg. guide allows them to do the complete approach of using $P_1$, $P_2$ and $P_3$. So you can reflect all this in your calculation.

And then also that by taking the Committee's comment we now entertain application conforming to RG 1.174 on a case-by-case basis and also that is also defended by the industry.

And another one that we made the commitment to make changes in SRP consistent with the changes we made in the reg. guide.

And the last one that we did not do because the industry wanted us to basically lower the $P_1$ as Mr. Stetkar just mentioned to make the criteria more generous. As I said, we think the current operating history is consistent with $10^{-4}$ failure rate. So we did not revise RG in that regards.

So this is the set of the industry

comments. However, the resolution resolved all that. It reflected the position we've taken the most recent RG incorporated in ACRS Committee's comments. Next slide.

It's the additional industry comments and soliciting comments again is required because the RG Revision incorporated ACRS comments which is rather significant. So we sent it out for additional comments with a shorter response time.

And the industry -- Most of the industry's comments involve definitions and wordings changes and we did it accordingly. And one of the comments is the review of risk-informed approach on a case-by-case basis to include generic application. And although the plant-specific, risk-informed approach is more practical, the Staff's consideration of a risk-informed approach on a case-by-case basis does not rule out generic application if the industry can find that to be very useful to plants.

MEMBER-AT-LARGE STETKAR: That came from one of the user groups. Right?

MR. SHENG: Right.

MEMBER-AT-LARGE STETKAR: They wanted to --

MR. SHENG: Basically from EPI.

MEMBER-AT-LARGE STETKAR: Yes.

MR. SHENG: Okay. So I'm going to present you the slide 19 which is our conclusion. And the proposed RG 1.115 becomes self-contained, providing preferred and acceptable approaches and acceptance criteria against the low-trajectory missiles and high-trajectory missiles.

And the proposed RG 1.115 is consistent with the current criteria emphasizing $P_1$.

It also considers the approach using $P_1$, $P_2$, and $P_3$.

It considers risk-informed approach on a case-by-case basis.

It has considered 2010 and 2011 industry comments.

It has fully addressed the six of seven ACRS comments. And the one that we didn't do now is that we are considering how and when to explore the means to provide detailed technical guidelines in the RG. So we're considering it. And this concludes our presentation. Thank you.

MEMBER-AT-LARGE STETKAR: Thank you very much.

Any comments? Questions from other members?

MEMBER SKILLMAN: I do.

MEMBER-AT-LARGE STETKAR: Mr. Skillman.

MEMBER SKILLMAN: Yes. In the systems that are protected, fire protection is not listed. One can infer it's among the systems. But I ask why that doesn't show up in your revised reg. guide. Where is fire protection in your list here? You've got 16 items. You've got to do a lot of translation to find it in there and you really need to know what you're talking about in terms of the pumping in a plant. Where is it please? Your SSCs?

MR. JONES: It's not listed among the SSCs. They're required to be protected because it's not typically accredited for station shutdown. But I understand what you're getting at.

MEMBER SKILLMAN: Let me ask another question. In a PWR I could pretty much be sold on a change to $P_1$. I recognize on a B the turbine missile violates reactor coolant system boundary. And so the notion of going from $10^{-5}$ to $10^{-4}$ brings with it at least in my mind the same comment that William Shack had. It's almost unthinkable to reduce that number because at least in a B the turbine casing is part of your reactor coolant system pressure boundary.

If you have a slight leak, if you're

running a couple of microcuries per cc of failed fuel, you now have a breather. You now have a release. So I'm wondering if the notion of allowing a reduction of $P_1$ is as prudent as one might think it is particularly for B and maybe the requirement for B may be different than for a pressurized water reactor.

And I'm a latecomer. Maybe all of this is processed information. I'm going to stop right here. Thank you.

MR. SHENG: We'll consider that.

MEMBER SKILLMAN: Thank you.

MEMBER-AT-LARGE STETKAR: Any other comments from Members? Questions?

(No verbal response.)

Are there any members of the public that have any comments or questions?

MR. DUBE: Don Dube, Office of New Reactors. John asked the question earlier of whether less than $10^{-7}$ could be considered negligible for new reactors in light of the fact that some plants have internal events, core damage frequency, of the order of $2 \times 10^{-8}$. That is true, but when one adds up external events, low power shutdown and external events during low power shutdown even though the lowest plant which is the ESBWR is above $10^{-7}$. And that does not include seismic which everyone keeps reminding me is probably the dominant contributor.

And while no one has submitted an application yet where they have combine that seismic hazard curve with fragilities to estimate seismically induced core damage frequency, we have done some back of the envelope calculations which indicated it would be mid $10^{-7}$ to mid $10^{-6}$ range probably depending on the site.

So qualitatively I'd feel comfortable saying that if you could get the probability of damage to an essential system less than $10^{-7}$ recognizing there is some reduction and margin to that from core damage it's pretty close to be negligible in my opinion.

MEMBER-AT-LARGE STETKAR: Thanks, Don. That helps put some perspective on those numbers.

Anything else? Anyone?

(No verbal response.)

If not, thank you all very much. I think it was a good presentation. We had a good discussion and I very, very appreciate all the effort you put into making the changes to the reg. guide since the Subcommittee meeting. It's been very responsive. I'm pretty happy with it.

So thank you. And with that, Mr. Chairman, it's back to you with seven minutes to share.

CHAIRMAN ABDEL-KHALIK: Thank you. The next item on the agenda is preparation of ACRS reports. But before we get to that I think Westinghouse may be ready to present the answer to the question that was posed during the previous session.

MEMBER RAY: Now we did go next door and debate a little bit about what question we were asking. So let me tell you what I told them. I hope it's satisfactory. It is that we're looking to judge the sensitivity of containment pressure to whatever measure of air temperature we have. And that's an ambient temperature I expect. We'll see here in a second.

They do have, of course, a profile of the temperature through the wall of the structure. But that doesn't really go to the question of effect on peak pressure which we may be able to infer from the information they have for us.

CHAIRMAN ABDEL-KHALIK: Thank you.

MR. CORLETTI: And I think as Harold said we heard the questions and I think we're going to try to present two aspects of it.

As we're preparing to get the slides up there, I think what we were hearing is what would be the effect of solar radiation or solar heat gain on the peak containment pressure analysis and we wanted to look at the effects of that effect of solar gain on the inlet air temperature. What might it be? So we looked at two aspects of how could that raise the air temperature.

One was we looked at the grating across the structure so that once the air had entered the shield building structure as it would travel down between the shield building all and the baffle. That's the first point.

And then the second point is we have done parametric studies. We have previously done parametric studies that just parametrically if the inlet air temperature is increased so many degrees what's the impact on the peak pressure.

The first slide you see there are the results from the calculations that we showed for our evaluation of solar gain. And for that what you see is when the temperature on the outside surface is 129 -- 128.5 is the exact number -- the inside wall temperature because this is a transient effect does not increase. It's 0.001 the inside wall temperature increases.

So essentially there's no heat into the air flowing between the baffle and the shield building wall because effective solar radiation is serving to heat up the concrete. And it's not of a duration. It's not a steady state problem where you've developed a grating across that structure. So really this is showing you the temperature gradient across the structure, across the shield building wall, in that condition when it's 128.5 degrees. That was one aspect.

I'm going to turn it over to Rick now. He's going to basically try to put -- If you put that aside, if we just look at parametrically the air inlet temperature -- Should I pause there?

VICE CHAIRMAN ARMIJO: Can you just go back again?

MR. CORLETTI: Sure.

VICE CHAIRMAN ARMIJO: I want to look at that.

MR. CORLETTI: Do you want me to keep going?

MEMBER RAY: I'd really like you to do that. But, of course, if Sam has a question.

VICE CHAIRMAN ARMIJO: Yes. I just want

to --

MEMBER RAY: I'm just afraid that we'll lose the parametric. But go ahead, Sam. Ask your question.

VICE CHAIRMAN ARMIJO: Just go back to that curve. I just want to make sure I understand it. You say that will be a steady state temperature gradient across the wall.

MR. CORLETTI: No.

MEMBER SHACK: It's the thermal history that you have for this. What temperature do you start with --

VICE CHAIRMAN ARMIJO: I'm having a hard time --

MEMBER SHACK: -- when you raised it to 115?

MR. CORLETTI: I believe we start -- Go ahead, Tod.

MR. BAKER: I'm sorry. We started at 115 degrees.

MR. CORLETTI: And then we turn on the sun.

MEMBER RAY: You turn on the sun and so it gets hotter on the outside.

MEMBER SHACK: Okay.

MR. BAKER: We started it at a steady state of 115 degrees.

MEMBER SHACK: And then just let the sun shine.

MR. BAKER: And we added the sun. Yes.

MEMBER SHACK: And after 16 hours you get to this.

MR. BAKER: Right. The sun is moving around the building.

MR. CORLETTI: I think we said at 4:45 p.m. was the maximum temperature in the west facing wall of the structure assuming the plant width is the way the plant is actually oriented.

VICE CHAIRMAN ARMIJO: Okay. I understand.

MR. OFSTUN: Can I ask a question? Did you guys run that for 24 hours and did you show the cooldown effect afterwards?

VICE CHAIRMAN ARMIJO: This is just taking it to the peak temperature. Right?

MR. OFSTUN: Yes.

VICE CHAIRMAN ARMIJO: And then you stop.

MR. OFSTUN: I just wanted to see if at the end.

MR. BAKER: We actually ran it for 24

hours at an ambient temperature of 115 degrees and with the sun the way the sun would go.

MR. OFSTUN: Did it get back down to 115 at the end of the day?

MR. BAKER: Roughly.

MR. OFSTUN: Okay.

VICE CHAIRMAN ARMIJO: Okay. I understand what the chart says.

MR. CORLETTI: So the next slide I think we're going to let Rick present is the parametrics. Set that aside. Parametrically if you increase the air inlet temperature what the impact might be.

MR. OFSTUN: Right. The first bullet here was what Mike just described that there's a very small amount of temperature rise on the inside surface of the shield.

MEMBER POWERS: How thick is that concrete wall again?

MR. OFSTUN: Three feet thick.

So we did just a rough estimate and assumed that the average incoming air temperature increase by three and a half degrees and we got that by just assuming that the sun was shining on one quadrant essentially full force and raised that quadrant to 129 degrees. And the other three were at

115. And then the average air temperature going that could -- The maximum average air temperature that could go into the inlets would be 118.5 degrees. And that's how we came up with the 3.5 degree number.

MEMBER BROWN: That's the external air.

MR. OFSTUN: Yeah.

MEMBER BROWN: Before the air comes down and then up.

MR. OFSTUN: Yes.

MR. CORLETTI: There is no physics behind this.

MR. OFSTUN: No.

MEMBER RAY: They did what I asked them to do.

MR. CORLETTI: -- wrong, but we are conservative I think was his words to us. But if you assume that the air is traversing on the outside of the shield building --

MR. OFSTUN: Filling up.

MR. CORLETTI: It's filling up into the air intake. Picking up that energy and it reaches the same temperature as the plate. So basically one-fourth is going in at 129 and the other three-fourths is going at 115. They calculated it could be as much as a 3.5 degree rise.

(Off the record discussion.)

MEMBER RAY: Yes, that's the point is what's the effect.

MR. OFSTUN: Yes.

MEMBER RAY: I don't know if this is a good idea or bad idea.

MR. OFSTUN: We have a sensitivity study that shows for a 10 degree increase in the ambient air temperature the containment peak pressure calculated went up by 0.05 psi. So if you consider a 3.5 degree increase in the ambient air temperature due to solar heating of the external surface and we're not even counting the cooling because as it goes down through the annulus it's going to cool off a little bit. And as it goes up it will heat up on the other side. But we came up with less than 0.02 psi for an increase in the containment pressure.

MEMBER SIEBER: Now does the sunshine have an effect on the temperature of the water in the tank?

VICE CHAIRMAN ARMIJO: It can be maintained at 40 degrees. Right?

MEMBER RAY: Yes. Again they assume the maximum allowable temperature by tech spec.

MR. OFSTUN: It is.

MEMBER SIEBER: Okay.

MEMBER RAY: And if you assume that they can't measure it accurately because of the sun I suppose that would be a problem. But there is so much darn inertia in that water.

MEMBER SIEBER: Yes, there's a lot of water up there.

MR. CORLETTI: That's right.

MEMBER SIEBER: Probably a degree or two.

MEMBER RAY: Okay. Do you guys want to say more?

MR. CORLETTI: I think we're done.

MEMBER RAY: I think the point that at least I was trying to get them to make was what is the sensitivity to a variation in the ambient air temperature for whatever reason, a brushfire or the sun or whatever you want to think about.

CHAIRMAN ABDEL-KHALIK: And this parametric calculation is part of the record.

MEMBER RAY: It is now. It's going to be part of this record.

MR. CORLETTI: Yes. It was a calculation that we did as part of one --

MR. OFSTUN: It's part of count note.

MR. CORLETTI: A Westinghouse count note. But by putting it on the record here I think we've just -- But we do have a QA record of it back in Cranberry.

VICE CHAIRMAN ARMIJO: Was that calculation done specifically for this meeting or had that been done before?

MR. OFSTUN: Had been done years before.

VICE CHAIRMAN ARMIJO: Okay. Thank you.

MEMBER RAY: All right, Mr. Chairman.

CHAIRMAN ABDEL-KHALIK: Well, thank you. At this time, I guess we're going to move onto the next item on the agenda.

(Chorus of thank yous.)

The preparation of ACRS reports. But before we do that, let's take a ten minute break. And when we get back we will be off the record.

(Whereupon, at 5:01 p.m., the above-entitled matter was concluded to adjourn to closed session.)

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*Protecting People and the Environment*

# Near-Term Task Force Presentation

**Advisory Committee for Reactor Safeguards**

September 8, 2011

# NRC Near-Term Task Force

- Leader
  - – Dr. Charles Miller
- Members
  - – Amy Cubbage
  - – Dan Dorman
  - – Jack Grobe
  - – Gary Holahan
  - – Nathan Sanfilippo

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# Near-Term Task Force Summary

- Similar sequence of events in the U.S. is unlikely
- Existing mitigation measures could reduce the likelihood of core damage and radiological releases
- No imminent risk from continued operation and licensing activities
- Safety enhancements recommended

# Summary of Recommendations

- 12 overarching recommendations
- Detailed recommendations support implementation
  - Policy Statement
  - Rulemakings
  - Orders
  - Staff actions
  - Long-term evaluation

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# Focus Areas

- Regulatory framework
- Defense-in-depth philosophy
  - Protection from natural phenomena
  - Mitigation for long-term station blackout (SBO)
  - Emergency preparedness (EP)
- NRC programs

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# Recommendation 1

Enhance NRC framework for regulating beyond design basis events and severe accidents

# Recommendation 2

Update seismic and flooding analysis and protect plants from these events

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# Recommendation 3

**Long Term Evaluation Topic:**

Evaluate potential enhancements to prevent or mitigate seismically induced fires and internal floods

# Recommendation 4

Strengthen coping for prolonged station blackout events

# Recommendation 5

Require reliable hardened vent designs in BWRs with Mark I and Mark II containments

# Recommendation 6

**Long Term Evaluation Topic:**

Identify insights about hydrogen control and mitigation inside containment or in other buildings

# Recommendation 7

Enhance spent fuel pool instrumentation and makeup capability

# Recommendation 8

Strengthen and integrate onsite emergency response capabilities

- Emergency Operating Procedures (EOPs)
- Severe Accident Management Guidelines (SAMGs)
- Extensive Damage Mitigation Guidelines (EDMGs)

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# Recommendation 9

Require that facility emergency plans address prolonged SBO and multiunit events

# Recommendation 10

Long-Term Evaluation Topic:

Additional EP topics related to multiunit events and prolonged SBO

- Protective equipment for emergency responders
- Decisionmaker qualifications
- Command and control
- Emergency Response Data System (ERDs)

# Recommendation 11

Long-Term Evaluation Topic:

Additional emergency preparedness issues

- Offsite emergency response
- EP decisionmaking
- Radiation monitoring
- Public education on radiation safety and use of potassium iodide (KI)

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# Recommendation 12

Strengthen regulatory oversight of licensee safety performance (ROP) by focusing more attention on defense-in-depth requirements

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# Next Steps

**Commission SRM issued August 19, 2011 directed the staff to:**

- Draft Charter for NRC's longer term review (complete)
- Prepare 21-day notation vote paper identifying actions that can and should be initiated without unnecessary delay
- Prepare 45-day notation vote paper prioritizing Task Force Recommendations 2 through 12
- Prepare notation vote paper regarding Task Force Recommendation 1 (due in 18 months)

NUCLEAR ENERGY INSTITUTE

**Adrian P. Heymer**
SENIOR DIRECTOR
STRATEGIC PROGRAMS
NUCLEAR GENERATION DIVISION

September 2, 2011

Ms. Cindy K. Bladey
Chief, Rules, Announcements and Directives Branch
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

**Subject:** Industry Comments on Proposed Near-Term NRC Actions Associated With the Fukushima Dai-Ichi Accident; Docket Number NRC-2011-0196

**Project Number: 689**

Dear Ms. Bladey,

The Nuclear Energy Institute[1] appreciates the opportunity to provide comments and input on the set of proposed near-term U.S. Nuclear Regulatory Commission (NRC) actions associated with the NRC report, *Recommendations for Enhancing Reactor Safety in the 21st Century, The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*. This letter supplements the industry comments made in the NRC August 31, 2011 public meeting and reflects input provided by several industry working groups and the chief nuclear officers of all U.S. nuclear operating companies.

Detailed comments on each of the six main recommendations are provided in the attachment to this letter.

In addressing the NRC task force recommendations, we encourage the Commission to adopt a flexible, performance-based approach, especially in the area of beyond design bases activities, to allow for the variations in siting, geographical and geological locations, and plant designs.

The industry agrees that there are important lessons to be learned and implemented from the Fukushima accident. The industry has developed a strategic plan, *The Way Forward,* to coordinate and manage its response to the Fukushima crisis. The plan emphasizes the importance of maintaining high safety

[1] NEI is the organization responsible for establishing unified nuclear industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all utilities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

performance at the 104 operating reactors and covers the development and implementation of lessons learned from Fukushima, R&D and technical support, international cooperation and support, communications, emergency planning and preparedness, training, and regulatory interactions and response.

The industry will soon complete a provisional timeline that reconstructs the progression of events and accident conditions at Fukushima. Once the provisional timeline is completed, discussions with Tokyo Electric Power Company are necessary to resolve a number of open issues and questions before the industry completes its evaluations. Also, that information will be critical in determining the extent to which insights related to the events and conditions pertain to U.S. plants and the potential plant enhancements that should flow therefrom. There must be a reasoned determination that the correct lessons have been learned and that those lessons are appropriately linked to the causal factors of the Fukushima accidents.

The industry, the public and the NRC must have a common understanding of the events and rationale for the actions taken at Fukushima before the industry—as required by the NRC and on its own initiative—implements plant enhancements. To attain this objective, the industry is willing to discuss the timeline with NRC staff. This will provide additional confidence in the development and understanding of the bases for regulatory actions being required in response to the Fukushima accidents as well as the manner in which new requirements are to be satisfied.

The NRC task force concluded that a sequence of events like the Fukushima accident is unlikely to occur in the United States and that continued operation and continued licensing activities do not pose an imminent risk to public health and safety. A preliminary industry qualitative, risk-informed assessment of the six NRC recommendations under consideration reaches the same conclusion. As a result, we do not believe that orders are necessary at this time. To the extent the NRC seeks information from all licensees or seeks to elicit a response from all licensees on a significant issue, there are regulatory tools such as generic letters and bulletins that can achieve those objectives.

If the NRC determines that it is necessary to impose new requirements on a generic, industry-wide basis, the appropriate regulatory process is rulemaking. If necessary, such rulemakings could be expedited. In summary, we believe that the NRC and all stakeholders would benefit from the transparent and deliberative process mandated by the Administrative Procedure Act.

The near-term actions should be focused on those enhancements that generally may be attainable within 12 to 18 months and where additional clarifying information forthcoming from Fukushima will not negate earlier decisions.

To effectively implement the multi-unit staffing proposal in the NRC task force recommendation 9 concurrent with the existing EP rule change, the implementation schedule for the emergency response organization needs to be extended by one year to accommodate the staffing criteria.

The industry is committed to ensuring that the U.S. nuclear industry learns from and incorporates the lessons from the Fukushima accidents in a manner that will improve safety and plant performance so that the nuclear industry will continue provide additional benefit to the nation's environment and economy.

Sincerely,

Adrian Heymer

Attachment

c: The Honorable Gregory B. Jaczko, Chairman, U.S. Nuclear Regulatory Commission
The Honorable Kristine L. Svinicki, Commissioner, U.S. Nuclear Regulatory Commission
The Honorable William D. Magwood, IV, Commissioner, U.S. Nuclear Regulatory Commission
The Honorable George Apostolakis, Commissioner, U.S. Nuclear Regulatory Commission
The Honorable William C. Ostendorff, Commissioner, U.S. Nuclear Regulatory Commission
Mr. R. William Borchardt, Executive Director for Operations, U.S. Nuclear Regulatory Commission

# Comments on NRC Proposed Near-Term Recommendations from the Fukushima Dai-ichi Accident

## NRC Task Force Recommendation 2

*The Task Force recommends that the NRC require licensees to reevaluate and upgrade as necessary the design-basis seismic and flooding protection of SSCs for each operating reactor.*

The Task Force recommends that the Commission direct the following actions to ensure adequate protection from natural phenomena, consistent with the current state of knowledge and analytical methods. These should be undertaken to prevent fuel damage and to ensure containment and spent fuel pool integrity:

> *2.1 Order licensees to reevaluate the seismic and flooding hazards at their sites against current NRC requirements and guidance, and if necessary, update the design basis and SSCs important to safety to protect against the updated hazards.*
>
> *2.2 Initiate rulemaking to require licensees to confirm seismic hazards and flooding hazards every 10 years and address any new and significant information. If necessary, update the design basis for SSCs important to safety to protect against the updated hazards.*
>
> *2.3. Order licensees to perform seismic and flood protection walk-downs to identify and address plant-specific vulnerabilities and verify the adequacy of monitoring and maintenance for protection features such as watertight barriers and seals in the interim period until longer term actions are completed to update the design basis for external events.*

NEI Comments and Input

The industry believes the initial focus should be on conducting walk-downs (Recommendation 2.3) to confirm that the plant is protected against the design bases flood and seismic events. The other recommendations are longer-term actions.

*Walk-downs*

Seismic: The industry proposes that a sample set of walk-downs should be conducted in accordance with procedures covering the walk-down criteria and validation against the design bases. In addition, a process for selecting the sample set of systems, structures and components should be developed together with criteria for determining when the sample should be expanded, if circumstances dictate. Regulatory interactions and endorsement of the walk-down criteria should occur prior to conducting the walk-downs to ensure that there is a common understanding on the approach and criteria. It should be recognized that additional time should be allowed for completing the seismic walk-downs because some safety-related structures, systems and components may be accessible only during shutdown conditions.

External flooding: A similar approach to the seismic walk-downs would be employed except there would be no need to use a sampling methodology. As with the seismic walk-downs, regulatory interactions should occur in advance to reach a common understanding on the approach and acceptance criteria prior to commencing the activity.

*Ten-Year Update of Seismic and Flooding Hazards*

NEI believes that a process should be developed for identifying and assessing new and significant information as it emerges rather than wait 10 years. Such an approach would be consistent with how the NRC and the industry manage other new information. The industry recommends a three-phase process approach:

1. Identification of pertinent information that is of sufficient significance to warrant assessment.

2. Assessment to determine whether the information would impact the hazard.

3. A process for updating the hazard and determining whether changes are needed. The update would be performed against current regulatory requirements and standards based on the new assumptions and information. For example, if the original design bases standard was a 500-year flood, the update would be based on the 500-year flood, but the impact of an increased downstream levy height would be evaluated. Similarly, if the Corps of Engineers changed the height of the 500-year flood standard based on updated or new meteorology information, the impact on the plant would be evaluated against the new 500-year flood, even though a new plant may be evaluated against a 750-year flood.

*Re-evaluation of Seismic and Flooding Hazard*

Re-evaluations of the seismic and flooding hazard are longer-term activities and should be considered as part of the NRC long-term activities.

For seismic, we believe GI-199 and any follow-on activities and changes would address this aspect of recommendation 2.1.

For flooding, once a process for assessing new and significant pertinent information has been developed and the walk-downs have been completed, along with actions to fix any identified deficiencies, an evaluation on whether the flooding hazard has changed and its impact on the plant can be evaluated.

Industry Near-term Recommendation

*External Flooding Walk-downs*

- *In response to a §50.54(f) letter, a licensee would develop procedures, including acceptance criteria for conducting external flood protection walk-downs and obtain NRC concurrence regarding the acceptability of the walk-down criteria.*

  *Conduct the walk-downs and validate the results against the existing design basis and report the results to the NRC within 120 days of NRC approval of the walk-down criteria.*

*Seismic Walk-downs*

- *In response to a §50.54(f) letter a licensee would develop procedures, including acceptance criteria for conducting a sample set of seismic walk-downs on safety-related systems, structures and components. Obtain a NRC concurrence regarding the approach, including the acceptability of the walk-down criteria and mechanism for expanding the scope of the structures, systems and components to be walked down if deficiencies are identified.*

  *Conduct seismic walk-downs for a sample set of critical safety-related systems, structures and components and verify against the seismic design bases. For areas that are inaccessible because of power operations, the walk-downs will be conducted at the first opportunity. Results will be reported to the NRC within 90 days of the end refueling outage of the first complete operating cycle following the issuance of the regulatory vehicle.*

*External Flooding and Seismic Hazard Update (Long-Term Activity)*

- *Initiate rulemaking to require licensees to confirm seismic hazards and flooding hazards as new and significant information is identified. If necessary, update the design basis to protect safety-related structures, systems and components against the updated hazards.*

NOTE: We do not believe there is sufficient information or understanding to be able to establish acceptance and implementation criteria for an order or proceed with implementation to enable completion within a period of time normally associated with an order.

**NRC Task Force Recommendation 4**

*4.1 Initiate rulemaking to revise 10 CFR 50.63 to require each operating and new reactor licensee to:*

(1) *establish a minimum coping time of 8 hours for a loss of all ac power,*

(2) *establish the equipment, procedures, and training necessary to implement an "extended loss of all ac" coping time of 72 hours for core and spent fuel pool*

*cooling and for reactor coolant system and primary containment integrity as needed, and*

(3) *preplan and pre-stage offsite resources to support uninterrupted core and spent fuel pool cooling, and reactor coolant system and containment integrity as needed, including the ability to deliver the equipment to the site in the time period allowed for extended coping, under conditions involving significant degradation of offsite transportation infrastructure associated with significant natural disasters.*

*4.2 Order licensees to provide reasonable protection for equipment currently provided pursuant to 10 CFR 50.54(hh)(2) from the effects of design-basis external events and to add equipment as needed to address multiunit events while other requirements are being revised and implemented.*

NEI Comments and Input

*Revision to 50.63*

The industry agrees that rulemaking is the correct process for implementing enhancements that would enable plants to better mitigate and manage an extended and complete loss of AC power event. There would be benefit in an advanced notice of proposed rulemaking to frame the scope and objectives of the rule. In addition, key aspects of coping time and access to offsite resources should be considered. We believe that such an initial step would help to focus stakeholder comments and provide for a more efficient overall implementation of recommendation 4.1.

The nature of challenges to AC power supplies by natural phenomena are plant- and site-specific. For example, external flooding progresses very differently at a river or lake site versus a site that has a significant tsunami hazard. Therefore, the identification of appropriate short- and long-term coping strategies can vary from site to site. The approach must assure a degree of flexibility to accommodate the variations in site configuration, features and hazards.

The basis for the proposed 72-hour additional coping is unclear. The barriers to logistic offsite support during an emergency vary depending on location, local geography and transportation infrastructure, the hazard and the extent of the natural phenomena impact on the local and surrounding counties. For some plants assistance and reliable AC generation may be able to be supplied within 24 or 48 hours, at other sites, under different circumstances it may be longer. Thus, the approach must assure a degree of flexibility in the implementation to accommodate varying extended coping time durations for a complete loss of AC power.

Rulemaking is a long-term activity and should be included under the NRC long-term Fukushima activities.

*Multi-Unit §50.54(hh) Requirements*

We agree that pre-staging additional contingency equipment to meet §50.54(hh)(2) requirements for multi-unit sites would be appropriate. The exact composition of the extra equipment at or near the site complemented by additional offsite equipment at pre-staged areas needs to be determined. It is important to note that the wide diversity of unit configurations, geographic locations, varying risks of natural hazards of different types, etc. make this analysis complex. A series of regional public meetings in preparation of the advanced notice of proposed rulemaking could be beneficial and would assure that the rulemaking is correctly framed.

The industry is evaluating the role that regional support centers could play in these situations. Such centers would house contingency equipment, especially for slow, evolving events. Prior to requiring a definitive site-specific solution to the 50.54(hh)(2) equipment, the strategies for use of pre-staged equipment at regional support centers should be established in the implementing guidance for the final rule. Distance from the site, accessibility under external events, and site-mitigation strategies that are, in part, dependent on location and proximity of amenities. Other support infrastructure are variables that need to be addressed before reaching a final conclusion on the additional equipment to be procured and the location of such equipment. We note that other countries are evaluating this approach.

Any requirement to require protection of the contingency equipment against natural phenomena events should allow for flexibility in implementation to achieve the objective. In view of the beyond design bases scenarios that are central to the events under consideration, the specifications for the protection criteria should be based on commercial standards and not the traditional nuclear special treatment specifications. In addition, depending on the site geography, natural phenomena hazards and transportation infrastructure, protection could be afforded by locating more than the minimal set of equipment at various locations on or offsite at a location where it would still be possible to commission the equipment in the timeframe required by the §50.54(hh) requirements. Diversity of location and possibly redundancy could be just as effective as housing the equipment in Category 1 structures to ensure the availability of equipment.

In the interim, until the issues described above are resolved and the equipment is in place, the industry believes that short-term actions could be taken to ensure that adequate equipment is in place to support the contingency needs for each unit, and that the equipment has adequate protection and accessibility.

At this time, we do not believe that there is sufficient knowledge to define the implementation criteria that would be required to accompany an order for the additional §50.54(hh) equipment and protection requirements. We believe a bulletin requesting information on how sites would address the multi-unit contingency equipment issue would be more appropriate. The industry is willing to work on implementing guidance in parallel with a rulemaking amendment to achieve the objective of recommendation 4.2 in the optimum time.

*New Plants*

The NRC task force recommendations recognize the advances of new plant designs. Yet the task force report states that COL applicants would have to address prestaging of any needed equipment for beyond 72 hours, and ITAAC should be established to confirm effective implementation of minimum and extended coping, as described in the recommendation. It is not necessary for prestaging to be addressed in COLs, including those for Vogtle 3/4 and Summer 2/3, for which the NRC staff has completed its technical review. There is no basis for requiring ESBWR or AP1000 COL applicants to adhere to a different coping strategy than existing plants.

Part 52 change processes and other regulatory vehicles exist and should be used for ensuring that new plant licensees comply with coping, prestaging or other new requirements. These matters may be addressed after design certifications or COLs are issued. ITAAC should not be the regulatory vehicle for adjusting the licensing basis.

<u>Industry Near-Term Recommendations</u>

- *In response to a NRC bulletin, procure additional equipment, as determined from site specific evaluations, sufficient to meet §50.54 (hh)(2) requirements for each unit at a nuclear power plant and protect it from natural hazards using commercial standards and taking into account the use of regional or offsite support locations, as circumstances allow and justify.*

  *<u>Long-Term Activities</u>*

- *Pursue an advanced notice of proposed rulemaking (ANPR) to revise §50.63 as a first step to define the scope and key objectives of the revision and to obtain stakeholder input on considerations necessary to address coping time, and offsite resources access before crafting a proposed rule and developing its implementing guidance.*

- *If necessary, amend, through rulemaking, the regulatory §50.54(hh) requirement based on the final implementation plans.*

## NRC Task Force Recommendation 5

*The Task Force recommends requiring reliable hardened vent designs in BWR facilities with Mark I and Mark II containments.*

The Task Force recommends that the Commission direct the staff to take the following actions to ensure the effectiveness of hardened vents:

*5.1 Order licensees to include a reliable hardened vent in BWR Mark I and Mark II containments.*

- *This order should include performance objectives for the design of hardened vents to ensure reliable operation and ease of use (both opening and closing) during a prolonged SBO.*

*5.2 Reevaluate the need for hardened vents for other containment designs, considering the insights from the Fukushima accident. Depending on the outcome of the reevaluation, appropriate regulatory action should be taken for any containment designs requiring hardened vents."*

<u>NEI Comments and Input</u>

The industry agrees that accessibility of BWR containment hardened vent valves and the ability to manually operate these valves under a loss of AC power condition need to be assessed.

*BWR Mark I Plants*

One of the conclusions from the industry reconstruction activities of the Fukushima events is that there are a number of open issues and questions surrounding the containment venting operation at Fukushima Dai-ichi. At this time, action and evaluation of hardened containment vent valve operation beyond a determination of accessibility and ability to operate hardened containment vent valves under loss of AC power conditions should be reserved until more information is known and confirmed about the venting operations at Fukushima.

*BWR Mark II Plants*

Under NRC Generic Letter 88-20, Supplement 3, BWR Mark II licensees were requested to consider the use of hardened vents in assessing heat-removal capabilities during severe accidents. As a result of these evaluations, BWR Mark II plants should not be required to re-evaluate containment heat removal capabilities until there is more confidence and knowledge of the venting operations at Fukushima Dai-ichi. At that time, the industry and NRC staff will be better positioned to reach a determination on whether additional BWR Mark II heat-removal evaluations are necessary.

*Other Containment Structures*

For other nuclear power plant containment structures, no additional evaluations should be performed until there is more definitive information on the Fukushima events that is applicable and relevant to these other containment structures. Once this information is available, probably towards the end of the year, a determination can be made on whether evaluations and modifications are necessary.

Industry Near-Term Recommendations

- *Issue a §50.54(f) letter to require licensees to review plant procedures and guidelines for operating existing BWR Mk I hardened vent valves and evaluate the accessibility for operation of these valves in accordance with existing design commitments assuming no AC power is available and to report the results to the NRC within 90 days of completion of the next refueling outage that starts after 1 January 2012.*

  *If improvements to assure accessibility are determined to be necessary they would be implemented consistent with operational schedules and as a separate activity.*

**NRC Near-Term Task Force Recommendation 7**

NRC Task Force Recommendation

*The Task Force recommends enhancing spent fuel pool makeup capability and instrumentation for the spent fuel pool.*

The Task Force recommends that the Commission direct the staff to do the following:

> *7.1 Order licensees to provide sufficient safety-related instrumentation, able to withstand design-basis natural phenomena, to monitor key spent fuel pool parameters (i.e., water level, temperature, and area radiation levels) from the control room.*
>
> *7.2 Order licensees to provide safety-related ac electrical power for the spent fuel pool makeup system.*
>
> *7.3 Order licensees to revise their technical specifications to address requirements to have one train of onsite emergency electrical power operable for spent fuel pool makeup and spent fuel pool instrumentation when there is irradiated fuel in the spent fuel pool, regardless of the operational mode of the reactor.*
>
> *7.4 Order licensees to have an installed seismically qualified means to spray water into the spent fuel pools, including an easily accessible connection to supply the water (e.g., using a portable pump or pumper truck) at grade outside the building.*
>
> *7.5 Initiate rulemaking or licensing activities or both to require the actions related to the spent fuel pool described in detailed recommendations 7.1–7.4."*

NEI Comments and Input

The events surrounding the Fukushima Dai-ichi spent fuel pools are a good example of where facts discovered later have invalidated earlier conclusions. There was early speculation that there had been a spent fuel pool accident. Now, with the benefit of visual inspections and samples from the four affected spent fuel pools, it is evident that the spent fuel rods did not experience significant failure.

The accidents at Fukushima demonstrated that spent fuel pools are robust, with a thermal inertia that provides time to plan and execute appropriate mitigation measures, allowing the early operator focus to be on stabilizing the reactor and achieving a safe reactor condition. Even so, the industry is taking proactive actions that include assuring that operators and the site emergency response team are aware of the estimated time for the spent fuel pools to reach 200F, following a loss of spent fuel pool cooling with a starting temperature that is normally around 90F.

The industry recognizes that there is a benefit to remote monitoring of the spent fuel pool during the accident conditions to assure that operator attention and plant resources are not diverted from higher priority and more safety-significant activities. The industry agrees that there should be a process for remotely monitoring the temperature and water level in the spent fuel pools. The power supplies for the monitoring equipment do not need to be safety related based on the thermal inertia and the time taken to reach a point of extensive evaporation.

We note that the events at Fukushima would not have benefited from safety-related power supplies. Safety-related requirements would not have changed the situation. We believe that diversity would appear to be a more important attribute. The proposal for a hardened seismically-qualified fuel pool spray line capable of being supplied from portable pumps outside of the reactor or fuel pool building would add diversity to spent fuel pool cooling capability. Such a requirement would support the use of non-safety-related power supplies for fuel pool cooling and instrumentation considering the slow evolution of a spent fuel cooling event.

There are numerous spent fuel pool configurations. As a result, we believe that the commission should allow for a flexible, performance-based approach for spent fuel pool monitoring. The requirements should define what is to be achieved, leaving the industry to define in general guidance the implementation options based on plant configuration and needs.

The low probability of a fuel pool severe accident and the slow progression of an event that would lead to a severe spent fuel pool accident do not warrant the imposition of an order. There is significant time to adjust, plan and implement mitigation measures based on the events at Fukushima and recent and unusual loss of spent fuel pool cooling events in U.S. plants.

<u>Industry Near-Term Recommendations</u>

*Issue a Generic Letter Identify and evaluate the instrumentation and equipment needed to monitor spent fuel level and temperature throughout an extended loss of AC power event that includes depletion of DC battery power.*

*Attain a common understanding with the NRC staff on the methodologies and guidelines for*

*performing the monitoring evaluation. Inform the NRC staff of:*
*(1) The methods and equipment that are used to monitor the condition of the spent fuel pools during an extended loss of AC power, and, if necessary,*
*(2) The action plan for assuring operators have the capability for monitoring the spent fuel pool during an extended loss of AC power event.*
*(3) Report the results of the evaluations and the action plan to the NRC within 180 days of reaching a common understanding on the methodologies and guideline for implementing the generic letter.*

## NRC Near-Term Task Force Recommendation 8

<u>NRC Task Force Recommendation</u>

*The Task Force recommends strengthening and integrating onsite emergency response capabilities such as EOPs, SAMGs, and EDMGs.*

The Task Force recommends that the Commission direct the staff to further enhance the current capabilities for onsite emergency actions in the following ways:

> *8.1 Order licensees to modify the EOP technical guidelines (required by Supplement 1, "Requirements for Emergency Response Capability," to NUREG-0737, issued January 1983 (GL 82-33), to (1) include EOPs, SAMGs, and EDMGs in an integrated manner, (2) specify clear command and control strategies for their implementation, and (3) stipulate appropriate qualification and training for those who make decisions during emergencies.*
>
> *8.2 Modify Section 5.0, "Administrative Controls," of the Standard Technical Specifications for each operating reactor design to reference the approved EOP technical guidelines for that plant design.*
>
> *8.3 Order licensees to modify each plant's technical specifications to conform to the above changes.*
>
> *8.4 Initiate rulemaking to require more realistic, hands-on training and exercises on SAMGs and EDMGs for all staff expected to implement the strategies and those licensee staff expected to make decisions during emergencies, including emergency coordinators and emergency directors."*

<u>NEI Comments and Input</u>

We agree that enhancements can be made to the process of migrating from EOPs to SAMGs and EDMGs to incorporate lessons learned from Fukushima. The integration of the EDMGs and SAMGs will be a complex and large endeavor. Such an activity needs to be split into manageable sections to ensure a coordinated, efficient and effective implementation. The industry has already started work on this activity and enhancements are being pursued.

Near-term actions should focus on improving the training and implementation of EDMGs, SAMGs and §50.54(hh)(2) mitigation procedures and measures. Training programs should be reviewed and, if necessary, enhanced to assure that operators and the emergency response organizations are capable of making correct decisions and implementing procedures. In the development and implementation of these enhanced training programs, it is critical for operators to be more knowledgeable of mitigation measures for more likely events (abnormal and EOP type events) than the mitigation of extremely low probability events such as an extreme beyond design basis seismic event that would result in a severe accident. We suggest that for SAMGs, EDMGs and B5b events, the training standard should be one of familiarization.

It is important that the industry and the NRC reach a common understanding on the standards and scope of training with an emphasis on emergency response organizations, while assuring that the training focus for operators remains on the more probable events and operations. As with other industry training programs, the National Academy for Nuclear Training in Atlanta would provide oversight of the training programs referenced in this section.

There needs to be further regulatory discussions on the implications of requiring Technical Specifications on the SAMG and EDMG training and what it means for operator exams.

*New Plants*

ITAAC should not be the regulatory vehicle for adjusting the licensing basis. The Part 52 change processes and other regulatory vehicles exist and should be used for ensuring that new plant licensees comply with of EOP/SAMG/EDMG implementation or other new requirements. These matters may be addressed after design certifications or as COLs are issued.

Industry Near-Term Recommendations

*Enhance implementation of EOPs, SAMGs and B5b strategies.*

*Issue a Bulletin to review and, if necessary, enhance training programs to assure that plant personnel are able to transition from EOPs to SAMGs and implement SAMG strategies. Personnel should be aware of the intent and scope of SAMG and B5b strategies so that they can be implemented in accordance with the stations emergency preparedness activities. The level and depth of knowledge should be commensurate with the safety significance and probability of the events.*

## NRC Near-Term Task Force Recommendation 9

NRC Task Force Recommendation

*The Task Force recommends that the NRC require that facility emergency plans address prolonged SBO and multiunit events.*

*9.1 Initiate rulemaking to require EP enhancements for multiunit events in the following areas:*

- *Personnel and staffing,*
- *Dose assessment capability,*
- *Training and exercises,*
- *Equipment and facilities*

*9.2 Initiate rulemaking to require EP enhancements for prolonged SBO in the following areas:*

- *Communications capability,*
- *ERDS capability,*
- *Training and exercises,*
- *Equipment and facilities*

*9.3 Order licensees to do the following until rulemaking is complete:*

- *Determine and implement the required staff to fill all necessary positions for responding to a multiunit event.*
- *Add guidance to the emergency plan that documents how to perform a multiunit dose assessment (including releases from spent fuel pools) using the licensee's site-specific dose assessment software and approach.*
- *Conduct periodic training and exercises for multiunit and prolonged SBO scenarios. Practice (simulate) the identification and acquisition of offsite resources, to the extent possible.*
- *Ensure that EP equipment and facilities are sufficient for dealing with multiunit and prolonged SBO scenarios.*
- *Provide a means to power communications equipment needed to communicate onsite (e.g., radios for response teams and between facilities) and offsite (e.g., cellular telephones, satellite telephones) during a prolonged SBO.*
- *Maintain ERDS capability throughout the accident.*

*9.4 Order licensees to complete the ERDS modernization initiative by June 2012 to ensure multiunit site monitoring capability"*

<u>NEI Comments and Input</u>

From discussions with some Japanese utilities, it is clear that U.S. industry emergency preparedness and the government (state, local and federal) emergency response infrastructure is more mature and is better positioned to manage an emergency on the scale of the Fukushima natural disasters and a nuclear emergency. U.S. company and government organizational structures, training, drills and the strong working relationships between the plants and state and local response centers are significant differences.

Nevertheless, the industry acknowledges that there are lessons to be learned and enhancements that can be made to the industry's emergency preparedness activities. Pre-Fukushima enhancements to EP programs have already been identified and are about to be implemented via the imminent NRC EP rulemaking and the completion of the revision to Radiological Emergency Preparedness Manual, soon to be issued by FEMA.

As the rule changes are being implemented, and as we learn more about the ongoing events at Fukushima, the NRC and industry can identify the prioritization and performance criteria for further enhancements, as recommended in the NRC task force report.

The revised rule that is about to become effective requires a comprehensive analysis of on-shift staffing to validate that the emergency plan can be implemented for five categories of scenarios. For multi-unit event Emergency Response Organization (ERO) staffing, new criteria need to be defined. This includes defining the events' characteristics, simultaneous occurrences, response time requirements and coping strategies. The new criteria would be appended to the staffing methodology prescribed in NEI 10-05. Analysis would follow the implementation of the initial staffing analysis requirement.

In order for the industry to implement the multi-unit staffing analysis concurrent with existing EP rule change, the implementation period for this rule change should be extended by one year in order to accommodate the development of new staffing criteria.

In the interim, as recommended in the NRC task force report, licensees could take voluntary action to develop a viable notification and transportation strategy to ensure staff needed to augment the site response would be available.

Revised guidance can be developed and implemented within the existing rule structure to encompass three of the recommendations:

- Multiple release point and spent fuel pool dose assessment
- Onsite protective equipment
- Backup ERO communication

The balance of the NRC task force recommendations warrant rulemaking. Based on industry-NRC staff interactions, consideration should be given to a parallel implementation-rulemaking approach. Such an approach would cover:

- Requiring licensed operators in the ERO outside the control room
- Drills and exercise changes
- Emergency facilities for multi-unit events (changing design basis and accident analysis requirements)

Rulemaking in these areas would provide the necessary regulatory predictability and the basis for consistent implementation and inspection.

*New Plants*

Part 52 change processes and other regulatory vehicles exist and should be used for ensuring that new plant licensees comply with of spent fuel cooling or other new requirements. These matters may be addressed after design certifications or COLs are issued, and ITAAC should not be the regulatory vehicle for adjusting the licensing basis.

Industry Near-Term Recommendations

*(1) Implement the revised EP rule that is about to become effective.*
*(2) Engage NRC staff and other stakeholders in developing guidance for EP recommendations that do not require rulemaking.*
*(3) For those recommendations that do require an additional rulemaking, guidance can be developed in parallel with the rulemaking and implementation could commence once the content of the final rule is known. (This is a long-term activity)*

*An action plan will be developed for implementation of the Fukushima-related recommendations beginning in 2012.*

7 September, 2011

MEMORANDUM to:

NRC ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
PUBLIC MEETING SEPT. 8-10, 2011 ROCKVILLE, MD.

ROOM T2-B1 TWO WHITE FLINT NORTH BUILDING
NRC HEADQUARTERS, 11545 ROCKVILLE PIKE
ROCKVILLE, MARYLAND

SIRS:

I ask that the following statements be entered in the record of this public meeting.

1] THE CATASTROPHIC EVENTS AT FUKUSHIMA DAI-ICHI SITE IN JAPAN HAVE RESULTED IN A GLOBAL RADIOLOGICAL CRISIS. THE NRC HAS ISSUED NO WARNING TO THE PUBLIC ON THIS MOST SERIOUS HAZARD.

2] MORE THAN 4000 TONS OF REACTOR FUEL AND SPENT FUEL POOLS ARE EXPOSED FOR GLOBAL DISPERSION, AIRBORNE AND SEABORNE.

3] THESE RADIOACTIVE GASSES ARE ADDED TO THE DAILY DISCHARGE OF OPERATING GASSES FROM HUNDREDS OF REACTORS WORLD-WIDE.

4] I ASK THAT PLUME PATHS OF DAILY REACTOR DISCHARGES BE MADE PUBLIC PRIOR TO ISSUING ANY FURTHER LICENSE EXTENSIONS.

5] COMPUTER PREDICTION OF PLUME PATHS, VOLUME AND TIME OF DISCHARGE IS LESS ACCEPTABLE THAN ACTUAL PHYSICAL TRACKING OF PLUMES TO DEPOSITION SITES.

ACCORDING TO NRC DISCHARGE RECORDS EACH 500 MEGAWATT REACTOR DISCHARGES SOME 20,000 CURIES PER YEAR. THE CUMULATIVE EXTENDED LIFE OF THESE PERMANENT TOXINS POSES AN UNACCEPTABLE RISK TO THE PUBLIC.

YOUR MANDATE IS SAFETY. PLEASE ACT ON THAT RESPONSIBILITY.

Patricia Pierce
Site Analyst Conservation Advocate
Millbrook Park, Rockport, Mass 01966

Patricia Pierce

MEMORANDUM

September 7, 2011

The White House
Washington, D.C.

I am responding to your form letter of August 30, 2011 on issues related to nuclear arms control and nuclear energy.

My letter cited the global radiological crisis created by the Fukushima Dai-'ichi reactor disaster which should alter your pre-conceived plans to encourage the "peaceful use of nuclear energy".

There is no safe nuclear fission. There is no way to dispose of reactor operating gasses other than to discharge them to the air and water. This is an unacceptable hazard.

Reactors do not emit carbon. Cars and furnaces emit carbon monoxide. Reactors emit gasses that remain radioactive for thousands of years. There is no place to store reactor waste or to store the daily operating gasses. All operating gasses are discharged into the atmosphere. Each reactor discharges 20,000 to 40,000 curies per year.

Each curie contains 37 billion emissions per second per gram.

I repeat. All reactor operating gasses are discharged into the air and water.

All reactor gasses are permanently toxic and cumulative. Add these toxic radioactive gasses to carbon monoxide plus hundreds of other pollutants, all within a few miles of the earth's surface and it is clear that life will suffocate.

Patricia Pierce
18 Millbrook park
Rockport,MA01966
Patricia Pierce

Copy to Gloucester Board of Health Sept 29, 2010 by P. Perci

ESSEX BOARD OF SELECTMEN

TOWN HALL • MARTIN STREET • ESSEX, MASSACHUSETTS 01929

July 11, 1989

Advisory Committee on Reactor Safeguards
Nuclear Regulatory Commission
Washington, D.C. 20555

Sirs:

It is our understanding that you have statutory authority to intervene as a party in reactor licensing hearings to raise any safety related issues. We ask that you intervene in the Seabrook Reactor proceedings to require resolution of the following hazardous reactor operating procedures which, if allowed, will cause predictable and permanent damage to the Town of Essex.

The Essex River Estuary is one of seven marine estuaries which form a series of interconnected pristine tidal marshes, coastal islands and barrier beaches extending continuously from Seabrook, NH, to Gloucester, MA, fourteen miles south. Contamination of any portion of these marshes will spread by tidal action to all portions.

Operating discharges to air and ocean from the Seabrook Reactor, which is sited within the northerly portion of these marshes, will accumulate in these marshes causing long-lived isotopes to enter nutrient cycles. These unstable radioactive particles being ingested or inhaled alter cell tissue and genetic coding in plants, humans, animals and marine micro-organisms causing genetic deformation, cancer and other disability.

The Town of Essex will suffer irreparable injury by reason of permanent contamination caused by the following unresolved reactor safety issues:

1) Venting of fission gases to the atmosphere in the form of "planned operating emissions" will release partially decayed gases, iodines and other unstable particles which will cool and fall over coastal temperature interfaces within the first hour after

discharge leaving permanent toxic residues on coastal marshes and meadows. Deposition of long-lived particles airborne with the gases will typically occur in corridors where wind velocity decreases due to topography, i.e., behind barrier beaches, coastal uplands and islands. The Essex marshes twelve miles south lie precisely in the first hour deposition path.

2) Containment of fission gases produced during radiological emergency is only temporary. All gases produced will be vented after the emergency, therebeing no other means of disposal. Release of active fission gases during the emergency may be necessary to avoid build up of concentrations leading to breach of containment and breach of heat exchange cooling system and consequent contaminated discharge at ocean outlets.

3) There is at present no means of disposal or storage of fission gases other than delayed discharge to the environment. There exists at present no method of accelerating decay for gases or solid wastes produced by atomic fission. There is no method for atomic fissioning that does not produce gases on a daily basis.

4) Class 9 catastrophic radiological emergency causing widespread permanent property contamination can occur at low or full power operation. Loss of coolant causing core fuel temperatures to rise from 600°F to 4000°F in seconds precludes timely warning of the public.

5) Seabrook Reactor having 100 tons of uranium fuel will produce in one fuel replacement cycle, gases equal in volume to those produced by vaporization of 1000 Hiroshima bombs. These gases will be vented as "normal operating emissions" to the atmosphere. There is no possible assurance those gases will be fully decayed or clean at the time of discharge.

6) Discharges to air and ocean during radiological emergencies will instantly violate "permissible discharge limits" required for compliance with existing NPDES permit and FES required by EPA laws. Those permits were issued based on incomplete information which omits impact of Class 9 emergencies on environment. The NPDES permit expires in 1990 and should not be renewed.

7) In a Class 9 catastrophic radiological emergency the reactor core at Seabrook cannot be isolated from the marshes and meltdown debris moving with ground water would leach to marshes. The ocean discharge would also be thoroughly contaminated at the outfall.

8) Corrosion of heat exchange pipes can be expected to allow exchange of radioactive materials to contaminate ocean coolant discharged to ocean.

9) Each fuel cycle releases gases produced by fission of 100 tons of uranium to the atmosphere.

10) Evacuation is not safety. It is extreme hazard. Being forced out of one's home onto dangerous highways during radiological contamination and being unable to return home due to permanent contamination is a violation of basic constitutional rights.

We are not required by our constitution to suffer fatal injury to demonstrate damage to life and property. Nor can any government agency impose upon persons circumstances requiring loss of life and property.

We consider contamination of properties and threat to life caused by operating discharges from Seabrook reactor to be taking of land without due process and a violation of our constitutional rights. We ask your intervention on our behalf.

Very truly yours,

Chairman

BOARD OF SELECTMEN
TOWN OF ESSEX, MASSACHUSETTS

cc: Atomic Safety & Licensing Board, Boston, MA
Environmental Protection Agency, Boston, MA
Governor of Massachusetts
Attorney General of Massachusetts

# 10 CFR Part 61: Site-Specific Analyses for Demonstrating Compliance with Subpart C Performance Objectives

**Deborah Jackson, David Esh, Andrew Carrera**

**Office of Federal and State Materials and Environmental Management Programs**

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**586th Advisory Committee on Reactor Safeguards**

September 8, 2011

U.S.NRC

United States Nuclear Regulatory Commission

*Protecting People and the Environment*

# Why are we here today:

- Staff following and addressing Commission direction:
  - Proposing rulemaking limited to site-specific analyses
  - Identifying technical requirements of analyses
  - Developing guidance outlining key parameters and assumptions
- Approach continues to protect public health and safety
- Approach is risk-informed, performance-based
- Approach provides flexibility to licensees to incorporate site information

# Today's topics and presenters:

| Topic | Presenter |
| --- | --- |
| Discussion: *Guidance for Conducting Site-Specific Analyses for Part 61* | David Esh, DWMEP |
| Draft Proposed Rule: *Analysis of Comments Received on Preliminary Rule Language* | Andrew Carrera, DILR |

# 10 CFR Part 61: Commission Direction

# Commission Directed Staff to….

- Perform rulemaking limited to adding a site-specific analyses prior to the disposal of significant quantities of DU (SRM-SECY-08-0147) and blended waste (SRM-SECY-10-0043)

- Identify technical requirements of the site-specific analyses

- Develop guidance that outlines the parameters and assumptions in conducting such site-specific analyses

# This rulemaking…

☑ Requires site-specific analyses to demonstrate compliance with Subpart C performance objectives

☑ Identifies the technical requirements of the analyses

- Definitions of analyses
- Period of performance
- Intruder dose criterion

☑ Develops risk-informed, performance-based guidance that outlines key parameters and assumptions

❖ Continues to protect public health and safety while providing flexibility to licensees

# This rulemaking does *not*…

- ☒ Update waste the classification tables at 61.55
  - ! The Commission directed staff not to alter waste classification
- ☒ Comprehensively revise Part 61 framework
  - ! The Commission directed staff to propose the necessary resources for a possible future comprehensive revision to risk-inform the 10 CFR Part 61 waste classification framework
- ☒ Remove protection of inadvertent intruder performance objective
  - ! Protection of the inadvertent intruder is integral to the current waste classification framework

# Proposed Amendments: Site-Specific Analyses

- Performance assessment — demonstrate compliance with protection of the general population (§ 61.41)
- Intruder assessment — demonstrate compliance with protection of inadvertent intruders (§ 61.42)
- Long-term analysis — demonstrate how the disposal system limits the potential radiological impacts from long-lived waste (§ 61.13 (e))
- Update analyses at facility closure — (§ 61.28 and § 61.52)

# Proposed Amendments : Technical Requirements

- Performance assessment :
  (1) Identifies the features, events, and processes (FEPs)

  (2) Examines the effects of these FEPs on the performance of the disposal system

  (3) Estimates the annual total effective dose equivalent (TEDE) to any member of the public considering uncertainties, caused by all significant FEPs

  (4) Two-tiered period of performance: (1) 20,000 years; (2) post-20,000 years analysis for long-lived waste.

# Proposed Amendments: Technical Requirements

- Intruder assessment:
  - (1) Assumes that an inadvertent intruder occupies the site after institutional controls are removed and engages in activities that might unknowingly expose the inadvertent intruder to radiation from the waste.
  - (2) Examines the capabilities of intruder barriers.
  - (3) Estimates the potential annual total effective dose equivalent, considering associated uncertainties.
  - (4) Dose criterion set for intruder (500 mrem/yr TEDE).

# Period of Performance: Technical Basis

- Within 20,000 years
  - Including climate cycling within the compliance period will encourage disposal of long-lived waste at more stable sites.
  - A value of 20,000 years better captures radionuclide transport characteristics (compared to 10,000 years).
  - While 20,000 years does not capture peak risk for all wastes, it captures more than shorter values. Possibly within 10x for depleted uranium.
  - Diminishing returns for longer periods (affected by increasing uncertainty).

- Post-20,000 years
  - Impacts can be better placed in proper context (NRC would complete environmental analysis of impacts for disposal licensing actions taking place in non-Agreement States).

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# 10 CFR Part 61: Guidance for the Low-Level Waste Rulemaking

# Purpose

- Provides guidance on conducting site-specific analyses to demonstrate compliance with the performance objectives in Part 61
- Supplements existing LLW guidance
- Discusses parameters and assumptions to be used in analyses in a broad sense rather than a prescriptive manner
- Provides licensees flexibility to demonstrate compliance and incorporate site-specific information

# Outline

- Main topics:
  - i. Introduction
  - ii. General Technical Analyses
  - iii. Performance Assessment Modeling Issues
  - iv. Intruder Assessment
  - v. Stability Assessment
  - vi. Long-term Analyses
  - vii. Other Considerations
  - viii. Performance Confirmation
  - ix. Use of other NRC Guidance Documents

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# 10 CFR Part 61: Guidance for the Low-Level Waste Rulemaking

## Examples

# Guidance on Period of Performance

- Discusses flexibility for short-lived waste or low concentrations of long-lived waste.

- Primary differences are in level of detail or justification for the calculations.

- Provides expectations for long-term analysis.

# Period of Performance: Example

**Example 2.3:** A facility is expected to receive typical low-level waste generated by commercial entities (e.g. limited concentrations of long-lived waste). The waste has concentrations of long-lived radionuclides at or below one tenth of the values listed in Table 1 of § 61.55. Additionally, the facility is expected to receive waste with long-lived radionuclides that are not found in Table 1 of § 61.55 that is less than the natural soils surrounding the facility.

**Conclusion:** A performance assessment should be completed to demonstrate compliance with § 61.41, § 61.42, and § 61.44. Because the waste is dominated by short-lived activity and long-lived concentrations are limited, specialized models and associated model support for long-term processes (e.g., cycling of climate) are not necessary.

# Guidance on Inadvertent Intruder Assessment Scenarios

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- Evaluate *reasonably-foreseeable* scenario resulting in greatest dose for compliance.
- Consider site information.
- Flexibility to identify reasonably-foreseeable site-specific scenarios in the near-term.
- For longer time frames, Part 61 default scenarios limit speculation about human activities.

# Inadvertent Intruder Assessment: Scenario Analysis

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- Default scenarios
  - Intruder-Construction/Discovery
  - Intruder-Drilling
  - Intruder-Agriculture
  - Intruder-Well
- Hypothetical constructs
- Provide reasonable bounds
- Limit speculation about human activities
- May not be appropriate at all sites

# Inadvertent Intruder Assessment: Scenario Analysis

U.S.NRC
United States Nuclear Regulatory Commission
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- Site-specific scenarios:
  - Physical Information
    - Waste Characteristics
    - Facility Design
    - Disposal Practices
    - Site Conditions
  - Cultural Information
    - Land Use
- Consider changes over time

# Conclusions

- Staff following and addressing Commission direction:
  - Proposing rulemaking limited to site-specific analyses.
  - Identifying technical requirements of analyses.
  - Developing guidance outlining key parameters and assumptions.
- Approach continues to protect public health and safety.
- Approach is risk-informed, performance-based.
- Approach provides flexibility to licensees to incorporate site information.

# 10 CFR Part 61: Stakeholder Comments on the Preliminary Proposed Rule Language

# Stakeholder Involvement

- Preliminary proposed rule language and technical basis documents published for stakeholder comments on www.regulations.gov web site on May 3rd.

- May 18th public meeting.

- Comment period ended on June 18th.

- Some stakeholders also presented their views during the ACRS meetings on June 23rd and July 13th.

# Stakeholder Comments

- Staff reviewed the comments and grouped them into nine issues:
  - Performance assessment
  - Intruder assessment
  - Long-term analysis
  - Period of performance
  - Agreement State compatibility
  - Feasibility of near surface disposal
  - Commission direction (SRM)
  - Rule language
  - Waste stream neutral approach
- Comments were both supportive and critical.
- Staff reviewed the comments and made several limited revisions to the proposed rule language.

# Path Forward

- Staff requests letter from ACRS.

- Staff expects to send the proposed rule package to the Commission in January 2012.

# Backup Slides

# Revisions Being Considered for Proposed Rule Language

# Revisions Based on Comments

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- Performance Assessment Language (§ 61.13)

  – (a) A performance assessment must represent features, events, and processes that can influence the ability of the waste disposal facility to limit releases of radioactivity to the environment. The features, events, and processes considered in the performance assessment must represent a wide range of phenomena with both beneficial and potentially adverse effects on performance. The performance assessment must consider the specific technical information provided in § 61.12(a) through (i). The performance assessment must evaluate uncertainties in the projected behavior of the ~~facility~~ disposal system (e.g. disposal facility, natural system, environment). The performance assessment must identify the specific characteristics of the disposal site that are necessary to demonstrate compliance with the performance objectives in Subpart C of this part consistent with the specific technical information found in § 61.12….

# Revisions Based on Comments *(continued)*

- Intruder Assessment Language (§ 61.7(c))

  – (7) An intruder assessment quantitatively estimates the radiological exposure of an inadvertent intruder at a disposal facility following the loss of institutional control. The results of the intruder assessment are compared with the appropriate performance objective. If intruder barriers are utilized, ~~T~~the intruder assessment must identify the intruder barriers and examine the performance of the barriers. The intruder assessment must also address the effects of uncertainty on the performance of the barriers. The barriers must inhibit contact with the disposed waste or limit the radiological exposure of an inadvertent intruder ~~over the duration of the compliance period~~. The technical basis provided for the performance of the intruder barrier will determine how long performance should be credited. An intruder assessment can employ a similar methodology to that used for a performance assessment, but …….

# Revisions Based on Comments *(continued)*

- Period of Performance Language
  - § 61.41

    (b) Compliance with paragraph (a) of this section must be demonstrated through a performance assessment that ~~evaluates~~ estimates peak annual dose ~~up to~~ that occurs within 20,000 years following closure of the disposal facility.

  - § 61.42

    (b) Compliance with paragraph (a) of this section must be demonstrated through an intruder assessment that ~~evaluates~~ estimates peak annual dose ~~up to~~ that occurs within 20,000 years following closure of the disposal facility.

# Revisions Based on Comments *(continued)*

- Waste Stability Language (§ 61.7(c))
  - (2) A cornerstone of the system is stability—stability of the waste and the disposal site— which minimizes the access of water to waste that has been emplaced and covered. Limiting the access of water to the waste minimizes the migration of radionuclides, which avoids the need for long-term active maintenance and reduces the potential for ~~inadvertent intruders to be exposed to the waste~~ release of radioactivity into the environment. While stability is desirable; it isn't necessary from a health and safety standpoint for most low-level waste because the waste doesn't contain sufficient radionuclides to be of concern. This low-activity waste (e.g., ordinary trash-type waste) tends to be unstable, which can become a problem if it is mixed with higher activity waste. If lower activity waste is mixed with the higher activity waste or long-lived low-activity waste, the deterioration of the unstable waste …..

# Revisions Based on Comments *(continued)*

- Ambiguous Language
  - § 61.7(a)

    (1) Part 61 is intended to apply to land disposal of radioactive waste and not to other methods such as sea or extraterrestrial disposal……. Technical requirements for alternative methods may be added in the future. ~~While there may not yet be detailed technical criteria established for all kinds of land disposal that might be proposed, a~~Alternative methods of disposal may ~~can~~ be approved on a case-by-case basis as needed.

  - § 61.55(a)

    (6) Classification of wastes with radionuclides other than those listed in Tables 1 and 2 of this section. If radioactive waste does not contain any nuclides listed in either Table 1 or 2 of this section, it is Class A. ~~Any waste classified under this subparagraph must be analyzed in the intruder assessment required by § 61.42.~~

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# Presentation to the ACRS Full Committee

## AP1000 DCD Revision 19 Containment Accident Pressure Confirmatory Analysis

September 8, 2011

# Containment Accident Pressure

## Confirmatory Analysis

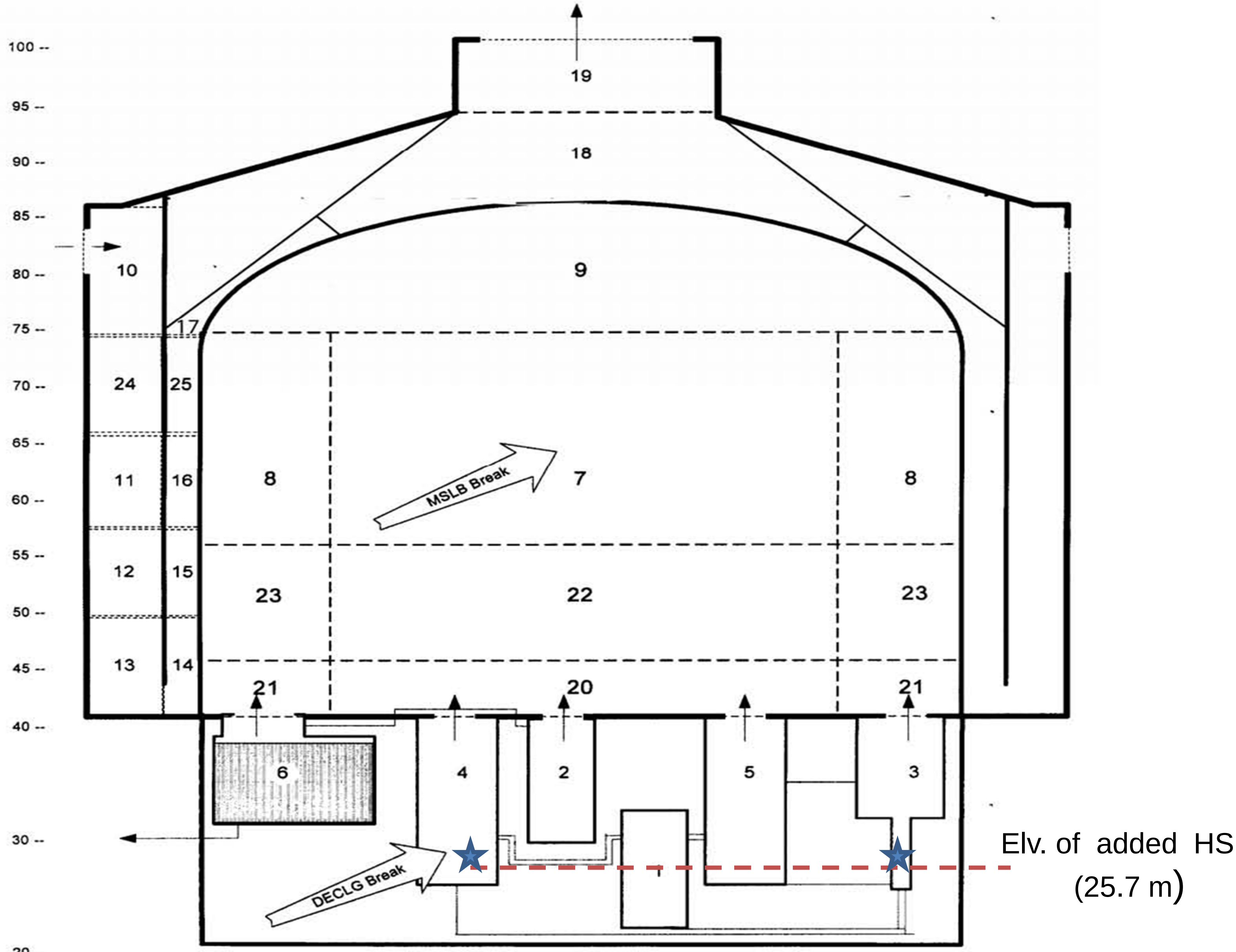
- Staff performed confirmatory analysis
  - Documented in SAND2009-2858
- In parallel with audit of applicants WGOTHIC analysis, staff performed confirmatory studies with MELCOR
  - DCD Rev. 19 revised mass and energy release
  - Additional heat conductors (surrogate for gratings)
- Performed a number of parametric studies with the updated MELCOR model.

# AP1000 Containment Studies (cont.)

## Major results:

| Case description | Pmax @ time<br>[psig] [s] | Safety margin<br>[psig] |
|---|---|---|
| RES original model | 55.3 @ 1500 | 3.7 |
| Rev. 19 M&E rate | 57.4 @ 1050 | 1.6 |
| Rev. 19 M&E rate + additional heat conductors | 56.8 @ 1050 | 2.2 |
| Westinghouse licensing (GOTHIC) | 58.3 @ ? | 0.7 |

# AP1000 Containment



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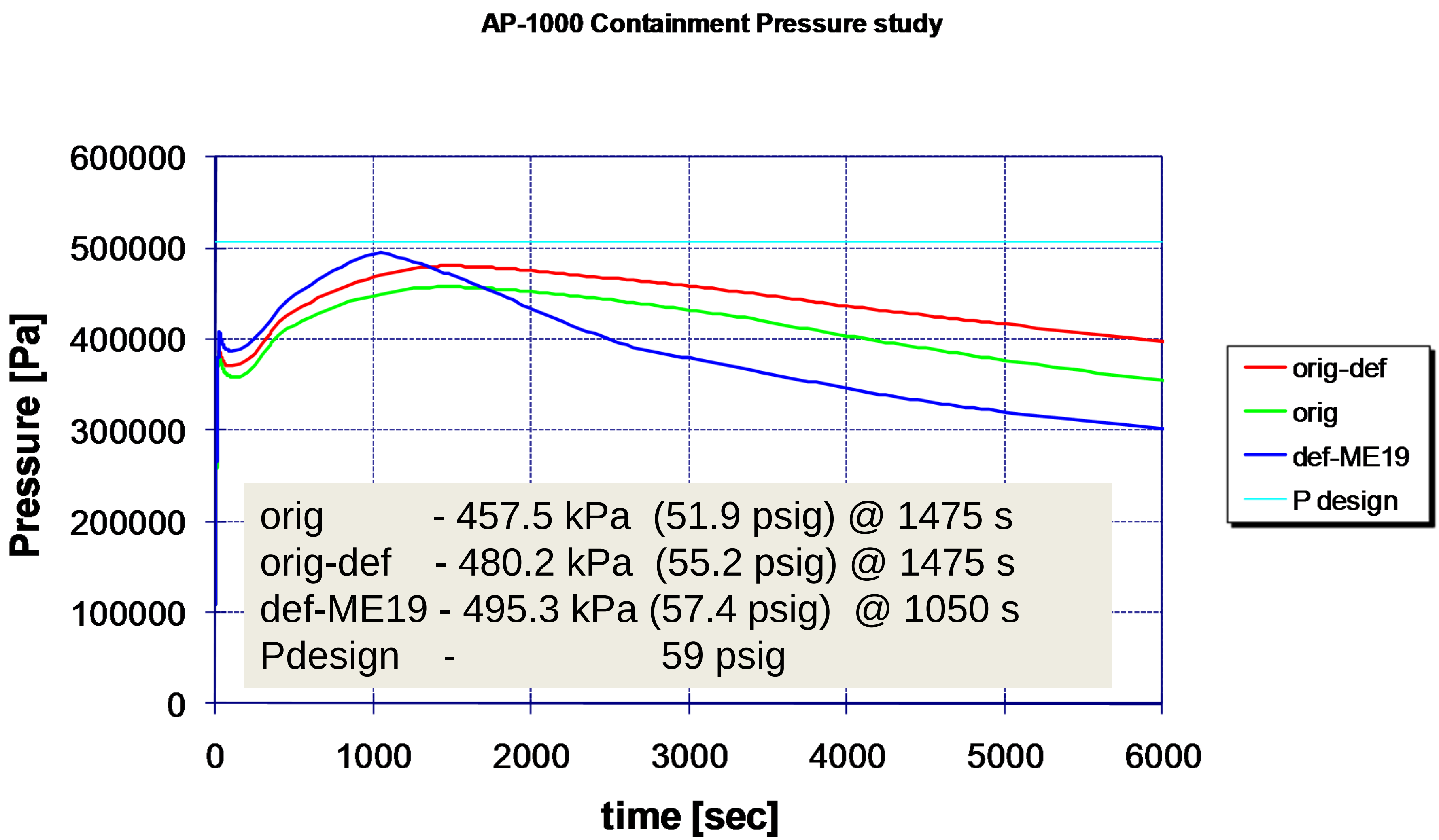

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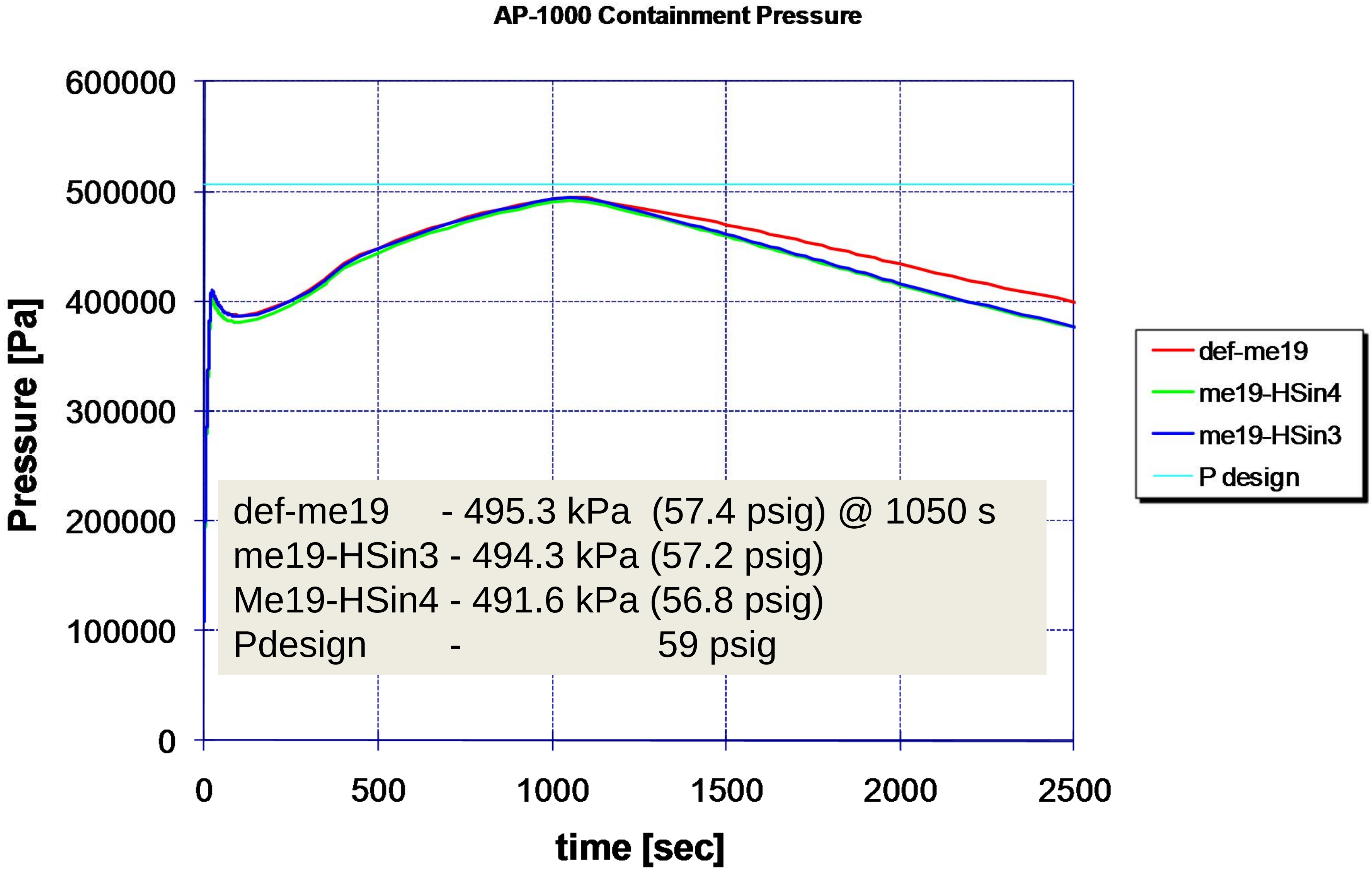

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# Presentation to the ACRS Full Committee

## AP1000 Structural Issues

September 7, 2011

# Shield Building Thermal Analysis

- WEC commitment to combine thermal and seismic demands in DCD Rev 18 was not carried out in some cases.

- WEC performed thermal stress analysis of shield building to develop thermal design demands (for combination with seismic demands)
  - Thermal and seismic demands combined
  - Demand increased slightly, but remained within design capacity (i.e., no design changes resulted)

- Staff reviewed analysis method and audited supporting calculations.

- Staff found WEC analysis method acceptable
  - Consistent with analysis performed for thermal accident load case
  - Approach consistent with ACI-349 which permits stiffness reduction to account for concrete cracking

# PCS Tank Seismic Analysis

- WEC performed revised seismic analysis of the PCS tank to be consistent with SB report commitment
- Staff performed review and audit of supporting calculations
- Found analysis to be acceptable
  - Method consistent with SB report commitment
  - Seismic analysis performed in accordance with SRP 3.7
  - Updated analysis parameter based on realistic PCS tank seismic demands

 

# AP1000® Design Control Document – Containment Pressure Analysis

Presentation to the ACRS

by Westinghouse Electric Company, LLC

September 8, 2011

Westinghouse

# Containment Peak Pressure Analysis Overview

- Peak pressure of 57.8 psig reported in DCD Revision 18
- Increased the steady state PCS water coverage time delay input value to resolve an ACRS review comment
  - Containment peak pressure calculated to be 58.1 psig
- Additional input changes to the LOCA M&E model and containment model input were made to address other items that could affect the peak containment pressure reported in the Technical Specifications.
- Peak pressure of 58.3 psig reported in DCD Revision 19

Westinghouse

 

# Containment Peak Pressure Analysis Overview

- Components of containment peak pressure calculation
  - M&E release methodology
  - M&E model inputs
  - Containment response methodology
  - Containment response model inputs
- The approved methodology that is applied in the M&E and containment response evaluation models is conservative
- Changes were made to the evaluation model inputs
  - Corrections applied in the conservative direction
  - Changes to reflect updated plant design information

# Containment Peak Pressure Analysis Overview

- Existing heat sinks in containment model were credited in order to
  - Offset model input changes impact on peak containment pressure
  - Maintain roughly same amount of margin reported in DCD Rev. 18
- Analysis performed in accordance with approved methodology
- New DCD Table 6.2.1.1-10 generated to capture key parameters (surface area, volume, material) of new heat sinks as Tier 2* information

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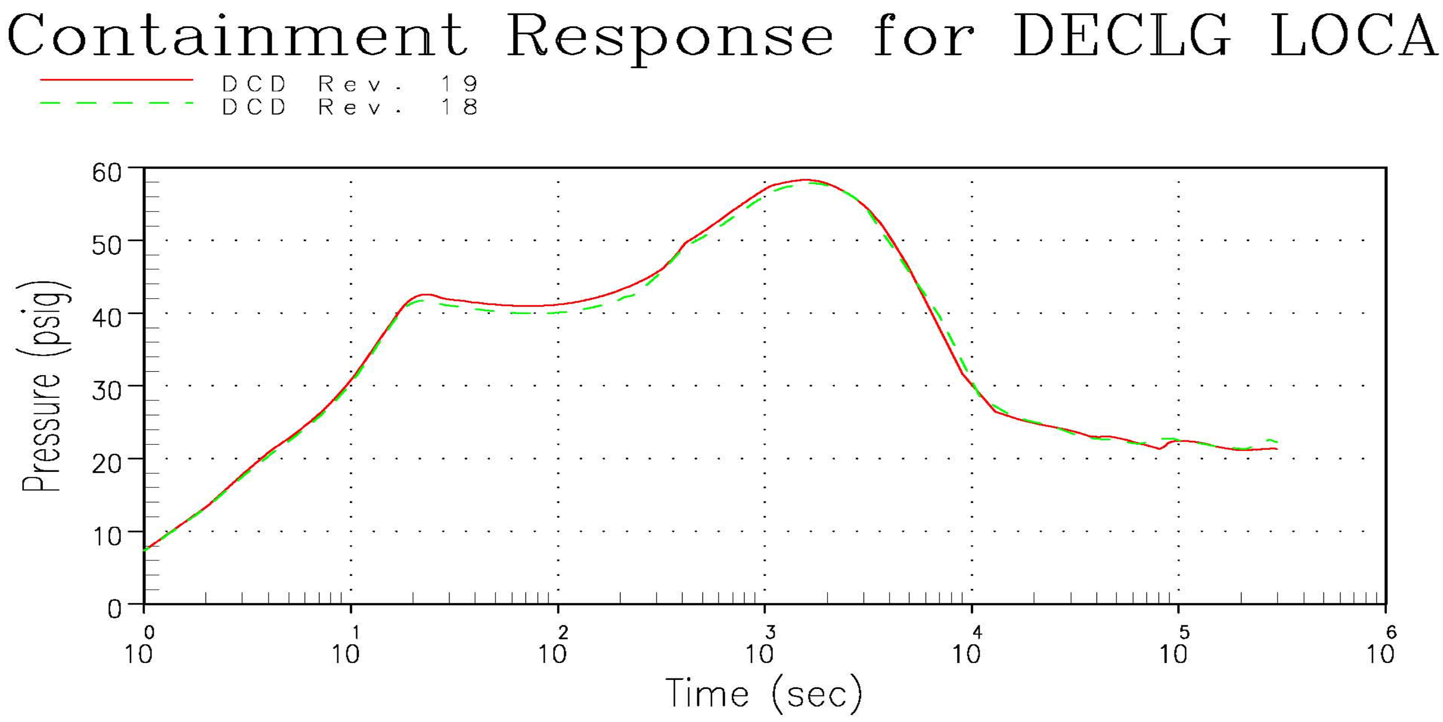
# Summary of Containment Pressure Analysis Results

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# Solar Radiation Impact on LST Data

- ACRS requested further review concerning impact of solar radiation heating on the large-scale passive containment cooling test results and application to the containment evaluation model
- LST data were used along with data from other tests to validate the convective heat transfer and the condensation heat and mass transfer correlations
  - Solar radiation had no impact on the LST data that were used for validation of the condensation heat and mass transfer correlation
  - Solar radiation did have some impact on the LST data that were used for validation of the convection heat transfer correlation, but the heat flux data were adjusted to account for this impact

# Conclusions

- Model input changes were made to address items affecting the peak containment pressure reported in the Technical Specifications
- No changes were made to the plant design
- Peak containment pressure remains under 59 psig
- NRC has reviewed the modeling changes, requested additional information and found the changes and responses to be acceptable
- Solar radiation – no impact on validation of the condensation correlations; the impact on validation of the convection correlation was addressed in the data evaluation

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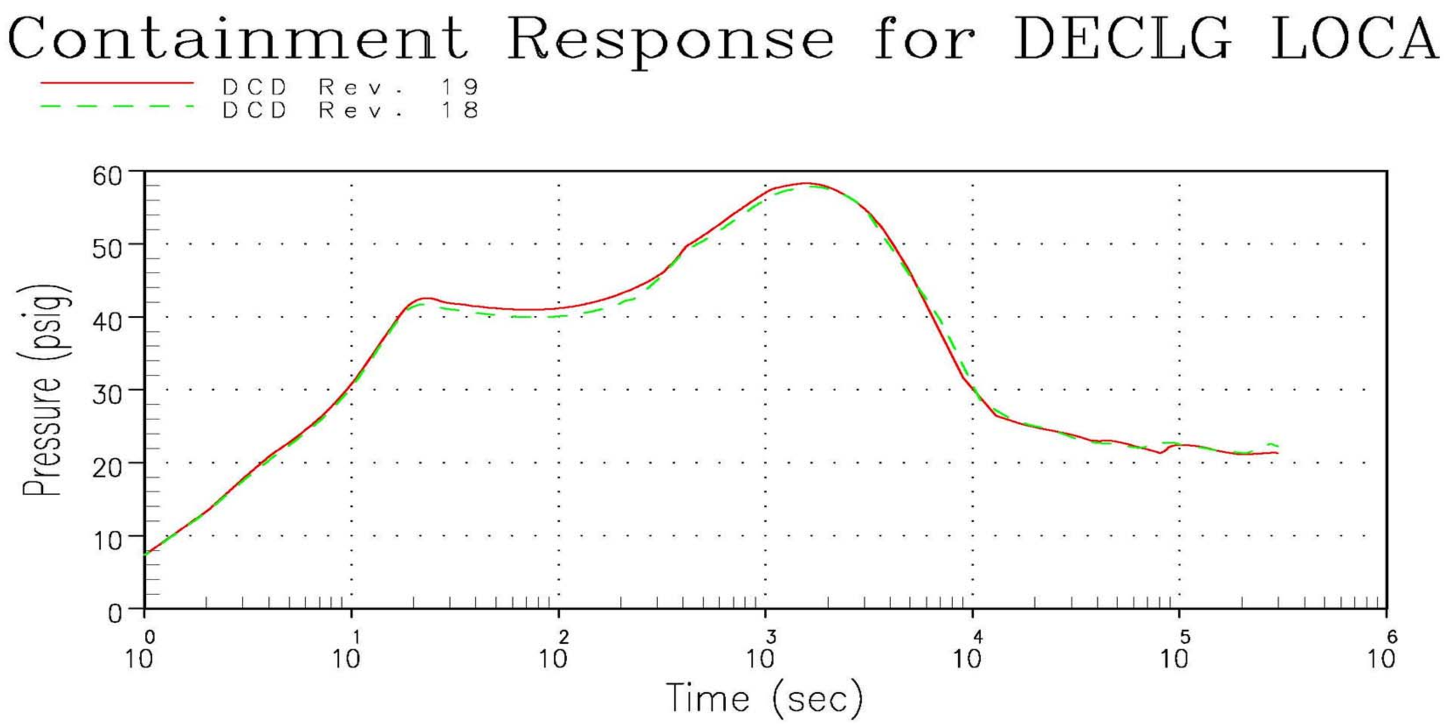


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# Summary of Structural Analysis Changes

Presentation to the ACRS

by Westinghouse Electric Company LLC

September 8, 2011

Westinghouse

 

# Topics

- Seismic and Thermal Load Combination
  - Welding Requirements
  - Effect of Solar Gain
- PCS Tank Analysis Presented in DCD

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# Normal Thermal Plus Seismic Load Combination

- The Shield Building design was performed using an established practice for considering structural behavior under normal thermal loading
  - The structural design calculations had not explicitly included a calculated normal thermal load contribution in combination with SSE when the thermal effects were considered small or self relieving

- NRC Staff requested Westinghouse to demonstrate with the direct combination of SSE + normal thermal that the design was acceptable

# Normal Thermal Plus Seismic Load Combination

- To validate the existing Shield Building design, Westinghouse updated calculations to explicitly combine normal thermal plus seismic
- The updated design calculations follow the ACI-349 code as well as the recommendations of ACI 349.1R-07, Reinforced Concrete Design for Thermal Effects on Nuclear Power Plant Structures
- The revised calculations demonstrate that no change in the structural design is required
- DCD text changes were included in Revision 19 to clarify the licensing basis and support completion of the FSER

# Shield Building Weld Requirements

- Weld detailing requirements for SC structures follow the requirements of AISC N690
  - Specified in the APP-GW-GLR-602 and DCD Rev. 19.
- Design details (steel-to-steel and steel-to-concrete) will follow AISC N690 or ACI 349 codes, as appropriate, per DCD Rev. 19 commitments. The implementations of these commitments are included in the detailed design of the Westinghouse critical sections.
- APP-GW-GLR-602, Rev. 1 specifies:
  - The welds that anchor the faceplates to the RC/SC connection are complete joint penetration (CJP) welds, as defined by AWS A3.0M/A3.0:2010. The welds that connect the faceplate to faceplate are also CJP welds.
- From DCD Rev. 19, Section 3H2.2:
  - The overall configuration of the shield building is established from functional requirements related to radiation shielding, missile barrier, passive containment cooling, tornado and seismic event protection. These functional requirements led to establishing the design based on two primary design codes used for nuclear plant structures: 1) ACI 349 for reinforced concrete design, and 2) ANSI/AISC N690 for structural steel design.

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# Impact of Solar Heating on Thermal Loading

- Thermal loads have been evaluated conservatively for the Shield Building
  - Thermal load case only – factor of 20% increase included
  - Seismic + Thermal Cases
    - Winter ΔT: 110F (70°F to -40°F)
    - Summer ΔT: 45F (70°F to 115°F)
      - The effects of solar gain raises the outside surface temperature to 129°F when the ambient temperature is 115°F. ΔT for summer condition still bounded by winter condition
      - For winter condition, the ΔT would be reduced if solar gain is considered
  - The effects of solar gain for the summer case shows no significant effects for the load combination of ambient thermal plus SSE

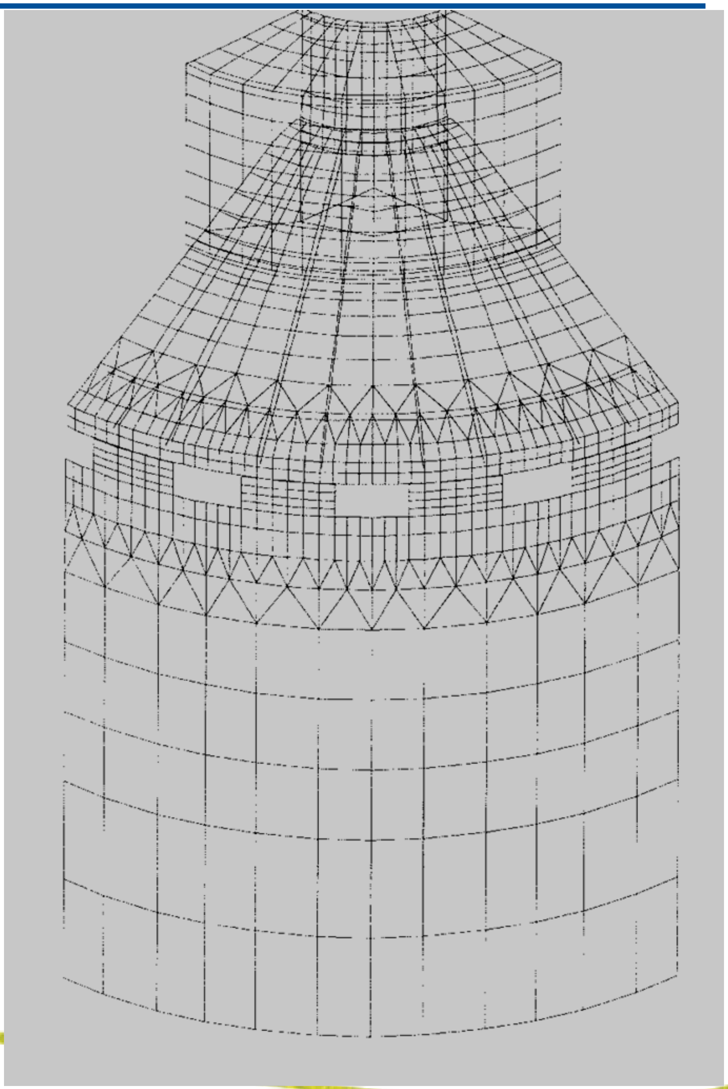
# PCS Tank Background

- As part of the resolution of the SSE plus normal thermal issue, WEC identified that the DCD Rev 18 was not updated to conform with a Shield Building Action Item
- The Action Item specified the application of hydrodynamic loads in the design of PCS tank
- Westinghouse has updated the calculations and the results are included in DCD Rev 19

# PCS Tank Design DCD Rev 15

## Hard Rock Design Certification

- Equivalent static analysis applying maximum acceleration from time history analyses
- Hydrodynamic load applied as pressure
- PCS exterior wall is a critical section with results summarized in the DCD



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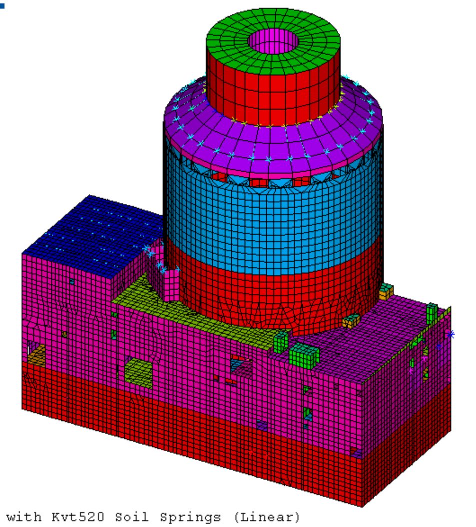
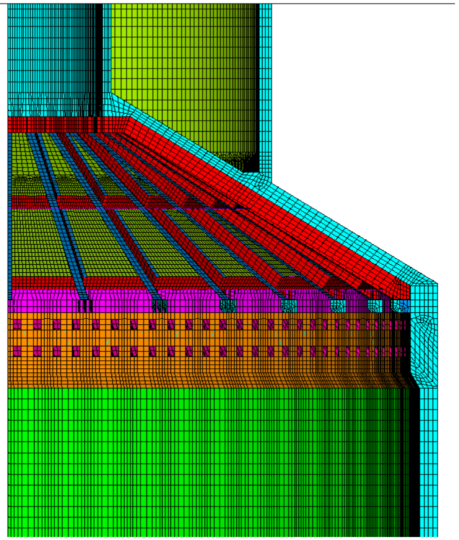
# PCS Tank Design DCD Rev 16-18

## Extension to Soil Sites

- Westinghouse adopted Response Spectrum analysis method using NI05 model for entire Nuclear Island Design
  - Including PCS Tank
- Equivalent static analysis was applied using detailed model applying maximum acceleration from time history analyses for selected portions of shield building roof design
  - Air Inlet & tension ring



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# PCS Tank Design Analysis

Action Item from NRC Shield Building Review (included in Shield Building Report)

- Required Westinghouse to apply equivalent static analysis to the PCS tank applying maximum acceleration from time history analyses
- A quadrant FE model of SB roof including the PCS tank, tension ring, and air inlet is used for the equivalent static analysis
- Design is performed using an equivalent static methodology similar to what was certified in DCD Rev. 15 and similar to method used for the air inlet structure and the tension ring
- Hydrodynamic loads are applied as pressure and validated against a time history analysis
- PCS tank design is described in DCD Section 3.7, 3.8. Appendices 3G and 3H
- The design of the reinforcement for the PCS tank critical sections is not changed in DCD Revision 19

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# Summary of Structural Analysis Changes

Presentation to the ACRS

by Westinghouse Electric Company LLC

September 8, 2011

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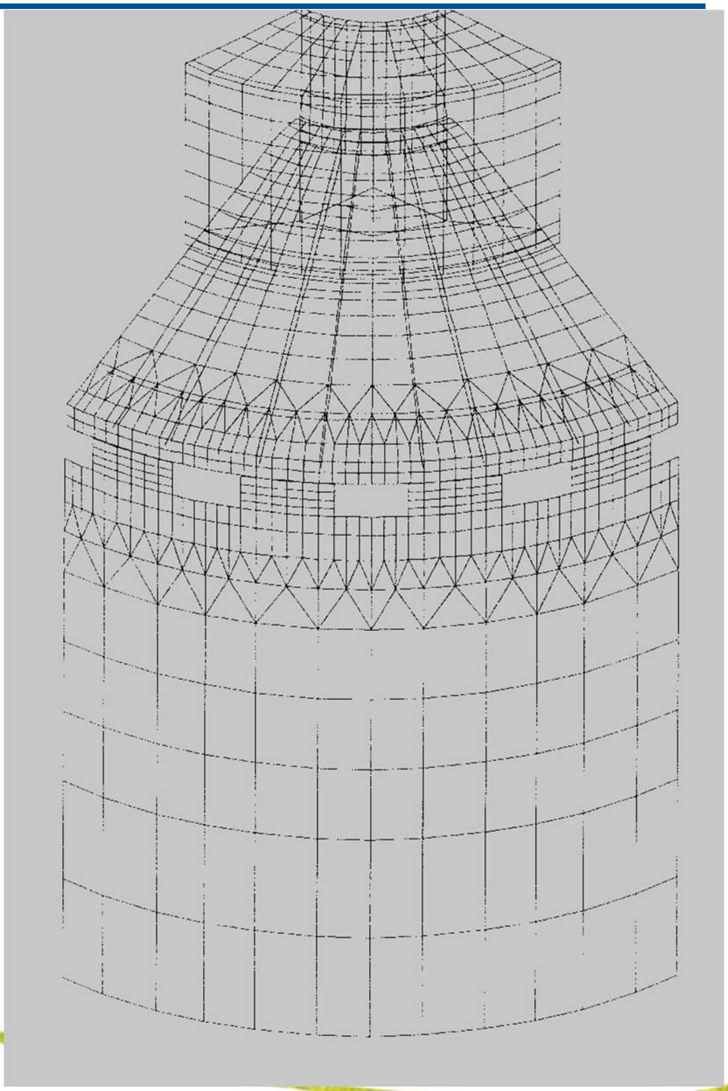

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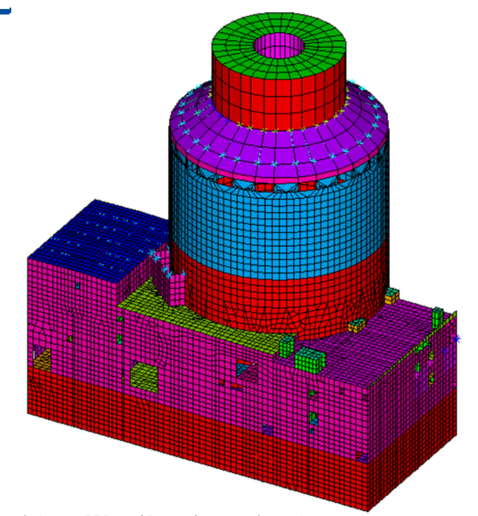


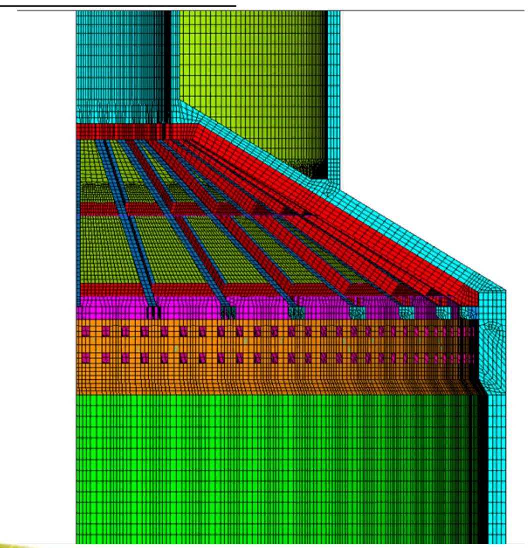

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# Questions

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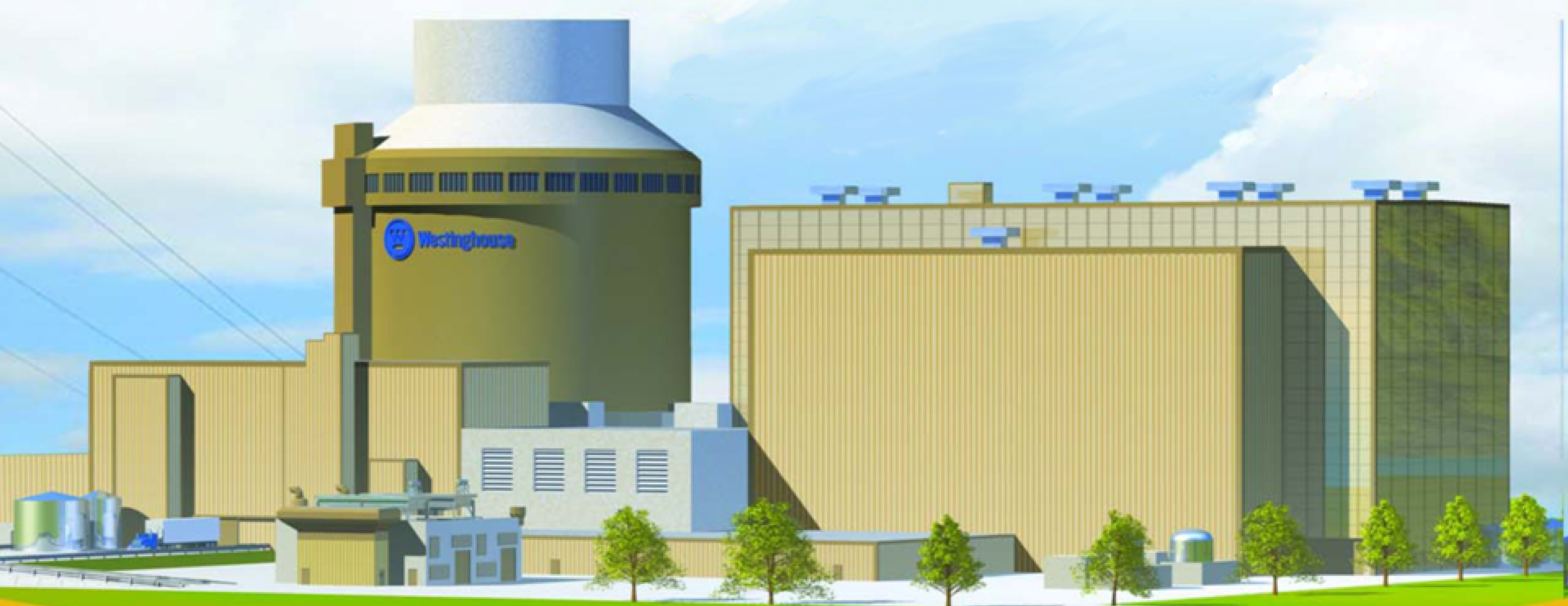
# AP1000® Design Certification

Summary of DCD Revision 19 Changes

Presentation to the ACRS

September 8, 2011

Westinghouse Electric Company LLC



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# Agenda Topics

- Design Control Document Revision 19 summary
- Discussion Structural Analysis Changes
  - Shield building load combination
  - PCS tank structural design
- Containment vessel pressure analysis

# DCD Revision 19: Scope of Revisions

- DCD Rev 19 was required to capture the resolution of NRC staff confirmatory items
- Additional DCD text was designated with Tier 2* controls:
  - Structural information including shield building details
    - Structural design information was added, designated, or clarified as Tier 2*
  - Containment debris limits
    - The ACRS recommended that the containment debris limit be controlled
    - Information in Section 6.3 related to debris was designated as Tier 2*
  - Additional Tier 2* information was added in agreement with the NRC Staff based on regulatory requirements, guidance, and review.
- Clarifications and consistency improvements:
  - Chapter 16 Technical Specifications
  - Tier 1 editorial improvements
  - Referenced document citations

# DCD Revision 19: Scope of Revisions

AP1000™

- Conforming revisions to address confirmatory review of:
  - Shield Building Load Combination
  - PCS Tank Analysis Methodology
  - Containment Vessel Calculated Peak Internal Pressure
  - Each topic above and the changes included in DCD Rev. 19 were the subject of NRC public meetings
- The DCD Rev 19 "design" is the same as DCD Rev 18
- DCD R19 is ready for certification

***No design changes included in DCD Revision 19***





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# DCD Revision 19

## ***Shield Building Load Combination Topic***

- The design and analysis requirements for the Shield Building steel concrete composite wall including treatment of normal thermal plus seismic load combination evaluation is documented in new DCD section 3.8.4.5.5.
- Tables in Appendix 3H are updated to include the ambient thermal plus seismic load combination

# DCD Revision 19

## ***Shield Building PCS Tank Topic***

- The use of equivalent static analysis for the PCS tank is summarized in Section 3.7
- Appendix 3G includes a more detailed description of the use of equivalent static analysis for the PCS tank
- A table (3H.5-15) and figure (3H.5-11, Sheet 6) added for additional design information on the PCS tank

AP1000™

# DCD Revision 19

***Containment Vessel Calculated Internal Peak Pressure***

- New calculated peak internal pressure is 58.3psig (compared to 57.8 psig)
  - ACRS comment related to the water film steady state coverage and additional updates
- Section 6.2 was revised to address updated CV peak pressure
  - Input changes in mass and energy model and containment response model
- Conforming change in Technical Specifications





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# Proposed RG 1.115, Protection Against Turbine Missiles

Simon C. F. Sheng
Division of Component Integrity

Steven Jones
Division of Safety Systems

(NRR)

John Honcharik
Division of Engineering (NRO)

ACRS Subcommittee Meeting
September 8, 2011

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

# Overview

- The ACRS Subcommittee Comments
- The GDC 4 Requirement
- The Current NRC Position on Protection Against Turbine Missiles
- Objectives of the Proposed RG 1.115
- Operating Experience since 1977
- Enhancements in the Proposed RG 1.115
- Industry Comments
- Conclusions

# The ACRS Subcommittee Comments

U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

1. Clearly Define SSCs to be Protected
2. Consider Non-Nuclear Power Plant Experience
3. Consider Risk-Informed Approach
4. Provide Turbine Missile Risk Goal for New Reactors
5. Clarify Use of Table 1 and Use of Barriers (√)
6. Clarify When Table 1 is Applicable (√)
7. Expand RG to Include Detailed Technical Guidelines

# The GDC 4 Requirement

GDC 4, "Environmental and Dynamic Effects Design Bases," requires:

"These structures, systems, and components [SSCs important to safety] shall be appropriately protected against dynamic effects, including the effects of missiles…that may result from equipment failures…."

# The Current NRC Position on Protection Against Turbine Missiles

U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

- By Turbine Orientation
  RG 1.115 (July 1977)
- By Control of Turbine Missile Generation Frequency
  Hope Creek SER (July 1986)
  SRP 3.5.1.3, "Turbine Missiles" (March 2007)
- By Missile Barriers
  RG 1.115 (July 1977)

# Objectives of the Proposed RG 1.115

- Assures Turbine Failure Is a Negligible Contributor to Risk
- Makes the RG Self-Contained Including All Acceptable Protection Methods Against Turbine Missiles
- Clarifies SSCs to Be Protected from Turbine Missiles (ACRS Comment 1)
  - Includes Safe Shutdown Functions (e.g., Makeup Water, Heat Sink, and Long-Term Decay Heat Removal)
  - Excludes Functions Necessary Only for Other Unlikely Design Basis Events (e.g., High-Head Safety Injection and Containment)
- Assesses Operating Experience since 1977

# Operating Experience Since 1977

Reassess Failure Data by Reviewing

<u>Before 1995</u>

- NUREG-1275

<u>After 1995</u>

- Licensee Event Reports (LERs)
- International Incident Reporting System
- INPO Significant Event Notifications

Purpose: To Explore the Possibility of Revising the Current $P_1$ and $P_4$ Criteria

# Defining $P_1$, $P_2$, and $P_3$

U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

The Ultimate Concern: The Probability of Failure of an Essential System $P_4$ Caused by Turbine Missiles

$$P_4 = P_1 \times P_2 \times P_3$$

- $P_1$: The Probability of Turbine Missile Generation
- $P_2$: The Probability of Ejected Missiles Striking an Essential System
- $P_3$: the Probability of the Struck Essential System Losing Its Safety Function

# Findings on Review of Turbine Operating Experience

U.S.NRC
United States Nuclear Regulatory Commission
*Protecting People and the Environment*

- An Event in 1991 Gives a Point Estimate of 1E-3 per Turbine-year for a Destructive Turbine Overspeed Event
- Turbine Operating Record has Improved in General During the Past 15 Years
- Still has Unignorable No. of Events Resulting in Scrams, Shutdowns, and Outage Delays Per Year

# Conclusions Based on Review of Turbine Operating Experience

- Consider Nuclear Power Plant Experience Only – Nuclear Operating Practices, Maintenance, Testing , and Inspections Changed After the Salem 2 Event (ACRS Comment 2)
- Operating Experience is Consistent with the Turbine Failure Rate of 1E-4 per Turbine-Year (RG 1.115)
- Maintain the Current Criteria of $P_1$ (Hope Creek SER) and $P_4$ (RG 1.115)

# Application of a Risk-Informed Approach

- Applications Conforming to RG 1.174 are Considered on a Case-By-Case Basis (ACRS Comment 3)
- Risk Goal is not Defined for Turbine Missiles for New Reactors (ACRS Comment 4)

# Enhancements in the Proposed RG 1.115

- Provides Guidance for High-Trajectory Missiles
- Define SSCs to be Protected (ACRS Comment 1)
- Clarifies the Current NRC Emphasis on $P_1$ (in the 1986 Hope Creek SE and the 2007 SRP)
- Permits the Approach of Considering $P_1$, $P_2$, and $P_3$
- Validates Operating Experience (NUREG-1275, LERs, IRS, INPO, etc.) since 1977

# Provides Guidance for High-Trajectory Missiles

Different $P_1$s for Low-trajectory and High-trajectory Missiles

$$P_1 = P_{1f} \times P_{1p} + P_{1o}$$

- $P_{1f}$ is probability of disk failure based on Probabilistic Fracture Mechanics considering SCC
- $P_{1p}$ is probability of the failed disk piece penetrating turbine case based on energy dissipation (different values for LTMs and HTMs)
- $P_{1o}$ is probability of overspeed protection system failure (quickly resulting in disk failure and turbine case penetration)

# Clarifies the Current Emphasis on $P_1$

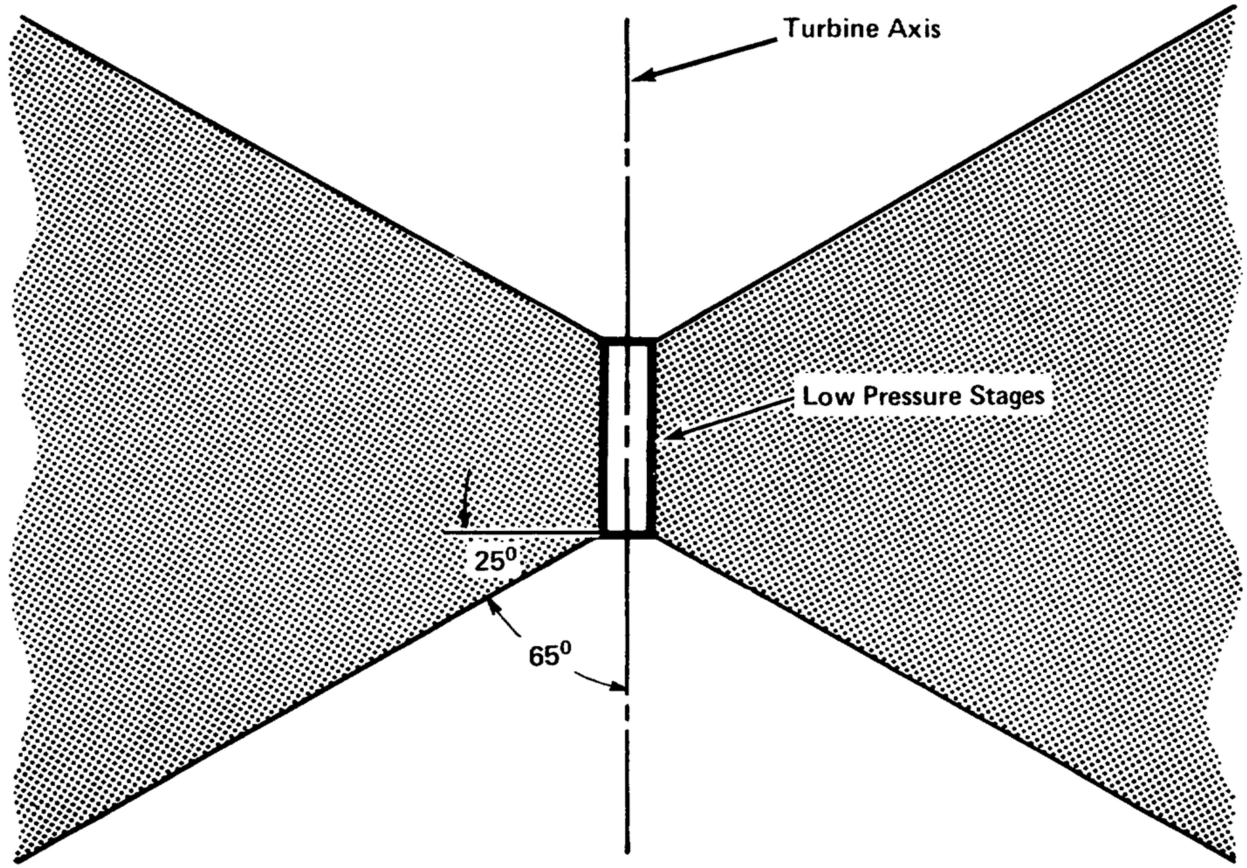
Favorably Oriented

- Low-trajectory: no additional analysis (RG 1.115)
- High-trajectory: 1E-4 (1986 Hope Creek SER)

Unfavorably Oriented

- Low-trajectory: 1E-5 (1986 Hope Creek SER)
- High-trajectory: No Additional Analysis since Low-Trajectory Analysis is Bounding

# Turbine Orientation



# Permits the Approach of Considering $P_1$, $P_2$, and $P_3$

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Unfavorably Oriented/Both Trajectories

$P_1$ (<1E-4) x $P_2$ x $P_3$ < 1E-7

Features

- Retain the RG 1.115 criterion of 1E-7 for the probability of failure of an essential system caused by LTMs
- Relax the current $P_1$ criterion for an unfavorably oriented turbine from 1E-5 to 1E-4 when $P_2$ and $P_3$ are also considered

# Industry Comments (Jan. 2010)

The Proposed RG Considers:

- Pathways for High Trajectory Missiles
- Robust Rotor Designs
- New Rotor Designs within Current Regulatory Process
- Credit for Existing Structures as Missile Barriers
- Sites with Multiple Units
- Applications Conforming to RG 1.174 on a Case-By-Case Basis
- Future Conforming Changes to the SRP
- Probability for Low-Trajectory Turbine Missiles Unchanged

# Industry Comments (June 2011)

Soliciting Comments Again is Required Because the RG Revision (ML103350136) Incorporating ACRS Comments is Rather Significant

The Proposed RG Considers

- Comments Involving Definitions and Wordings (Majority)
- Review of Risk-Informed Approach on a Case-by-Case basis to include Generic Application

# Conclusion

## The Proposed RG 1.115

- Becomes Self-contained, Providing Preferred and Acceptable Approaches and Acceptance Criteria Against LTMs and HTMs
- Is Consistent with the Current Criteria Emphasizing $P_1$
- Considers the Approach Using $P_1$, $P_2$ , and $P_3$
- Considers Risk-Informed Approach Case-by-Case
- Has Considered 2010 and 2011 Industry Comments
- Has Fully Addressed 6 of 7 ACRS Comments
  - Will Explore Means to Provide Detailed Technical Guidelines as a Long-Term Goal (ACRS Comment 7)

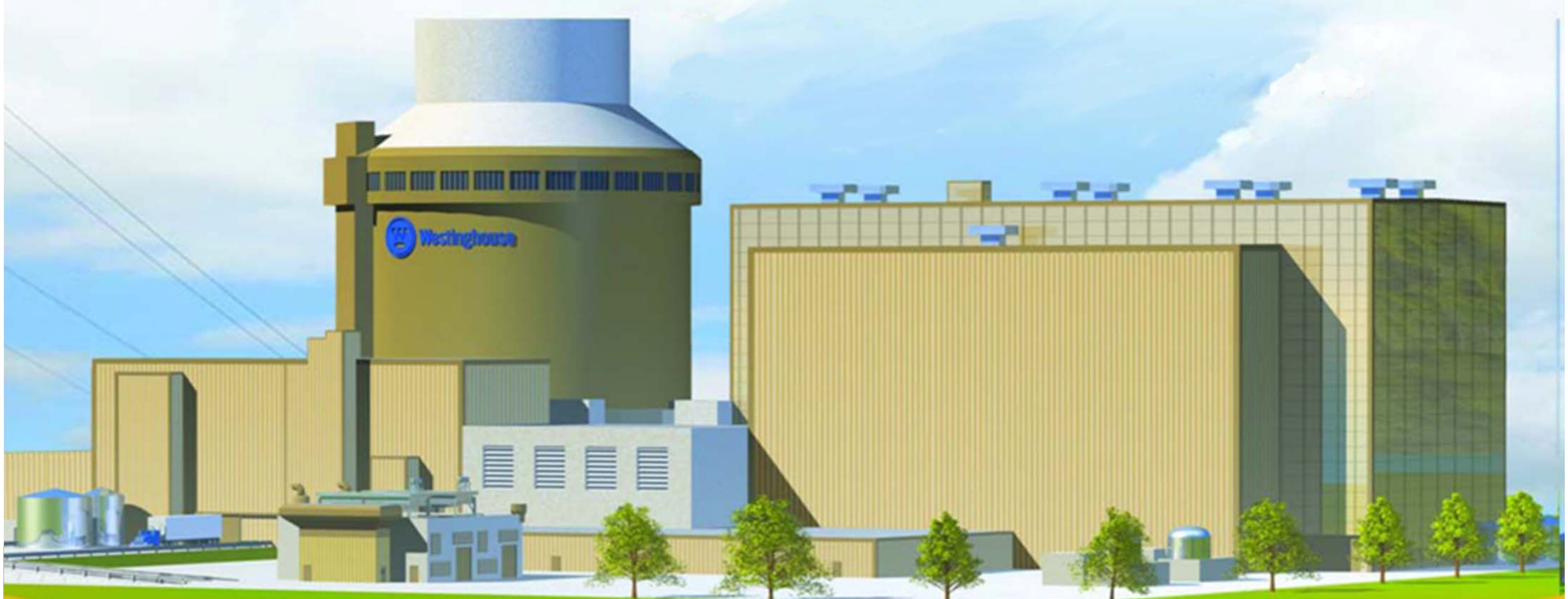
# AP1000® Design Certification

Summary of DCD Revision 19 Changes

Presentation to the ACRS

September 8, 2011

Westinghouse Electric Company LLC



# Agenda Topics

- Design Control Document Revision 19 summary
- Discussion Structural Analysis Changes
  - Shield building load combination
  - PCS tank structural design
- Containment vessel pressure analysis

# DCD Revision 19: Scope of Revisions

- DCD Rev 19 was required to capture the resolution of NRC staff confirmatory items
- Additional DCD text was designated with Tier 2* controls:
  - Structural information including shield building details
    - Structural design information was added, designated, or clarified as Tier 2*
  - Containment debris limits
    - The ACRS recommended that the containment debris limit be controlled
    - Information in Section 6.3 related to debris was designated as Tier 2*
  - Additional Tier 2* information was added in agreement with the NRC Staff based on regulatory requirements, guidance, and review.
- Clarifications and consistency improvements:
  - Chapter 16 Technical Specifications
  - Tier 1 editorial improvements
  - Referenced document citations

# DCD Revision 19: Scope of Revisions

- Conforming revisions to address confirmatory review of:
  - Shield Building Load Combination
  - PCS Tank Analysis Methodology
  - Containment Vessel Calculated Peak Internal Pressure
  - Each topic above and the changes included in DCD Rev. 19 were the subject of NRC public meetings
- The DCD Rev 19 “design” is the same as DCD Rev 18
- DCD R19 is ready for certification

***No design changes included in DCD Revision 19***

# DCD Revision 19

## ***Shield Building Load Combination Topic***

- The design and analysis requirements for the Shield Building steel concrete composite wall including treatment of normal thermal plus seismic load combination evaluation is documented in new DCD section 3.8.4.5.5.
- Tables in Appendix 3H are updated to include the ambient thermal plus seismic load combination

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# DCD Revision 19

## ***Containment Vessel Calculated Internal Peak Pressure***

- New calculated peak internal pressure is 58.3psig (compared to 57.8 psig)
  - ACRS comment related to the water film steady state coverage and additional updates
- Section 6.2 was revised to address updated CV peak pressure
  - Input changes in mass and energy model and containment response model
- Conforming change in Technical Specifications

# Questions and Discussion

# AP1000® Design Control Document – Containment Pressure Analysis

Presentation to the ACRS

by Westinghouse Electric Company, LLC

September 8, 2011

# Containment Peak Pressure Analysis Overview

- Peak pressure of 57.8 psig reported in DCD Revision 18
- Increased the steady state PCS water coverage time delay input value to resolve an ACRS review comment
  - Containment peak pressure calculated to be 58.1 psig
- Additional input changes to the LOCA M&E model and containment model input were made to address other items that could affect the peak containment pressure reported in the Technical Specifications.
- Peak pressure of 58.3 psig reported in DCD Revision 19

# Containment Peak Pressure Analysis Overview

- Components of containment peak pressure calculation
  - M&E release methodology
  - M&E model inputs
  - Containment response methodology
  - Containment response model inputs
- The approved methodology that is applied in the M&E and containment response evaluation models is conservative
- Changes were made to the evaluation model inputs
  - Corrections applied in the conservative direction
  - Changes to reflect updated plant design information

# Containment Peak Pressure Analysis Overview

- Existing heat sinks in containment model were credited in order to
  - Offset model input changes impact on peak containment pressure
  - Maintain roughly same amount of margin reported in DCD Rev. 18
- Analysis performed in accordance with approved methodology
- New DCD Table 6.2.1.1-10 generated to capture key parameters (surface area, volume, material) of new heat sinks as Tier 2* information

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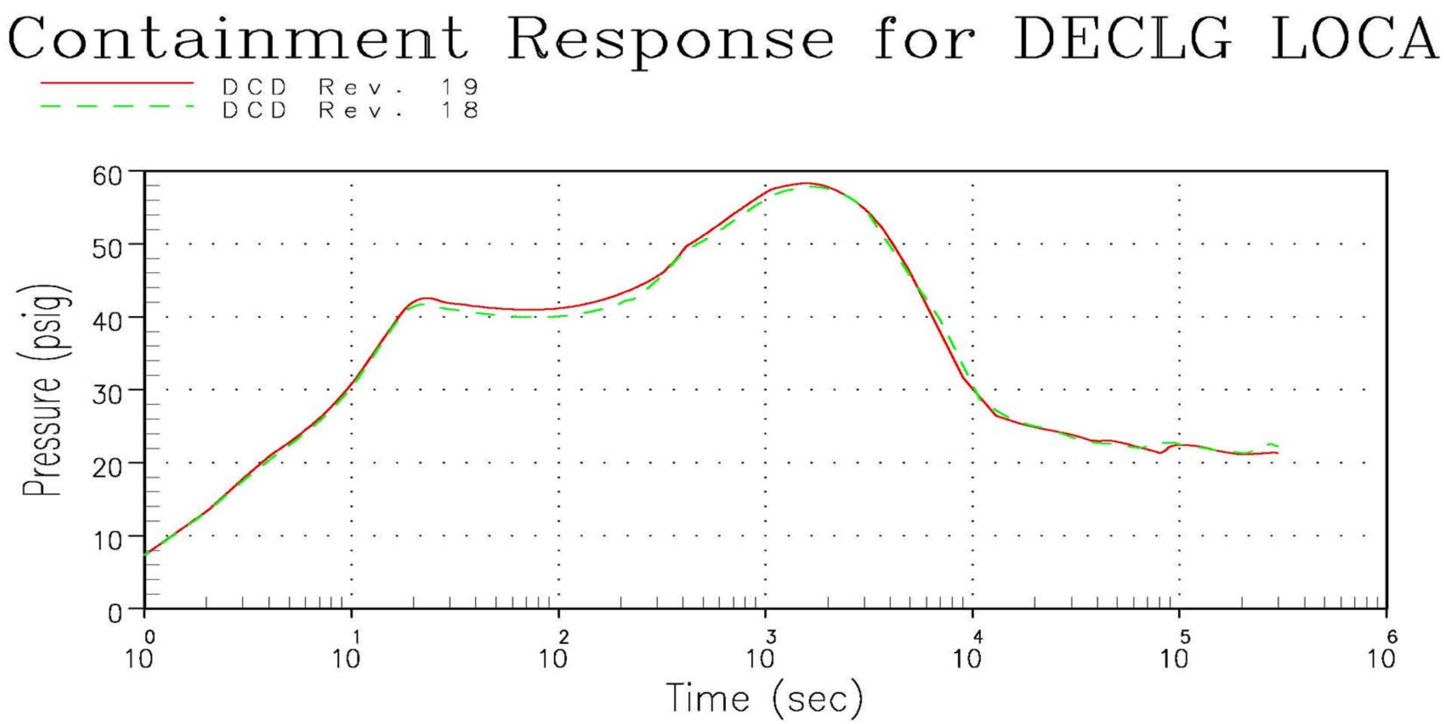
# Summary of Containment Pressure Analysis Results



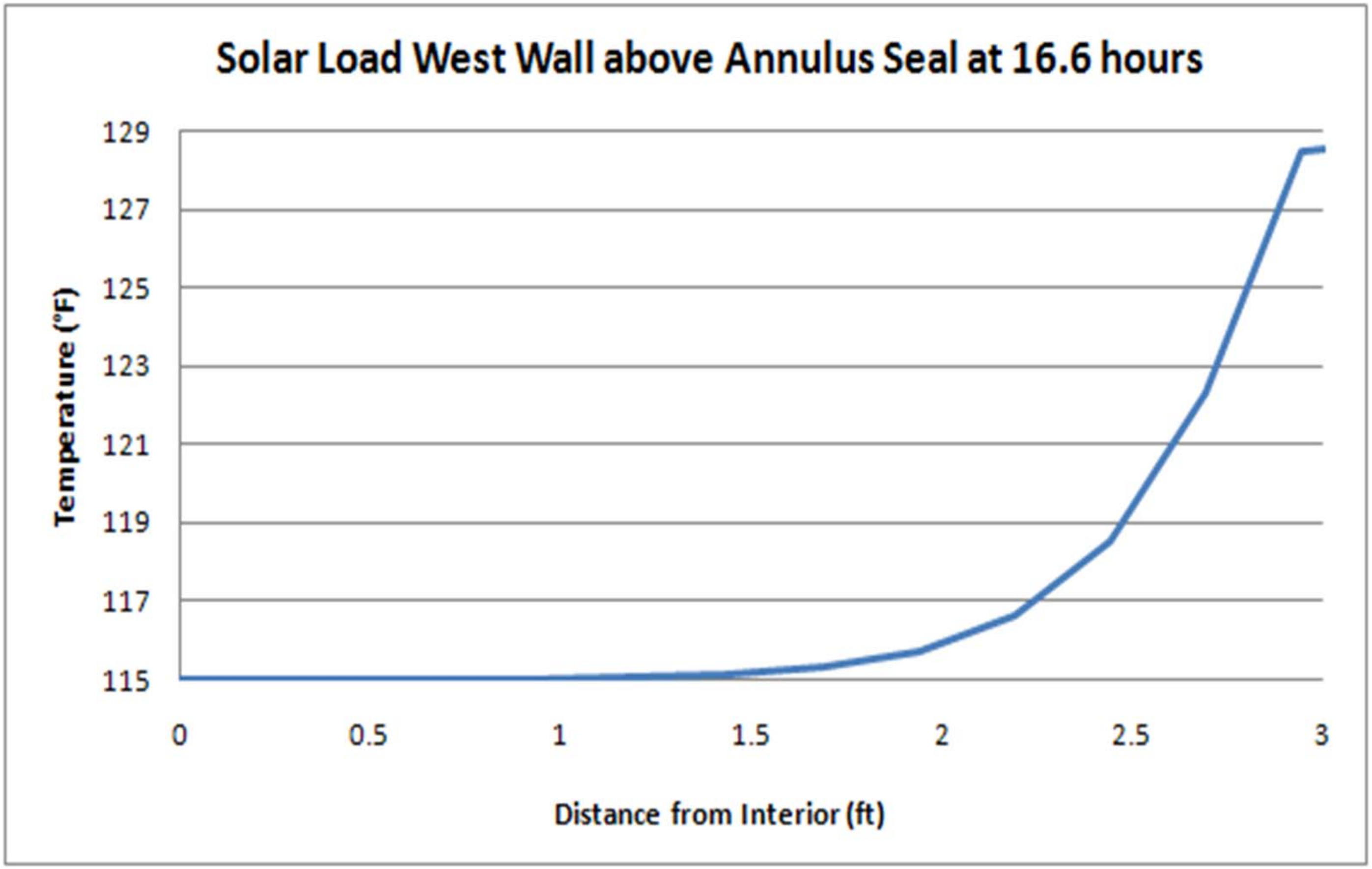
# Solar Radiation Impact on LST Data

- ACRS requested further review concerning impact of solar radiation heating on the large-scale passive containment cooling test results and application to the containment evaluation model
- LST data were used along with data from other tests to validate the convective heat transfer and the condensation heat and mass transfer correlations
  - Solar radiation had no impact on the LST data that were used for validation of the condensation heat and mass transfer correlation
  - Solar radiation did have some impact on the LST data that were used for validation of the convection heat transfer correlation, but the heat flux data were adjusted to account for this impact

# Conclusions

- Model input changes were made to address items affecting the peak containment pressure reported in the Technical Specifications
- No changes were made to the plant design
- Peak containment pressure remains under 59 psig
- NRC has reviewed the modeling changes, requested additional information and found the changes and responses to be acceptable
- Solar radiation – no impact on validation of the condensation correlations; the impact on validation of the convection correlation was addressed in the data evaluation


Solar Load West Wall above Annulus Seal at 16.6 hours
Temperature (°F)
129
127
125
123
121
119
117
115
0
0.5
1
1.5
2
2.5
3
Distance from Interior (ft)

# Effect of Solar Radiation on Calculated Peak Pressure

- The conservative Shield Building heat-up calculation resulted in an increase of the interior wall temperature of ~0.001 °F. Therefore, an insignificant amount of heat would be added from the inside surface.
- Assume the average incoming air temperature increases by 3.5°F (0.25*129 F+0.75*115 F) due to solar heating of the outside surface of the Shield Building.
- The increase in the calculated peak containment pressure has been calculated to be 0.05 psi for a 10 F increase in the ambient air temperature
- Therefore, a conservative calculated increase in peak containment pressure would be less than 0.02 psi

Westinghouse

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135 Baker Hall
Carnegie Mellon University
Pittsburgh PA 15213

August 12, 2011

Mr Weidong Wang, Senior Engineer
ACRS/TSB, Nuclear Regulatory Commission
Mailstop 2 E26 TWFN
Rockville, Maryland 20852

References:
1. Email from Billy Gleaves, Sr Project Manager dated 28 June 2011, "RE: Request to listen via teleconference [PUBLIC MEETING WITH WESTINGHOUSE ELECTRIC COMPANY ON THE AP1000 DESIGN CERTIFICATION - SHIELD BUILDING ROOF PASSIVE CONTAINMENT COOLING WATER STORAGE TANK ANALYSIS Thursday, June 30, 2011 9:00 a.m. - 11:30 a.m.]"
2. "Evaluation of the Effect of the AP1000 Enhanced Shield Building Design on the Containment Response and Safety Analysis", APP-GW-GLR-097, Rev. 1, submitted to the NRC as part of docket on AP1000 rulemaking, as enclosure 4 to DCP-NRC-002998, August 6, 2010.
3. "A Review -- Cooling by Water Evaporation Over Roof" by G. N. Tiwari, A. Kumar, and M. S. Sodha, in *Energy Conversion Management*, Vol. 22, pp. 143 to 153, 1982.
4. Letter from S G Sterrett to Billy Gleaves dated 7 July 2011 "Thermal loads and effects due to radiative heating and cooling of AP1000 shield building exterior surface, which are in addition to all thermal loads and effects due to ambient air temperature" (Written question submitted regarding PUBLIC MEETINGS WITH WESTINGHOUSE ELECTRIC COMPANY ON REV 19 OF THE AP1000 DCD that were held on June 30, 2011)

SUBJECT: **Question for ACRS Meeting on August 16th, 2011 (Rev 19 of AP1000 DCD) concerning whether solar radiation on the physical model was accounted for in interpretating experimental data in the "Large Scale Test" that was used to validate WGOTHIC, which is used in Rev 19 calculations for predicting heat and mass transfer aspects of the effectiveness of Passive Containment Cooling System in reducing containment pressure.**



## 1. Background to the Problem (from which the question about WGOTHIC validation using the PCS (Passive Containment Cooling System) Large Scale Test (LST) arises)

In the meetings about Rev 19 of the AP1000 DCD held on June 30, 2011, the topic of including thermal loads on the AP1000 shield building was discussed, and various sections of revision 19 of the AP1000 DCD were cited, including Appendix 3H. In an earlier letter addressed to the NRC's Billy Gleaves, (Ref. 4), which I attach to this letter for convenience, I discussed that issue as it related to the AP1000 nuclear safety accident analyses and analysis of the shield building structure: It is clear from looking at the values of the thermal loads listed in Appendix 3H of Rev 19 of the AP1000 DCD that Westinghouse assumed the building exterior surface temperatures to be bounded by the ambient air temperatures. It is also a matter of very basic science that doing so is not correct.

The quantitative values of the neglected quantities are not small (~ 30 degrees F or more difference added onto the high end of the range; about half that added on the low end of the range). The data presented by Westinghouse in Appendix 3H of Rev 19 of the AP1000 DCD implies that Westinghouse and/or the NRC staff did not consider, and/or did not realize that it was relevant to take into account the fact that there can be radiative heating of an exterior surface due to the sun, and radiative cooling of an exterior surface due to radiation to the night sky. These temperature changes are distinct from, and in addition to, seasonal and daily temperature changes due to seasonal and daily temperature changes in the ambient air temperature.

The fact that Westinghouse made this error (neglecting the effect on building exterior surface temperatures due to radiative heat gains due to the sun (solar radiation) and radiative losses to the night sky) in the work done for the Rev 19 changes raises the question of whether there is a more fundamental problem with the safety analysis of the AP1000: if they really didn't know that they needed to consider the effect of heat of solar radiation for the Rev 19 calculations for the shield building exposed to the sun, did they know to do so when interpreting the test results of the Large Scale Test of the Passive Containment Cooling System? The steel containment as installed is inside the concrete shield building and is not exposed to the sun, so there would be a problem if the scale model of the steel containement was exposed to the sun during the test.

In a Westinghouse document submitted as part of Rev 19, the following photograph of the Large Scale Test Facility is provided:

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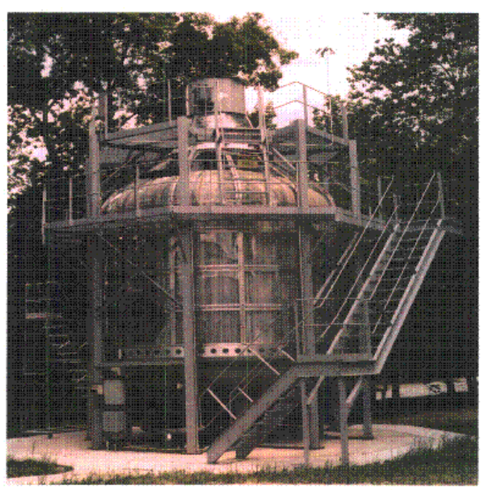


Figure 6-4: Large Scale Test Facility

APP-GW-GLR-097 Rev. 2

25

If the above is a photograph of the site on which the test was performed (i.e., if the test was performed outdoors during the day), which I believe it is, then the wetted surface of the Large Scale Test (LST) of the Passive Containment Cooling System (PCS), was in the presence of the sun when the experimental test data was taken. The figure below, which is from an article in an engineering journal (Ref. 3 ) is applicable to that situation, and the factors depicted in it need to be taken into account when interpreting the test data:

146 TIWARI *et al.*: A REVIEW

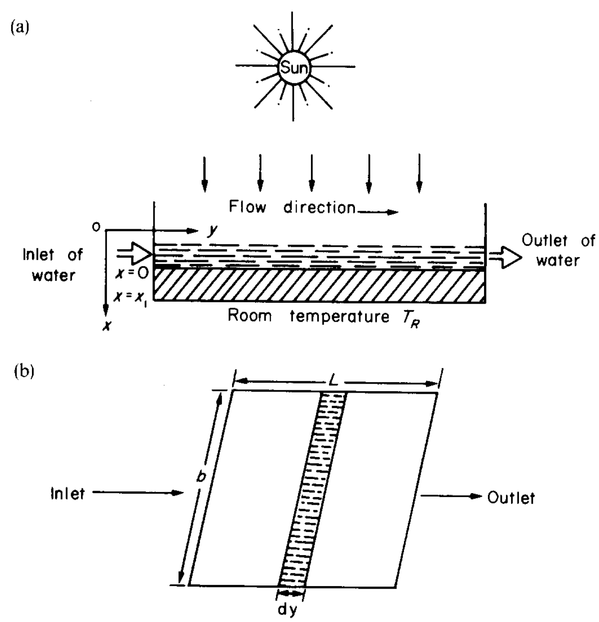



Fig. 1. (a) Schematic sketch of, "Flowing water over the roof" system. (b) Overside view of the flowing water system.

Now, compare the two situations: the PCS LST physical model in the outdoors, and the PCS under the conditions at which it is supposed to operate:

<u>Large Scale Test (LST) -- Outdoors in Presence of Sunlight</u>

The above figure (Figure 1 of Tiwari 1981) correctly depicts the role of the sun in the **Large Scale Test situation** of the Passive Containment Cooling System (PCS) **LST**, which, it appears, was performed outdoors, in the presence of sunlight.

In the LST model, which is a physical model, the baffle/shield building was represented, if at all, using a *transparent* material. **The physical model's being in the presence of sunlight thus aided evaporation in the PCS LST test.**

Conditions under which AP1000 PCS is designed to operate -- Inside shield building, largely shielded from Sunlight

> The **installed situation** for which the AP1000 Passive Containment Cooling System is to perform its safety function of heat removal from the steel containment is *inside* the concrete shield building, and the concrete shield building is *opaque* to solar insolation. Whatever the weather outdoors, the wetted surface of the steel containment from which evaporative losses are taken credit for in the AP1000 safety analysis is largely shielded from receiving the benefit of sunlight (solar insolation) in the situation in which the PCS operates, as installed in an AP1000 nuclear power plant.

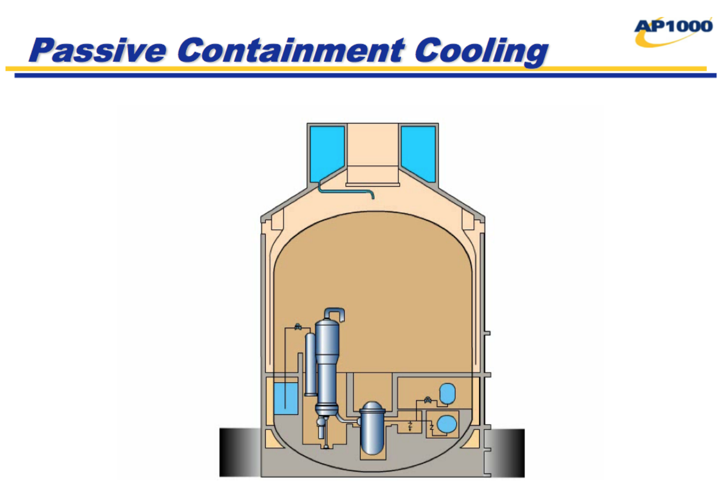
Thus there might well have been more evaporation, and more heat removal, earlier, in the LST experimental test situation than there will be in the situation in which the PCS is actually to operate when installed in an AP1000 nuclear power plant. At any rate, accuracy calls for considering the important relevant factors in a calculation, and the factor of whether or not a surface is in the presence of solar radiation or not is a relevant factor in the calculation of heat transfer.

I have so far not run across any discussion of the fact that the test model of the steel containment shell was located in the sun whereas the actual containment is located within the shield building, largely shaded from sunlight.

## 2. Technical Discussion of the Problem

2a. WGOTHIC Validation of Indoor Systems Using Outdoor Test

The problem is that it appears that in the test situation (PCS LST) against which the computer code WGOTHIC was compared, the wetted surface was exposed to solar insolation (i.e., radiative heating from sunlight was present), whereas the situation WGOTHIC is being used to make predictions about is one in which it is not: inside the shield building, which is where the PCS delivers the water film over the steel containment. The interior is largely shielded from sunlight. The Westinghouse presentation at an NRC meeting on 30 June 2011 presented this figure:



It was also stated that the computer code WGOTHIC was used in the safety analysis for the AP1000 to predict PCS effectiveness in removing heat from the containment, and thus to predict its effectiveness in reducing containment pressure. Per the docket materials submitted describing the analysis performed in calculating containment pressure for Rev 19 changes, the computer code was validated by comparing the results that WGOTHIC predicted for the LST test with the results obtained experimentally in the LST test.

Since the LST test was conducted in the presence of sunlight, and the WGOTHIC model of the PCS performance was validated against it, won't the WGOTHIC model of the AP600/AP1000 containment response tend to *overestimate* the evaporative losses that will occur when the PCS operates as installed in the AP1000 plant? I ask this because, in the AP1000 plant, as in the AP600 plant, the wetted containment surface is indoors, in the dark, inside the shield building. Since evaporative losses *reduce* containment pressure, doesn't this mean that, unless the effect of the sunlight is quantified and accounted for in some way, using this approach to validate a computer code such as WGOTHIC results in a computer code that *underestimates* the containment pressure ?

## 2b. Some Points of Basic Physics

The symbol for solar radiation in the cited paper (Tiwari 1981) is $H_s$ , as indicated in the nomenclature list on the first page of the paper. $H_s$ occurs in the general energy balance equation for figure 1(b) in Tiwari 1981's paper (reproduced above). The general energy balance is equation (2) of the Tiwari 1981 paper; **the energy balance is basic physics and not a matter of controversy or interpretation**.

Refering to Fig. 1b, the energy balance equation for water moving over the roof along $y$-direction is

$$\left(bd\rho_w c_w \frac{\partial T_w}{\partial t} + \dot{m}_w c_w \frac{\partial T_w}{\partial y}\right) \mathrm{d}y = [\tau_1 H_s - Q_r - Q_e - Q_c + h_0(\theta|_{x=0} - T_w)]\, b\, \mathrm{d}y \qquad (2)$$

where

I would like to emphasize something I said as a participant via telephone in the NRC public meeting that was held on the morning of June 30th, 2011: that *neither the effect of radiative heat gains (via solar radiation) nor the effect of radiative heat losses (via radiation to the night sky) is captured by considering the effect of ambient air temperature.*

To get this point across, I draw your attention to the portion of Tiwari's paper on cooling by water evaporation over roofs that makes a general comment about the cycles of solar radiation and cycles of temperature change due to daily night-and-day cycles. This paragraph of the paper (p. 146) makes clear that they are two distinct factors. $H_s$ is the symbol for solar radiation, and $T_a$ is the symbol for ambient air temperature:

On account of their periodic natures, solar insolation and ambient air temperature can be Fourier analysed in the form

$$H_s = a_0 + \sum_{n=1}^{\infty} a_n \exp(in\omega t) \qquad (7a)$$

and

$$T_a = b_0 + \sum_{n=1}^{\infty} b_n \exp(in\omega t) \qquad (7b)$$

To put this in nontechnical terminology: The *difference between ambient air temperature in night and in day* is one thing *(diurnal cycling, indicated by (7b)),* and *the difference due to the very presence or absence of solar insolation* is another thing. The *presence or absence of solar insolation* is the difference between *being in the shade* and *being in direct sunlight, at the same ambient air temperature* (indicated by (7a)).

Both diurnal *thermal cycling* (due to ambient air temperature daily cycles) and daily temperature variation due to *solar insolation* can be periodic for a particular engineering project, and both are in some manner due, ultimately, to the heat of solar radiation. They are, however, two *distinct*, quantifiable effects whose variation does not coincide in time and place, and neither includes the other.

2.c. Conclusion of the above considerations: The effects of solar insolation (sunlight hitting the surface of something) that were present in the Large Scale Test of the Passive Containment Cooling System (and so aided evaporation), but which are not going to be present in the actual situation to which the safety analysis applies (since the wetted surface from which evaporation is supposed to take place is indoors, shielded from sunlight), should be quantified and subtracted from the LST test results before comparing it to the WGOTHIC analysis. The question is: was this done? Did the ACRS check whether it was done when they approved the designs based upon the analyses using the computer models whose validation appealed to this test? The difference between the test situation and the situation for which WGOTHIC is to be used for prediction needs to be taken into account in some manner. Otherwise, the LST does not serve to validate the WGOTHIC analysis for the PCS as it will perform when it is installed and used in the AP1000 plant.

The photograph of the Small Scale Test Facility, also taken from material submitted for rev 19 of the AP1000 DCD, likewise portrays it outdoors, so agreement between the small scale test experiments run on this facility, and the large scale tests cannot be appealed to in order to dismiss the significance of the test being performed outdoors:

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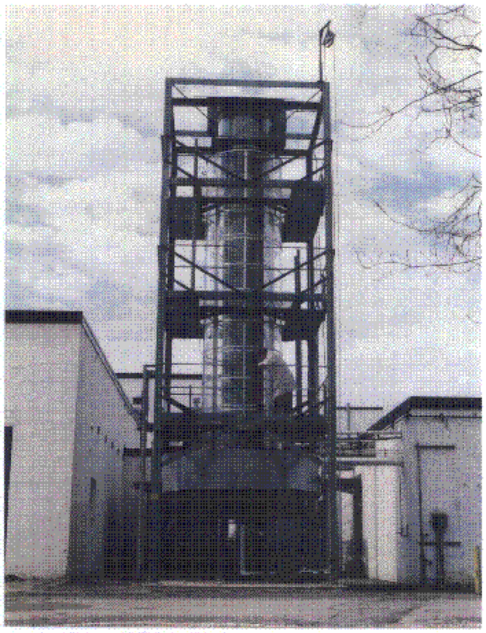

Figure 6-3: Small Scale Test Facility

APP-GW-GLR-097 Rev. 2

22

**3. Question to the NRC ACRS about WGOTHIC validation for Rev 19 Containment Pressure Calculations**

QUESTION: Did the NRC review how the difference between:

(i) the Passive Containment Cooling System Large Scale Test (PCS LST) test situation, in which solar insolation (the presence of sunlight, i.e., solar radiation) aided evaporation,

and

(ii) the situation to which the AP1000 computer-based safety analysis (using the WGOTHIC computer code) applies, in which the wetted surface is not exposed to sunlight and solar insolation does *not* aid evaporation,

is accounted for when appealing to the PCS LST experimental test results to validate the use of the WGOTHIC computer code analyses for predicting the effectiveness of the PCS in reducing containment pressure? Radiative effects act in addition to convection and conduction, and affect the calculated peak containment pressure.

I note that the analysis for Rev 19 shows that the margins on containment pressure have been further narrowed to the point of almost vanishing, even after much so-called "pencil sharpening" (taking credit for things for which credit was not previously taken).

Can the ACRS Committee members say whether, and, if so, how, the effects of solar insolation were quantified and subtracted from the LST test results when using the PCS LST to validate the WGOTHIC results for use in the AP1000 design certification? Or, whether this dissimilarity between the test and the situation about which WGOTHIC is being used to make predictions in the safety analysis is accounted for in some other way? If not, can you indicate what the NRC staff ought to do (or require of the applicants) concerning quantifying these effects to determine how they would change the NRC's safety evaluation of Rev 19 of the AP1000 safety analysis?

## 4. Concluding remark on significance of the question

*Put briefly,* the question above arises because it appears that on the AP1000 a scale model test of evaporative effectiveness performed outdoors in sunlight was used to validate predictions for a process that does not occur in the presence of sunlight. (I.e., a computer program was validated for the purpose of predicting quantitative values arising from a physical process *in which evaporation is important* and that occurs in the *absence* of sunlight, using a scale model test that was performed in the *presence* of sunlight.) I emphasize that the factor that was neglected is a matter of basic science, not a matter of interpretation or analysis methodology.

*Put in terms of an everyday example,* it seems to me that this would be akin to validating computer model predictions for a device that its manufacturer claims will rapidly dry clothing indoors in a darkened room, by constructing a physical model of the device and setting it outdoors in sunlight. That is, saying that the PCS LST scale model test validates the predictions of a WGOTHIC computer analyses of the effectiveness of the PCS in removing heat via evaporative heat losses is analogous to referring to the experimental tests of a clothes-drying device from data collected on a model of it used while outdoors in the sun, and then saying: look, my computer predictions were confirmed and I have thus proved how speedily this device works! My computer model calculations predicting how quickly water will evaporate when using this device indoors in the dark are now validated!

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Attachment -- Reference 4 is an attachment to this letter.

**<u>Remarks by S G Sterrett, Carnegie-Mellon University, Pittsburgh PA</u>**
**<u>(slide images have been incorporated into the text below)</u>**

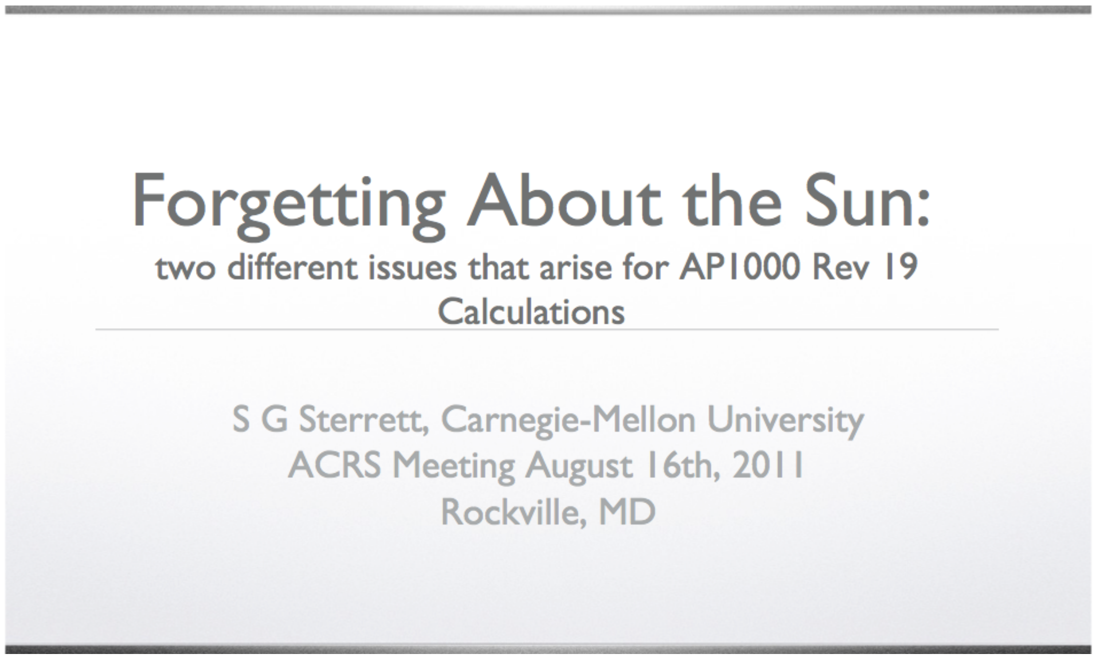
**(to accompany slideshow of SterrettSlidesACRSMeeting16August2011.pdf )**

**[conveyed via telephone from Pittsburgh around 3:50 pm on August 16th, 2011 to the meeting of the ACRS (Advisory Commitee on Reactor Safeguards) Subcommittee on the AP1000, held at the Nuclear Regulatory Commission headquarters in Rockville, MD]**

*Thank you for allowing me time to speak today.*

*For the record, this is Dr Susan G Sterrett, of Carnegie Mellon University. Prior to my academic career, I worked in the nuclear power industry, including work in structural mechanics and work in fluid systems design. Although I did some work on Westinghouse passive plant designs, I never worked specifically on the AP1000. I obtained the information referred to here from the materials made available to the public on the NRC's website.*

*ACRS members have been given two letters laying out detailed reasoning and technical references for the two issues I raise; my oral remarks will be brief summaries.*




In the midst of the severe heat waves our nation has been experiencing this summer, there have been news reports of road and bridge surface temperatures exceeding 140 degrees F, of airports that have closed because their concrete runways buckled[1], of concrete roads, ramps, and bridges that have buckled[2] [3] [4] [5], and of water pipes across the US that have burst open from thermal loads[6] . These effects remind us *of the powerful effects of the sun* because they are effects that are not due to air temperatures alone, but to the effects of sunlight heating up surfaces,

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[1] "Tim McClung with the Iowa Department of Transportation's Office of Aviation said at least two airports have reported buckling concrete runways, shutting down both." http://journalstar.com/news/state-and-regional/nebraska/article_c4dca640-2d40-52eb-b3e8-e48a84962414.html#ixzz1V6JhQXaW viewed on August 15, 2011.

[2] http://www.myfoxdfw.com/dpp/traffic/080311-heat-causes-roads-to-buckle. The high temperatures were a surprise to many, and are known only because of sensors put in for another reason: "Lege said the NTTA roadway sensors were originally installed to detect problems in freezing temperatures. She never imagined they'd record such high measurements." Read more on myFOXdfw.com: http://www.myfoxdfw.com/dpp/traffic/080311-heat-causes-roads-to-buckle#ixzz1V6IQGmua viewed on August 15, 2011.

[3] http://www.youtube.com/watch?v=J8RIcnC6kcA

[4] "Excessive heat also will cause concrete to expand, which can lead to buckling along roads, bridges, sidewalks and other thoroughfares made of the material." http://www.constructionequipmentguide.com/Midwest-Roads-and-Rails-Buckle-Under-Intense-Heat/16696/

[5] There are far too many events of concrete roads, bridges, and other structures buckling in the heat this year (summer 2011) to list. They have occurred across the nation, from the southern regions in Texas to the northern ones in Wisconsin, and lots of places in between. Articles reporting these events can easily be located using a search engine for items in the "news" category, and limiting the search to the past few months.

[6] http://www.cnn.com/2011/US/08/13/water.infrastructure/index.html

i.e, of solar thermal radiation.  There is a heat influx due to the sun that is not captured by considering air temperatures alone.  Correct engineering design and analysis must recognize that.

The problem is that the AP1000 analysis seems to have forgotten about the sun.

Today I want to talk about how this error -- this false assumption -- affected rev 19 calculations.  The error must be corrected, and today I will try to explain why.

## Forgetting About the Sun Issue #1: Forgetting about Heat of Solar Radiation on the Exterior Surface of the Concrete Shield Building

- Rev 19 analyses per Appendix H (as of June 30th, 2011):
  - falsely assumes that range of exterior surface temps of concrete shield building is same as range of the outdoor ambient air temperatures.
  - analyses and conclusions incorrect because temp of concrete shield building exterior surface can be much hotter than ambient due to solar radiation, and much cooler than ambient due to radiation to night sky.
  - variety of calcs should be affected:  calculation of peak containment pressure,  thermal loads, stresses & displacements of concrete shield building,  concrete max temperature, PCS water tank temperature, etc.

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## "Forgetting about the sun Issue #1

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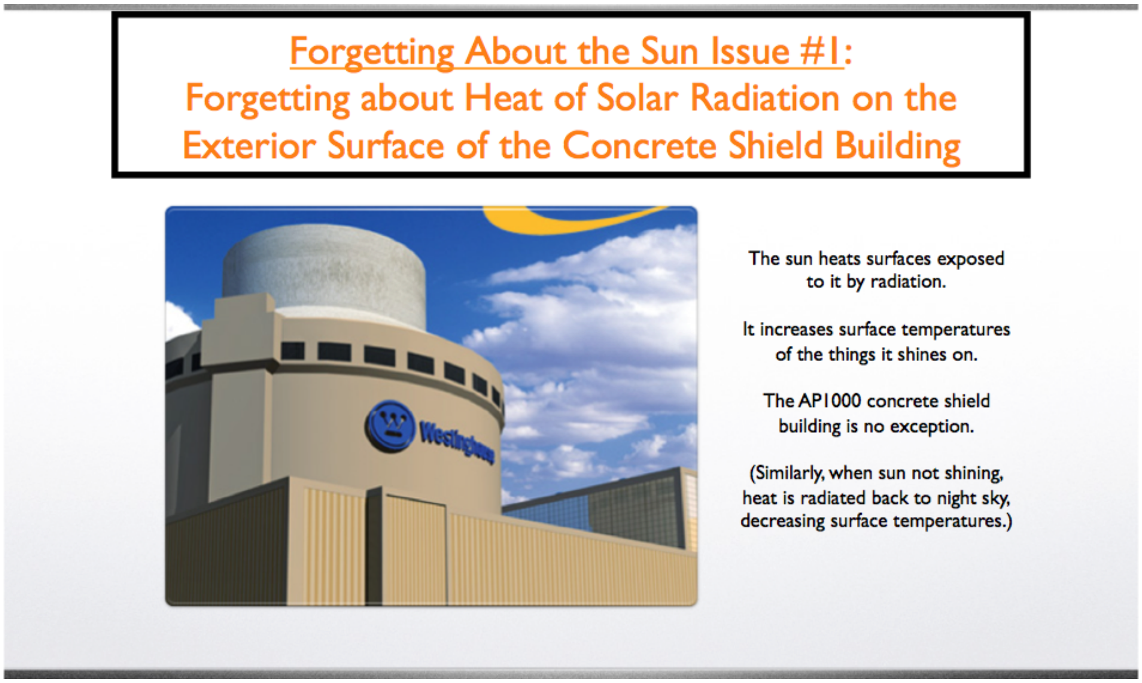
-- The calculations of thermal loads on the shield building in the rev 19 documentation submitted to the NRC reveal that a false assumption had to have been employed, since the maximum temperature used in the calculations is never higher than the maximum ambient air temperature, nor lower than the minimum ambient air temperature. Whereas, we *know* that the building exterior surface can get hotter than the ambient air due to solar radiation -- *much* hotter -- and that it can get much cooler than the ambient air due to radiation to the night sky.

-- It is important to understand the significance of this error; I worry that the NRC staff does not understand that **many** calculations are affected by this **false assumption**, not just the concrete temperatures. The safety significance is the role of the heat input from the sun -- it is a flux, a heat RATE, into the reactor building, not merely an initial temperature condition. I've listed some affected calculations on the slide; notice that peak containment pressure is one of them. Heat transfer to and from the reactor building is a very important factor in the safety analysis of this passive plant. Throughout all of the AP1000 supporting technical documents I have seen, I have not once seen the radiative heat fluxes from the sun or to the night sky depicted. They are important to the conclusions of the safety evaluation of the effectiveness of the Passive Containment Cooling System in removing decay heat in an accident situation. This must be corrected.




Here is the applicant's sketch of an AP1000 on a sunny day. There is a nuclear fission reactor inside the shield building. There is also the nuclear fusion reactor 92 million miles away. Both are sources of heat input.

The error I am pointing out is a simple matter of basic physics: The sun shining on the AP1000 reactor building will add heat to it by the mechanism of thermal radiation; by the same mechanism of thermal radiation working in the opposite direction, the AP1000 reactor building will lose heat to the night sky. These thermal transfers are **in addition to** heat transfer due to convection and conduction. It is that simple. Yet this simple fact seems not to be reflected in the AP1000 calculations. It seems to be missing from analyses sketches setting up heat balances that are used to derive equations or upon which reasoning of all sorts, including reasoning from experimental test results, is based.

It leads one to ask: is it just the understanding of the effect of solar radiation on the shield building that is affected by the error of forgetting about the sun? The answer is no. That leads to issue #2.

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**"Forgetting about the sun Issue #2:**

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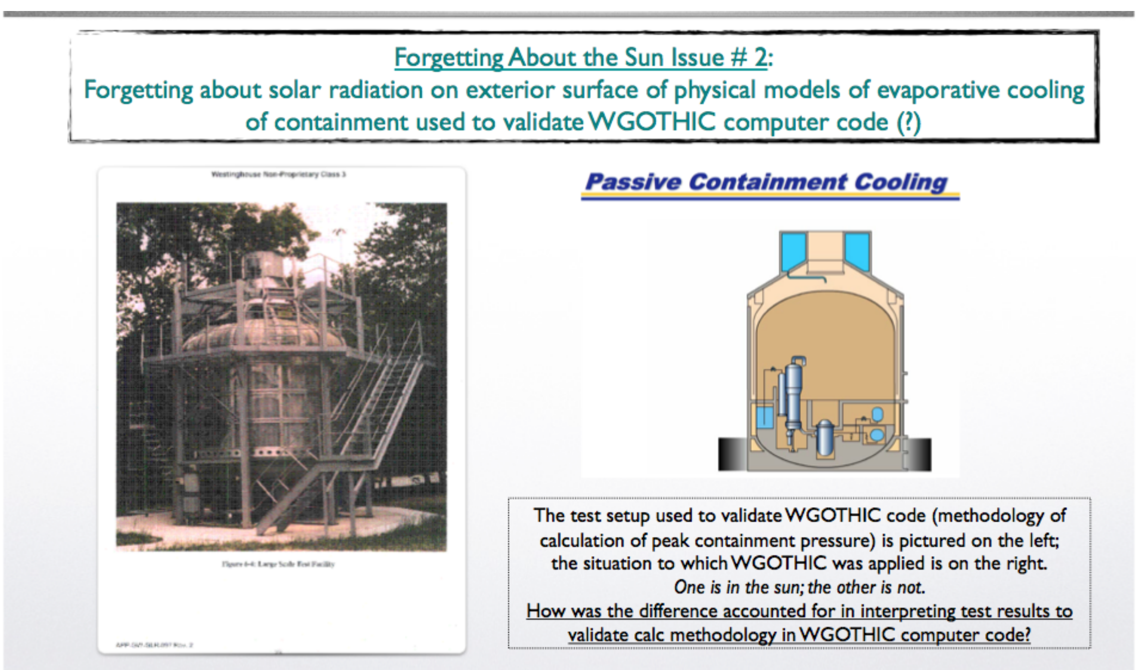
Forgetting About the Sun Issue # 2:
Forgetting about solar radiation on exterior surface of physical models of evaporative cooling of containment used to validate WGOTHIC computer code (?)

- Calculations of peak containment pressure, which depends upon evaporative cooling of the steel containment dome wetted by Passive Containment Cooling System flow, were redone for AP1000 Rev. 19.
- AP1000 Rev 19 calcs of peak containment pressure used WGOTHIC computer code; WGOTHIC was validated by comparing its calculated results to experimental ones for a physical model test in which dome was wetted.
- But test model was out in the sun (?), so solar radiation would have aided evaporation -- how did the validation of WGOTHIC account for that? If effect of the sun not accounted for, the validation of WGOTHIC for analyses of Passive Containment Cooling System effectiveness in accident mitigation is not valid. *Did they remember to account for the sun or did they not? If so, how?*

According to the applicant's submittal of the rev 19 changes, the peak containment pressure, which is extremely important to public safety, was calculated using the WGOTHIC computer code. Keeping peak containment pressure sufficiently low to protect the public relies upon evaporative cooling of the steel containment, which is wetted by flow from the Passive Containment Cooling System. The steel containment is located *inside* the concrete shield building.

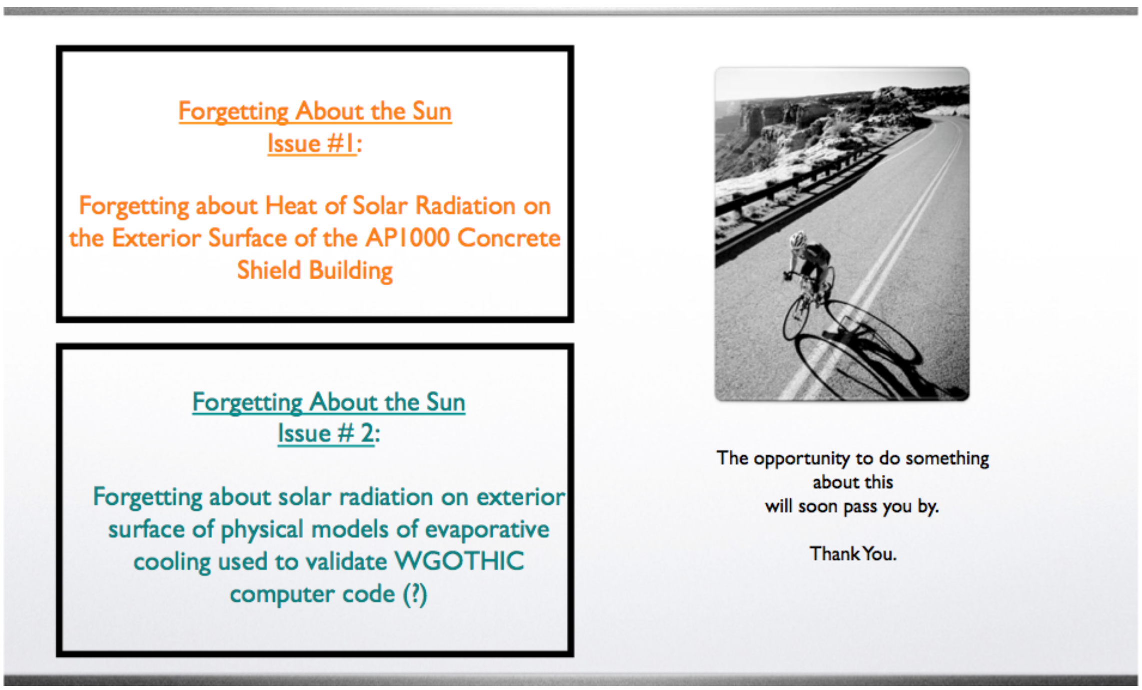
As explained in the rev 19 submittal, WGOTHIC was validated using a physical model test in which the dome was wetted -- but this experimental test appears to have been run outdoors, in the sun.  I could find no discussion of, nor any recognition of, the significance of this difference between the experimental setup and the situation for which the calculations were made.

The side by side pictures on this slide may help make the point clear:  "The test setup used to validate the applicant's WGOTHIC computer code (i.e., the methodology of calculation of evaporative losses and of peak containment pressure) is pictured on the left; the situation for which WGOTHIC was used for calculations is on the right.




One is in the sun -- the other is not.  Evaporation in the test model will be *aided by* the sun.  Since WGOTHIC was validated using this model, the tendency may be for

WGOTHIC to *overestimate* evaporative losses and thereby to *underestimate* peak containment pressure. What, if anything, was done to account for this? From photographs the applicant submitted, it appears that the small-scale test facility was out in the sun, too, so agreement between those two tests doesn't aid us in answering this question. The same questions apply to analyses by the NRC staff using the NRC's own computer codes.




These two issues are important. One is important to the structural integrity of the shield building, which supports the water tank for the passive containment cooling system. Both are important for predicting the heat removal capability of the passive containment cooling system to remove decay heat after an accident.

More hangs on keeping the containment cooled in this passive plant design than on other PWRs: I remind you that there is no core catcher on the AP1000. I remind you that, unlike other PWRs, the concrete shield building does not function as an airtight secondary containment on the AP1000, backing up the steel containment. The containment integrity plays a much more important role in ensuring public safety, so public safety depends heavily on the passive containment cooling system being able to remove decay heat. I have just explained to you that the analysis and interpretation of test results upon which claims of its ability to do so are predicated are incorrect.

You have the opportunity to do something about what is certainly a serious omission, and what might be a error that has serious consequences.

Here is why it is so important that you do so now: the only check and balance left at this point in the 10CFR52 process are the ITAACS[7] and the ITAACS -- the criteria the system capabilities have to meet to be deemed acceptable, such as flowrates --- were developed based on the same false assumptions. The ITAAC for the PCS heat removal capability is stated just in terms of providing a certain flowrate, not in terms of demonstrating actual heat removal capability in a realistic environmental context. The ITAACs will NOT provide a check on this error, and so won't necessarily indicate whether or not this omission meant that the safety systems won't be able to remove a sufficient amount of decay heat using the passive containment cooling system. Neither the structural testing of component capabilities nor the ITAACS are designed to let you know that this kind of error -- forgetting about the sun --- has serious safety consequences.

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[7] ITAACS stands for Inspection, tests, analysis and acceptance criteria. The rule governing how this only remaining step after Design Certification and COL issuance, prior to plant operation is still undergoing change: http://www.federalregister.gov/articles/2011/05/13/2011-11678/draft-regulatory-guide-guidance-for-itaac-closure

You don't want to find out that this serious omission does in fact have serious consequences via a serious accident. I don't, at least. I urge this committee to use whatever means it has to try and get this error corrected now. This might really be the last opportunity for anyone to do so.

Thank you.

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July 7, 2011

Billy Gleaves, Sr Project Manager
AP1000 Projects Branch 2
Division of New Reactor Licensing
Office of New Reactors
Nuclear Regulatory Commission
Rockville, Maryland 20852

<u>References:</u>

1. Memorandum from Billy Gleaves, Sr Project Manager, AP1000 Project Branch 2, NRO/DNRL to Eileen McKenna, Chief, AP1000 Projects Branch 2, NRO/DNRL dated June 21, 2011. "PUBLIC MEETING WITH WESTINGHOUSE ELECTRIC COMPANY ON THE AP1000 DESIGN CERTIFICATION – SHIELD BUILDING ROOF PASSIVE CONTAINMENT COOLING WATER STORAGE TANK ANALYSIS"

2. Materials (slides) prepared by Westinghouse for subject meeting, entitled "AP1000 Shield Building Roof PCS Water Storage Tank - June 30, 2011" (included in pdf format as Attachment I)

3. APPENDIX 3H "AUXILIARY AND SHIELD BUILDING CRITICAL SECTIONS", AP1000 Design Control Document, Revision 19, Westinghouse Electric Corporation. (http://pbadupws.nrc.gov/docs/ML1117/ML11171A441.pdf)

4. "Guide for Estimating Differences in Building Heating and Cooling Energy Due to Changes in Reflectance of a Low-Sloped Roof", ORNL-6527, by E. I. Griggs, T. R. Sharp, and J. M. MacDonald, for Oak Ridge National Laboratory, August 1989. ( http://epminst.us/otherEBER/ornl6527.pdf )

5. "A Computer Model to Predict the Surface Temperature and Time-of-Wetness of Concrete Pavements and Bridge Decks", by Dale P. Bentz, August 2000. National Institute of Standards and Technology Report No. NISTIR 6551 (http://fire.nist.gov/bfrlpubs/build00/PDF/b00037.pdf )

SUBJECT: **Thermal loads and effects due to radiative heating and cooling of AP1000 shield building exterior surface, which are in addition to all thermal loads and effects due to ambient air temperature.**
(Written question submitted in regard to: PUBLIC MEETING WITH WESTINGHOUSE ELECTRIC COMPANY ON THE AP1000 DESIGN CERTIFICATION – SHIELD BUILDING ROOF PASSIVE CONTAINMENT COOLING WATER STORAGE TANK ANALYSIS on June 30, 2011)

I. Background

II. Technical Discussion

III. Relevance to AP1000 meeting topic of including thermal loads

IV. Question addressed to NRC by means of this letter

1. Background

In the subject meeting held on the morning of 30 June 2011, the topic of thermal loads on the AP1000 shield building was discussed, in that the presentation stated that the AP1000 DCD had been revised (from rev 18 to rev 19) to include thermal loads in some load combinations used in the shield building roof analysis. I raised a question as to the variety of thermal loads and effects that the term "thermal loads" was meant to include. The purpose of this letter is to follow up on *one aspect* of that question -- how surface radiative gains and losses were computed -- by providing more detail. In doing so, I have made a special effort to cite references from sources that are both readily available on the internet and whose authority I expect all involved would accept without question.

Slides for the meeting were provided in pdf format, which are extremely helpful (included in Attachment 1, for convenience). On slide 8, the first bullet notes that in its review of rev 18, the NRC had **". . . requested Westinghouse to provide additional justification to demonstrate that the load combination requirements for inclusion of thermal loads were satisfied."** During the meeting, it was stated that details about the thermal loads considered could be found in Appendices 3G and 3H of rev 19 of the AP1000 DCD.

2. Technical Discussion

Referring to the table 3H.5-1 "NUCLEAR ISLAND: DESIGN TEMPERATURES FOR THERMAL GRADIENT" On page 3H-24 of Appendix 3H of rev 19 of the AP1000 DCD (Ref, 3, downloaded from http://pbadupws.nrc.gov/docs/ML1117/ML11171A441.pdf on 6 July 2011), it can be seen immediately that the outside surface temperatures considered never exceed the maximum ambient air temperature and are never less than the minimum ambient air temperature. **This indicates that the analyses and/or calculations of roof and wall surface temperatures are incorrect.** Here is why: Thermal inputs to and thermal losses from a roof located outdoors will occur due to all three heat transfer processes: convection, conduction, and radiation. Temperature effects arise *not only* from the fact that the ambient air is at a certain temperature, but also from the fact that there is radiative heating of the surface of a roof from the sun during the day and radiative losses from the surface of the roof to the sky at night.

In response to this point, which I brought up at the meeting, someone in the meeting mentioned that "diurnal changes" were included. Now, it is true that the diurnal changes *in the ambient temperature* are, ultimately, due to radiative gains and losses of the *earth's* surface. However, these diurnal changes in *ambient air* *temperature* do not include the changes in *roof surface temperatures* due to the radiative gains and losses. The topic of radiative heating and cooling of *exterior surfaces of building and structures* does not seem to be mentioned in the sections of the AP1000 DCD relevant to the analysis discussed in the meeting of 30 June 2011. Nor did the participants in the discussion from industry or the NRC during the public meeting seem to recognize that this deficiency or error in the analysis presented in rev 19 of the DCD existed.

Another comment made at the meeting was that solar radiation would "help." I assume the speaker meant that increased temperatures would result in reduced peak containment pressure. I understand that point, which may well be true, but even if it is true, it does not mean that shield building radiative gains and losses can be neglected, for two reasons: (i) radiative losses can cause the minimum temperature to be lower than the ambient air temperature, which, by the same token, might *increase* peak containment pressure, and (ii) there are other design considerations, such as limits due to structural effects, that need to be considered besides the limit on peak containment pressure. The additional temperature rise is not of the magnitude that it can be dismissed as insignificant. Its magnitude depends on the features of the surface, but it could easily be 20 or 30 degrees F *additional* temperature rise *above* the ambient air temperature for a concretized surface in a southern latitude.

The role of radiative gains and losses from building surfaces is explained more precisely in many basic references on roof engineering; to cite a paper that specifically discusses the situation of an *external concrete roof surface exposed to the outside atmosphere* from an organization whose technical authority on this matter I trust you will agree to recognize, I refer to a report from Oak Ridge National Laboratories' Energy Division "Guide for Estimating Differences in Building Heating and Cooling Energy Due to Changes in Solar Reflectance of a Low-Sloped Roof" (ORNL-6257, Ref. 4 ). On page 13, we find the following comments that I hope will make the point that roof surfaces can get hotter than the ambient air during the day, and cooler than the ambient air at night:

> " A roof surface radiates infared energy to the sky and the surroundings. During the day incident solar energy more than makes up for this infared radiation, and a roof can be heated well above the ambient air temperature. During the evening, however, with no solar radiation, the loss of radiant energy to the sky can cool a roof below the ambient air temperature. Evening surface temperatures 20 [degrees] F below air temperature on clear, low humidity nights are common for well insulated roofs. " (p. 13, ref. 4 )

From another source I trust you will accept, I cite the NIST report "A Computer Model to Predict the Surface Temperature and Time-of-Wetness of Concrete Pavement and Bridge Decks" (Section 3.1 of ref. 5 ):

> "[. . .] during the day, the concrete surface temperature generally rises above the ambient temperature due to the incoming solar radiation. At night, the concrete temperature falls due to

radiation from the concrete surface to the sky, sometimes falling below the ambient air temperature and occasionally falling below the dewpoint. "  (ref. 5, p. 5)

3.  Relevance to AP1000 meeting topic of including thermal loads

In the June 30, 2011 morning meeting, the NRC staff stated that they are still evaluating the information submitted in rev 19 of the AP1000 DCD.  As explained above, the thermal loads reported in rev 19 cannot be correct.  The NRC staff should examine the methodology and calculations of temperatures and thermal loads provided in the DCD in light of the above points, all of which are a matter of very basic science and not a matter of opinion, convention, or interpretation.

These additional temperature changes will *add* to the *thermal gradients* currently listed in rev 19 of the AP1000 DCD, which may add to the stresses and thermal loads.  Since the correct temperature range is larger at *both* ends than the values reported in rev 19 of the DCD (the correct lows are lower and the correct highs are higher) the effect on the calculation of peak containment pressure cannot be dismissed by saying it "will help"; the corrected value for calculated peak containment pressure could *increase*, as well.

There may be other design limits and licensing commitments that need to be reviewed, to see how calculated magnitudes are affected by using the corrected temperatures and thermal loads.  One limit mentioned in the meeting was thermal stresses and loads due to any differences in coefficients of thermal expansion between different materials; perhaps whether material properties at extreme temperatures using corrected values are the same as the values used needs to be examined, etc.  The NRC staff doing detailed reviews are in a better position to identify these than I am; I note only that of course any other ones affected should be identified and reviewed as well.

4.  Question addressed to the NRC by means of this letter

**Question:  From the considerations in this letter, it is clear that the values of the temperatures and thermal gradients reported in rev 19 of the DCD cannot be correct.  I have indicated some corrections that need to be made to the analyses.  These considerations also raise a larger question as to whether any of the other analyses and rationales for the AP1000 safety and nonsafety analysis that involved exterior building temperatures directly or indirectly used an inappropriate methodology.  Can you please inform me as to how the NRC plans to handle the error identified herein?**

Sincerely,

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