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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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576TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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FRIDAY,

OCTOBER 8, 2010

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ROCKVILLE, MARYLAND

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The Advisory Committee convened in Room T2B1 at the Nuclear Regulatory Commission, Two White Flint North, 11545 Rockville Pike, at 8:30 a.m., DR. SAID ABDEL-KHALIK, Chairman, presiding.

MEMBERS PRESENT:

SAID ABDEL-KHALIK, Chair

J. SAM ARMIJO, Vice Chair

SANJOY BANERJEE

DENNIS C. BLEY

MARIO V. BONACA

CHARLES H. BROWN, JR.

HAROLD B. RAY

JOY REMPE

MICHAEL T. RYAN

MEMBERS PRESENT (Continued):

WILLIAM J. SHACK

JOHN D. SIEBER

JOHN W. STETKAR, Member-at-Large

ACRS STAFF PRESENT:

EDWIN M. HACKETT, Executive Director

CHRISTINA ANTONESCU, Designated Federal Official

KENT HOWARD, Designated Federal Official

HANSRAJ ASHAR

NORBERT CARTE

DARRELL DUNN

PATRICK HILAND

LOIS JAMES

PAUL KLEIN

G. EDWARD MILLER

ALSO PRESENT:

GORDON CLEFTON, NEI

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

(8:29 a.m.)

7) OPENING REMARKS BY THE ACRS CHAIRMAN

CHAIRMAN ABDEL-KHALIK: The meeting will now come to order. This is the second day of the 576th meeting of the Advisory Committee on Reactor Safeguards.

During today's meeting, the Committee will consider the following: digital I&C interim staff guidance on licensing process, ISG-6; two, staff efforts to address containment liner corrosion; three, future ACRS activities/report of the Planning and Procedures Subcommittee; four, reconciliation of ACRS comments and recommendations; five, assessment of the quality of selected NRC research projects; six, preparation for a meeting with the Commission on November 5th, 2010; and, seven, preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Ms. Christina Antonescu is the designated federal official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members

of the public regarding today's sessions. 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 discussions.

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.

At this point, we will proceed to the first item on today's agenda: digital I&C interim staff guidance on licensing process. And Mr. Brown will lead us through this discussion. Charlie?

8) DIGITAL I&C INTERIM STAFF GUIDANCE ON LICENSING PROCESS (ISG-6)

8.1) REMARKS BY THE SUBCOMMITTEE CHAIRMAN

MEMBER BROWN: I do. This morning the staff will be presenting to us the latest revision, rev. 50, to let you know how late this revision is, --

(Laughter.)

MEMBER BROWN: -- to ISG-6, digital I&C, ISG-06, the licensing process, which is kind of a compendium of all the things that need to be done in order to get through the licensing process for

operating plants upgrading to digital instrumentation and control systems.

Our subcommittee reviewed this particular revision on September 8th, 2010. Prior to that review -- we had reviewed this back in August of 2009. Subsequent -- that was roughly revision 4, 5, 6, whatever it is. Subsequent to that, there has been what I would call substantial and far-reaching revisions, the result of numerous public meetings and extensive industry comment.

We had a wide-ranging discussion of a number of issues during the meeting, which the staff will be highlighting in their presentation. And, with that, I will ask the staff for your remarks, you or Lois?

MS. JAMES: I have the introduction.

MEMBER BROWN: Lois?

MS. JAMES: Yes.

MEMBER BROWN: Okay. I'll turn it over to Lois, then, for her introductory remarks and to proceed.

MS. JAMES: Thank you.

8.2) BRIEFING BY AND DISCUSSIONS WITH REPRESENTATIVES OF THE NRC STAFF AND NEI

MS. JAMES: Good morning. My name is Lois

James. And I am the licensing lead for task working group number 6 on digital I&C licensing process.

With me at the table are Ed Miller -- Ed Miller is a project manager from the Division of Operating Reactor Licensing in NRR. Next to Ed is Norbert Carte. He's a senior I&C engineer with Division of Engineering.

Over on the side table, we have Bill Kemper, the Chief of the Electrical Engineering Branch; Steve Arndt, who is our senior-level adviser, NDE; and Pat Hiland, the Director of the Division of Engineering.

As just stated, the purpose of this meeting is to brief the full Committee on the current version of the interim staff guidance for the licensing process for digital I&C activities under part 50.

Before I begin the presentation, I would like to offer sincere thanks to this Committee and the Subcommittee. The Committee members and staff have spent a lot of time reading and working with us on this product. We are proud of the efforts that we have made and the staff and the ACRS have provided with us.

The task working group number 6 was tasked

with developing interim staff guidance intended to outline and describe the requirement and guidance for submitting, processing, and documenting digital I&C licensing actions. Our hope is by providing such detail, that the stability and repeatability of the digital I&C licensing process will be improved.

I would like to say at this point that the working group has worked long and hard and has interacted with several headquarters offices and regional offices. We have held numerous public meetings with industry, NEI, and the public. And we are very pleased and proud to present to you the draft ISG.

Next slide. The agenda for today's presentation is as follows. The introduction will address the purpose of the ISG, stakeholder involvement, and the significant changes to the guidance since we last came to the Committee.

The next will be the licensing process. This will discuss the process flowchart and the tiers of review, explain where we are taking advantage of the flexibility in the process.

The next topic we'll address is the ACRS comments. This is structured to address comments we received previously from the full Committee and then

in detail the comments we received last month from the Subcommittee.

We are looking forward to your thoughts and your input via a letter. And we hope to receive your support in that letter for issuance of this guidance.

With that, I will turn the meeting over to Ed Miller.

MR. MILLER: Great. Thank you, Lois.

Again, thank you for having us here today. The purpose of ISG-6, as Lois alluded to, is to really describe the part 50 licensing process for a digital I&C upgrade. In doing this, we're hopeful that both providing consistency in what we get from licensees and consistency in how we review that as the staff, you know, really, what we wanted to lay out in this document is what do we need to come to that conclusion that there is reasonable assurance that this system will perform the functions that it's supposed to when it's supposed to.

As an additional benefit, the ISG-6 is supposed to serve as a knowledge management tool. You know, we have already had a few of our senior I&C reviewers retire. We are expecting to see more of that occur in the future.

So one of the big benefits of this is that we can put down their thoughts on paper before they leave and provide those to the new staff as they come in, allowing them to come up to speed, learn how to do these reviews, and continue that knowledge forward.

In developing ISG-6, we really tried to capture the lessons learned from previous reviews, you know, Oconee, Wolf Creek, things like that. And, going forward, we plan to inform it as well, providing any revisions to the ISG as appropriate from those.

Where we started with ISG-6 was RS-001, which is a review standard that was developed previously for extended power uprates. It has proven pretty successful. So we tried to use that as a model where it breaks down the different review areas for an EPU. We looked at the different review areas for digital I&C upgrade and tried to do the same mapping back and forth between them.

And, too, I would like to point out that ISG-6 is really meant to be the fast lane approach. As with how we regulate in any situation, a licensee is more than entitled to come in with whatever approach they want to do, but we tried to lay out the one that we think would be the easiest, provide the fastest path to getting a license amendment to

implement the form.

Next slide. So just a little bit of past history on what we have done. Over about the last two years, we have had approximately nine public meetings.

NEI has served as a wonderful tool for helping focus the comments from all the different stakeholders. Gordon Clefton is back there. I think he has some comments, too, later, has been instrumental in helping us get through that.

As you can see here, I mean, we had over 200 comments come in. And Norbert has spent a tremendous amount of time going through those. I think he can incorporate it. And I think there is a lot of benefit we got from those, too.

One of the things that we noticed is a lot of times we had a comment. And we would sit there and say, "Well, that is exactly what we meant to say with something, but it's not what we actually had on paper or it wasn't clear with that. And it really serves as an excellent tool for helping us get through that and make sure that what we meant to say is what we actually put down on paper with this for being clear.

And, again, going back to the objective of clarity in the process and regulatory process, a couple of things that came up during the commenting

period, though, that we weren't able to implement with the ISG-6, most notably because we aren't changing the review we do with the ISG-6. We're just clarifying what we do with the ISG.

So a couple of things that we put in parking lots. And what we're doing is we're retaining those for future updates to things like the SRP, where we can implement those changes, are use of license conditions for completing the review. You know, where do we stop the review or where does the licensing process stop and where does the inspection process begin?

Another thing, too, is portal technology, which we will go into in a little bit more depth later, but, you know, we did acknowledge in the ISG that portal technology; i.e., online document access, could be useful. Also in the future, we'll be exploring how to use that better.

Next slide. So here is a quick history dating back to April of '09 with our interactions with the Committee. Most recently, on September 8th, we did present to the Subcommittee. And you will see a major portion of the presentation today is our address of all the comments that we received from that meeting as well.

The next slide. So I would like to turn it over now to Norbert to just briefly talk about some of the changes that have occurred since the last full Committee presentation.

MR. CARTE: Right. I would like to back up just briefly to the previous slide. So the last full Committee was in April 2nd of 2009 as well. And that Committee issued a recommendation that the ISG should not be issued until sections C and D are revised.

We subsequently met with the Subcommittee on August 21st and discussed the ISG. At that point, sections C and D had been partially revised. And it was emphasized to us that we should focus on independence, determinism, complexity, defense-in-depth, and diversity.

And, then, finally, we had the meeting on September 8th, which provided some of the same guidance that we received on August 21st.

We have listened to that guidance, and we have made some changes and are making some changes to the guidance. But, more specifically, since August '09, we have added three new enclosures: a sample safety evaluation, a license amendment table of contents, as well as a glossary.

And the reason for the glossary is we find sometimes we use the same terms with different meanings when we are trying to flesh out clear definitions when that occurs.

We also did an explicit cross-reference between enclosure B and the body of the ISG. So enclosure B is the succinct listing or naming of the information that we are seeking. In the body of the ISG is a detailed explanation of that.

We found that a lot of people go straight to enclosure B and say, "Well, what do you mean by that?" And this gets into the definitions. So we provided references back to the body, say, "That is what we meant."

In addition, we added a table of recommended inspection items. That was, in part, to allow to provide direction to the regional staff or suggestions to the regional staff but also, in part, to define what we were not looking at in the ISG. We said, "This is an inspection item." And we'll discuss that a little bit more later.

One of the things that we learned from the Oconee application was that we didn't look at all the material that we saw in the SRP Branch Technical Position 7-14, which is focused on software. The

software installation plan, the software operations plan, the software maintenance plan, and the software training plan were moved to regional inspection items because they're controlled by the regional oversight program, reactor oversight program. also, since 2009, we added significant detail to the body of the ISG.

MR. MILLER: Okay. Before we get into addressing the comments, I did want to do a quick recap just of the process that we described with the ISG-6.

We have truncated this a little bit to allow for more comment discussion, but most of you have seen the flowchart we have here before. We didn't change or add anything new to the licensing process that we currently have, but we did find a few creative ways to augment the way we do the reviews.

Most notably is the introduction of this phased concept. You know, the phase one and phase two are really the meat of what we normally do in a licensing review, but we added in this phase zero, which is pre-meetings, where we engage the licensee before they have even submitted, before they have finished drafting their amendment request.

Now, that in and of itself is nothing. We do that pretty frequently for large licensing reviews.

But what we do is we introduce a lot of rigor into the documentation of what comes out of those meetings. So there's good direction in the ISG-6 about how to document what was said, what was agreed to, what was understood from the meeting in the hopes that that feeds directly into both the acceptance review that we performed upon the receipt of the LAR, ensuring that we get what we thought we were going to get as an application, and the licensee has an expectation that we understood what they were planning on submitting as well.

You know, just the feedback we have gotten from the industry, too, has been very embracing of this concept. There have already been, I believe, two or three -- there might be two phase zero meetings that happened for the planned pilot plant for the use of ISG-6. They have already started engaging in these. We have had the documentation out of these. So we're really hoping to see a lot of benefit from that.

So transitioning from phase zero into phase one and phase two, this is where we do the traditional licensing review of the application. The reason we had the break point is we recognized that for a digital upgrade, there just is some information

that the licensing will not be able to provide upon initial submitting of the LAR, which is a bit out of round for our normal processes.

But since it has to occur here, we wanted to acknowledge that, okay, it's going to happen. And we'll break it into two phases. The first one is when the amendment request comes in. The second one is when they submit the remainder of the information necessary for the staff's review.

And then phase three is really more acknowledging that there is also inspection and regional activities that occur after issuance of the license amendment.

Next slide. Another concept we introduced with the ISG is that of tiers of review. We broke down into three different categories where we could bin any amendment request that comes in with the hope that if you know what tier you're in, you have a good expectation of the amount of effort that it is going to take for the staff to get through the review.

Tier 1 is the lowest level of effort expected. This is where there is a previously approved topical report or platform out there that the licensee is proposing to use with no deviations from what was previously approved. That is, they're not

changing the platform to be implemented. And they're not changing the situation in which it is going to be implemented; i.e., the envelope we defined by the previous approval.

Very close to that was Diablo Canyon. And they were coming in -- Norbert, do you know the platform they're coming in for?

MR. CARTE: Diablo Canyon is expected to come in in May of 2011. They're using two platforms based on two different previously approved -- well, which will be based on approved topical reports.

They're using the Tricon. And that platform is being updated as well as the ALS platform, which was recently submitted. That was the platform that was used on Wolf Creek.

It did not have a topical report. They have submitted a topical report. And so they will use both the Tricon and the ALS platforms.

MR. MILLER: And that is a very good example, too, there that shows how -- you know, it doesn't have to just be a topical report, but if we previously define some approval envelope, a licensee can come in. And, really, the task there is to demonstrate to us how they fit within what was previously approved versus us having to do a new

review from start.

Transitioning from tier 1, you go into tier 2.

MEMBER BROWN: The difference between a topical report -- and I'm trying to get a little bit of a definition here between the two and a system. You talk about platforms. A platform is a platform. It's a CPU card, relative, like a Common Q, like the NUMAC, like whatever, whatever, the other one you just mentioned.

That's just a computing box. The architecture, the system architecture, total system architecture, and how you interface that train to train, division to division is not necessarily defined wholly by the platform.

You probably understand what I am trying to get at here. I am not disagreeing with the approach. Don't take my comment that way. I'm just trying to get an understanding. I guess I didn't ask that at the Subcommittee meeting.

So if you want to elaborate?

MR. CARTE: Right. One thing that is interesting about a topical report is it's not linked directly to a licensing action. And it can be of any scope that the applicant chooses to define. So

sometimes we have licensing topical reports that are specific to one component, like a priority module that's used to prioritize decisions made for different safety systems.

Sometimes we have a topical report that defines maybe what would be called an application framework. So that is a set of hardware, associated software, as well as developmental tools that will be used to build an application.

And sometimes a topical report also includes a system description. And the example would be the Common Q topical report. The original topical report did include appendices that describe system applications based on the platform proposed. So the appendices included a post-accident monitoring system, a core protection calculator system, a reactor protection system, a plant protection system.

So far Westinghouse has built a core protection calculator and used that at Palo Verde, based, in part, on the appendices in the topical report. Also, under review currently is another application using the post-accident monitoring system.

So the topical report can span the whole gamut. And it's what they choose to span.

MEMBER BROWN: What I am trying to get to

is let me just use what you are talking about. The Common Q topical report may do all of that, but, yet, for one of the applications, which we are reviewing, one of the other plant design certs, there's another topical report, which has the entire architecture defined, theoretically. And the Common Q is just a reference within that for the actual computing platform.

So the architecture is different. And I'm trying to get a differentiation from you in terms of tier 1 versus tier 2.

MR. MILLER: I think that --

MEMBER BROWN: Where is the dividing point? If somebody came to me and said, "We're going to use the Common Q topical report," I'd say, "You're not tier 1. You're not necessarily tier 2, but you're not tier 3. You're somewhere in between 2 and 3."

MR. MILLER: Right. And when we came up with the tiers, we didn't plan to actually assign somebody a tier number when they come in for review so much as use them as a general guide. You know, if somebody is a tier 1.5 or something, they know they're going to be somewhere in between the effort of a 1 and a 2.

Like your question got to, what if they're

using a previously approved topical report but there are still additional things they have to describe to make that implementation work? Well, yes. They're going to start to transition a little bit more towards the tier 2 review effort level.

So, you know, whatever part of the review we can do as confirmatory tends to be a much lower level of effort on the staff's part versus when we actually have to do the full initial review.

MEMBER BROWN: If the licensee reads the ISG and he sees the words, which say, "I am using a previously approved system and/or platform" and then you talk about deviations," his expectations -- again, I'm stepping above the details here -- of what he's going to -- and I presume you're going to address that, but, I mean, if he walks in the door thinking, "Hey, this is kind of a piece of cake" because here's the box, it's all been approved, don't talk to me anymore, and you say, "Ooh. Hold on," you've got some other issues to deal with.

MR. MILLER: Yes.

MEMBER BROWN: You don't say that. You don't express that in the description of the tier 1. The nuances aren't discussed. My memory says that. Okay? I don't have it in front of me.

MR. MILLER: That's excellent feedback. I think we should be sure that our intended use of the tiers is very clear in the document. Initially during the phase zero meetings, too, we would expect that topic to come. And that way, you know, again, so they're not caught cold when they come in the door as to where the --

MEMBER BROWN: Yes. And I didn't see that. This is a kind of a new subject, relatively new to our process, relative to our past --

MR. MILLER: Yes.

MEMBER BROWN: Just somehow a description to say that it's not cut and dried. Now, if they come in and, for instance, said, "Hey, I'm going to use the -- I'm not going to say the particular project, a whole project's architecture," we're going to buy all of the same stuff and put it in," --

MR. MILLER: Right.

MEMBER BROWN: -- that becomes pretty straightforward so that you really have a more abbreviated type of review. I'm just trying to make a differentiation that there might ought to be some discussion on the table relative to -- when I talk about piece parts, systems get you one place. Piece parts get you another place. And there's a mix in

between.

MR. MILLER: Yes, yes.

MEMBER BROWN: That's the only thought process.

MR. MILLER: Yes because there are really a lot of permutations as to how somebody could come in with that.

MEMBER BROWN: Okay.

MR. MILLER: So we'll make it clear as to what we were thinking with the tiers or ensure that we are clear.

MEMBER BROWN: Jack?

MEMBER SIEBER: Actually, this is more guidance to the staff than it is to the licensee. Licensee has access to it. So they have expectations as to what they produce, but the guidance is designed to tell the reviewer "I can accept this except where deviations occur, and I need to look in detail." And they can choose those areas. They communicate that. The licensee provides information to go forward.

I'm not sure exactly how much detail you need to go into because as digital I&C reviews it, there's been at least 40 of them that I'm aware of so far that have been conducted.

MEMBER BROWN: Well, and, as you said,

that --

MEMBER SIEBER: It's clear what you're doing.

MEMBER STETKAR: That initial phase zero meeting is where you sort of --

MEMBER BROWN: Sort it out.

MEMBER SIEBER: Marshall it out.

MEMBER STETKAR: -- get clear between the staff and the applicant, the licensee where what level of information is expected and what falls out of that, then, is guidance to the staff on what level of effort of review.

MEMBER SIEBER: My idea of how this would happen is that for a given project, you're going to be in all three tiers for different aspects of it depending on what is exactly the same as some previously licensed thing, what is a new innovation that is not novel, what is a new innovation that is novel, or what is a totally new application altogether.

I see, actually, four tiers because if you're starting from scratch on something that has never been tried and is a new concept, that requires very in-depth review. And I think perhaps your tier 3 covers that. That's how I see it.

MR. MILLER: Yes. What we found, too, is that even partway through the review, you know, things transition from a tier 1 to a tier 2 when we learn more or I guess it's possible that it can transition down as well, but that doesn't happen quite as frequently. So --

MR. CARTE: But part of this is a little bit of guidance-based. Basically our guidance says that if there is a change to something that was reviewed and approved, they have to discuss that explicitly or the staff need to review that explicitly. So to the extent that things have changed, you need to address those changes.

Now, part of the confusion comes in that different applicants have different perspectives about what was reviewed and approved in the topical report. And one applicant might say, "Well, we think you approved the philosophies and concepts involved. And so as long as we don't change the philosophy of how we do things, we don't need to come to you with a revision."

And then another applicant has said, "Well, we believe that everything we said was reviewed and approved." And it is really somewhere in between. And that is what we are struggling with.

But we need them to be aware of what was in the topical report and where they deviate from what was in the topical report and explain that to us. And that's where the concept of a tier 2 review is.

And it is highly variable. Sometimes they add a new module, and sometimes they change things that they have done in the topical report. But each of those needs to be explained and justified, identified and justified.

MEMBER BROWN: The point is you are all in charge of what tier they put in.

MEMBER SIEBER: That's right.

MEMBER BROWN: That point needs to be gotten across. You point the finger. You are the one that determines where they fit. They don't make that judgment. They can have opinion and they can discuss it, but you make the final decision as to what tier to fit in. That is the only point I am really trying to make.

MR. CARTE: Right. And I think that that needs to be discussed in the phase zero meeting.

MEMBER BROWN: Yes, yes. I just add a little bit of emphasis. That's all.

MEMBER SIEBER: The interesting thing is there may be changes that are sort of barely

detectable. For example, you can buy a platform. The platform includes hardware, cards, cases, all that stuff, plus software that goes with it. You modify that software in some routine someplace so that proportional band control is, the driving module for that is, different than what was approved in another one.

You may introduce new sources of errors and so forth. So you need enough detail to be able to pick those kinds of things out from the process. I also think that in my meager experience with digital systems, they change every day.

You know, you buy something, you buy a laptop from somebody, and you buy another one two months from now, you have no guarantee that the parts are going to be the same, same manufacturer. And look at all the updates that come along.

MR. MILLER: Yes. We have had a number of examples, too, where that was identified during the review. And, like you said, it essentially transitions from one to two or two to three because of that.

MEMBER SIEBER: Yes.

MEMBER BROWN: Okay. Just wanted to make it clear up front that you all are in charge.

MR. MILLER: Was there any doubt?

MEMBER SIEBER: Once you guys say something, how do you deal with ongoing updates or software, for example? Do you deal with it or do you rely on the licensee to deal with it or the vendor or --

MR. MILLER: It's actually a good question because, you know it depends, too, on whether or not you're talking about the licensee or the vendor. Process governs how they control that.

Norbert, do you want to talk a little bit, maybe skip ahead on integration and control?

MR. CARTE: Right. We actually will discuss that a little bit. There is a specific subcommittee question on making changes. And that is a question that we will be talking about in more detail later. And I am trying to find the question number, maybe question four, three or four, four, in terms of configuration management.

But basically after a license amendment is issued, changes can be made, but that is governed by the 50.59 and associated processes.

MEMBER SIEBER: Right.

MR. MILLER: So, you know, licensee has their appendix B change/control process. I think it's

reg. guide 133 as well. 50.59 will dictate without any prior approval on this, but, you know, they control and implement the configuration management under the program they have for regulating it.

The other side of that, though, is vendor change and control, which they're not a licensee home to us. So we don't have a regular --

MEMBER SIEBER: Don't have a reach to the vendor.

MR. MILLER: But we do have a hold the next time somebody wants to use the vendor's technology. So, again, we put that as an onus on the licensee to figure out what has changed from the last time we approved it and justify why it continues that reasonable assurance of separation.

MEMBER SIEBER: Well, I know there are many instances that illustrate this, but I can think of two that personally happened. One was we had a failed instrument and decided that we would replace that. It had a detector. It had an EPROM in it. The detector was identical to the one that failed. And it failed for external reason. However, the EPROM was different. We didn't figure that out for a little while. And it made a difference as to how the system operated.

Another example is where you ordered a supposedly identical part and it was not identical at all, even though it functioned the same as the previous one. So it's sort of difficult in departure, in updates and replacements to make sure you stay within the license basis.

MR. CARTE: That's basically --

MEMBER BROWN: Norbert, let's wait until we get to that and go ahead and talk about that when you get to it. We need to get moving on the slides a little bit.

MEMBER SIEBER: All right.

MR. CARTE: Okay.

MR. MILLER: I guess this will be a good point, then, to transition to addressing the comments from the full Committee meeting in 2009. And we will turn that one over to you.

MR. CARTE: Right. I'm just taking a note.

MR. MILLER: Yes.

MR. CARTE: Slide 4 that I have to talk about. So what was stated first -- well, maybe not first but what was originally stated in 2009 and again in September 8th were the different areas of emphasis that we should consider and emphasize.

Diversity and defense-in-depth, this is emphasized in the ISG because it has its own section, section D.6.

Independence, there are two aspects of independence. One aspect of independence that is most important for digital systems is communication independence or that is introduced when we talk about digital systems. And that is communication independence. And that is addressed in section D.7 as well, which is an embodiment of ISG-4, digital communications, ISG-4.

Another areas of emphasis is deterministic behavior. The one thing that is interesting about this aspect is there are basically two clauses deep down that emphasize deterministic behavior that say that Revere should specifically look at that. We need to elevate that in importance in the discussions. And we have done that in the changes we will make. As a result of comments we will elevate determinism in those discussions, bring that discussion to a higher level.

The other aspect is redundancy. Redundancy in a sense, it's not -- there are some GEC requirements for redundancy, but, in essence, the real requirement for redundancy is in a single failure

criteria. In other words, you need to withstand a single failure. And the only way that you can do that, really, is redundancy.So there is a specific regulatory criteria. And that is spoken to.

Complexity is addressed in various places throughout the ISG. And we'll discuss it later on these slides. That is another one that doesn't have a strict -- the word "complexity" isn't used in the regulations. So if a complexity is stressed, then it's stressed in terms of reliability. Simple systems are more reliable. And that's how you get at complexity.

So we'll talk about those throughout the slides. We'll touch on some of these topics throughout the slides as we talked about the specific questions that came up in the September 8th Subcommittee meeting.

One of the questions, there were 15 questions. Question number 1 was that the tone of sections B and C should be revised to match the review described in section D. And we will do that. We will adjust the tone.

There were some words suggested. In the last bullet is a summary of the words suggested. And we will use those words as well as make some other

changes to the ISG as a result of that.

And part of that is we will include examples of diversity and defense-in-depth, independence, deterministic behavior in some of the more introductory sections in section B. And that's how we will elevate the emphasis or provide emphasis of those four areas.

Question number 2 is the ISG should make a clear distinction between software, hardware, and integration. Further, it should be clear that the NRC reviews more than just process.

We agree with that comment. The ISG does address all regulatory criteria, such as independence and redundancy. What it does is it emphasizes certain aspects that are unique to digital I&C systems. And one of the things, as explained in section B.1.1, is that for software-based or digital I&C systems, we also review process. And that is the main thing that is added in digital systems. And we have attempted to provide a more balanced emphasis in the changes that we make, but process is still very important for reviewing software.

The review of process is based on NRC-endorsed consensus-based industry standards. So when we look at the verification and validation

process, there is a reg. guide that addresses V&V specifically and that endorses an IEEE standard, 1012, on verification and validation, which is not a nuclear industry-specific standard -- it's a computer society standard -- as well as for digital computers, there is a specific reg. guide that endorses IEEE 7-4.3.2, which adds criteria for digital computers that addresses both hardware and software. For configuration management, there is a reg. guide that endorses two IEEE standards on how to perform configuration management.

One of the things which is interesting to emphasize in this area is that these different standards each have a view. And sometimes that view is partially overlapping. So in configuration management, it talks about audits. And reg. guide 1.168 endorses 10.28, which talks about audits. So there is overlap in some of these criteria. And that might be one of the things that's confusing to industry.

MEMBER SHACK: One of things that, just as I did it, you're always falling behind the industry standards. Is there a uniform process for somehow catching up on that or, I mean --

MR. CARTE: Well, we do have members who

are participating in the standards process, the IEEE standards. We have representatives from NRR and Research. And I'm not sure how much NRO participates. That emphasis is really in the Office of Research. They are the ones who evaluate --

MEMBER SHACK: Oh. They are the ones who evaluate when to do the update?

MR. KEMPER: No.

MR. CARTE: When to --

MR. KEMPER: This is Bill Kemper. If I could just add a comment there? No. Actually, we follow that very closely. So once the IEEE standard is issued finally -- for example, 7432 was just issued in September -- we have already interacted with the Office of Research and tasked them with starting a revision to reg. guide 1.152. So you're right. It's a sequential process by definition.

MEMBER SHACK: That's the thing. You asked Research to update the reg. guide?

MR. KEMPER: That's correct, yes. They do the work. Basically they do the labor to do it. We participate from a technical standpoint.

MR. CARTE: Well, yes. It's their responsibility. We're just pushing them a little more these days.

MR. MILLER: Okay. So question 3, the Committee expressed interest in how do we regulate changes to the platform made after the licensing process ends and it's transitioned to the inspection process? As with any implementation in a plant, the licensee has their change control process for evaluating and implementing that again governed by 50.59 for whether or not they need to come back to us for approval.

But I think one of the, really, most important things I want to stress here is the interaction between the headquarters staff and the regional inspection staff because they're still in the process of getting up to speed on digital upgrades, gaining the knowledge and inform people to do these inspections.

So we provide and have provided in the past experts from headquarters to go out and help them do these inspections. In addition to that, when we draft the SE, when we issued the SE approving the amendment, we included in it a list of items that we think are good for inspection or that we would suggest to the region to make sure they focus on during the site acceptance testing and things like that.

There is an inspection procedure as well

for digital I&C upgrades that we have put out. But, again, you know, I really do want to stress that, you know, we provide input to the regions and are available for assistance in implementing the platform on site.

MR. CARTE: The question which was raised earlier with respect to configuration management, it's an interesting -- it really does span the two questions, question 3 and question 4. But the point that I would want to add about the configuration management about the platforms is in general, there are one of two situations that can occur.

Either you have an approved appendix B supplier who has developed the platform and in that case, they have their approved appendix B program that covers changes and should be capable of notifying us of any changes or the licensees of any changes.

The other option is that you have a platform that is commercially dedicated. Now, the commercial dedicator must be an appendix B supplier. So they take the responsibility of notifying the licensee of any changes to the platform. That commercial-grade dedication normally includes a survey of the platform vendor to assure that they have the requisite configuration control practices in place so

that they can notify the dedicator of the changes to versions in hardware and software.

And typically when we look at platform updates or at license amendments based on previously approved topical reports, we ask for a description of each and every change that has occurred, hardware and software, to the components that are used in that application. And we have received that. But that addresses the previous question.

So who reviews software configuration management? In general, the vendor's configuration management is reviewed during the licensing process because that's just the way it happens. And the plant's configuration management is part of the reactor oversight program.

So, in essence, an applicant should review a vendor and assess whether the vendor is adequate. And that review should include configuration management. However, it has been the practice during the licensing process that we do look at the application or platform vendor and we do look at the configuration management process during the licensing process.

And the last bullet stretches back to question 3. So changes that are made in a platform

after the platform is installed would be covered by the 50.59 process if an amendment came into the staff, either to the topical report or for some other reason, we would look at that vendor again.

MEMBER BROWN: Correct me if I am wrong. I thought I remembered reading that configuration management was not one of the areas that you would explicitly review. You just said either that or I misunderstood what you said, that you do look at as part of the licensing review are they establishing an --

MR. CARTE: Right. We make --

MEMBER BROWN: -- adequate configuration management program. But, yet, you weren't -- that's a little bit different than what you say.

MR. CARTE: Right. Well, the distinction is whose configuration management.

MEMBER BROWN: Yes.

MR. CARTE: During the licensing process, we do not review the site's configuration management program. That is a program that is covered by the reactor oversight program.

MEMBER BROWN: Okay.

MR. CARTE: We do look at the vendor's or application developer's configuration management plans

and implementation. And that is explicitly addressed in technical position 714 as well as this ISG.

MEMBER BROWN: Okay. So it is already covered by other documents, other requirements that you -- not requirements but other positions that you have?

MR. KEMPER: This is Bill Kemper again. If I could just add here? It depends on who is developing the system, quite honestly. If a licensee chooses to develop their system, which they certainly could, then their configuration management would come under review by the staff as part of the review and approval.

MEMBER BROWN: If they didn't go to an outside contractor.

MR. KEMPER: That is correct. That is correct.

MEMBER BROWN: In-house with their own engineering staff, et cetera?

MR. KEMPER: That is correct. Yes, sir. Now, typically that does not happen. Typically they contract it out to a vendor shop and they do all of the work. And then they turn over all the configuration control to the licensee. And it goes under their appendix B program, as Norbert said.

MR. CARTE: Right. And, actually, to that effect, I have already started making changes to the ISG with respect to the comments. And one of the changes that I have made is removing the word "vendor" to application developer and platform developer because that is more in line with what we would do.

In the past, it always has been a vendor, although some licensees have talked about it. So we need to consider that. And that is why the word "vendor" was in there, but "application developer" is a more appropriate term. We look at the application --

MEMBER BROWN: More generic?

MR. CARTE: Yes.

MEMBER BROWN: Okay.

MEMBER SIEBER: Well, the ultimate response, once the system is licensed and installed, the ultimate responsibility for configuration management belongs to the licensee because he can choose any vendor or he can do it himself.

MR. MILLER: Yes. And I think we even got a question that gets to that a little bit later, but yes, absolutely, responsibility lies with the licensee for implementation of this.

MEMBER SIEBER: That's an O&M task, as

opposed to a --

MEMBER RYAN: Does the staff --

MEMBER SIEBER: I mean, if you get a qualified vendor, you're going to look at the QA process that the licensee has used to accept that product from a vendor.

MR. KEMPER: Again Bill Kemper. Yes. That would be typically done, though, as part of the reactor oversight program --

MEMBER RYAN: Okay.

MR. KEMPER: -- in their typical reviews, as John just said, as an O&M type of function.

MEMBER RYAN: Pretty well-established, of course?

MR. KEMPER: That is correct.

MEMBER RYAN: All right. It's not a new thing because it's for this particular topic?

MR. KEMPER: No, it's not.

MEMBER RYAN: Okay. Thanks.

MR. CARTE: So question number 5 was the discussion of the phase zero only mentions defense-in-depth and diversity as a topic. This should be revised to clarify that there are other important topic areas to be discussed during the meetings as well.

All topics may be discussed in phase zero. And we will expand that topic, for instance, the comment today, to discuss the tier determination as well as emphasize the other points that have been mentioned several times: diversity and defense-in-depth, deterministic behavior, communication, independence. I'm not sure we have a complete list at this time, but we have added at least the four major areas of emphasis that have been discussed previously.

Question number 6 is, what would trigger a source code review? Basically it's a deviation from an accepted approach that relied upon software. And the example is the Oconee. In the Oconee, they used a software to inhibit communications versus a physical disconnect. And, as a result of that, the physical disconnect is what was deemed as acceptable in ISG-4. Because they chose to rely on software, we did a specific audit to review code specifically with respect to that item.

Another item that got increased scrutiny on the Oconee RPS/ESPS review was they had a non-safety-related device that performed a data diode function. And we spent a lot of time trying to get the schematics --

MEMBER BROWN: You mean one-way communication?

MR. CARTE: Yes.

MEMBER BROWN: Thank you.

MR. CARTE: Yes. It's jargon. Sorry.

So those two aspects received a detailed review that we may not have done otherwise. So that is where we looked at hardware schematics as well as code.

We have a bullet for engineering judgment. So any time we think it's necessary, we will, but that is more of an exception-based, rather than as a thing we do all the time.

Question number 7, what is the division between cyber security and secure development and an operational environment? And how does this correlate to licensing and inspection?

The secure development and operational environment is addressed during licensing. It's approved in the safety evaluation. The regulatory basis for that is reg. guide 1.152, which references system integrity, control of access, and reliability, which are all clauses in -- so reg. guide 1.152 augments and supplements the regulatory requirements identified in 6.03. These are all clauses in 6.03.

The secure development environment supports that.

With cyber security is address programmatically by the Office of NSIR, it's addresses inspections. It addresses malicious actors and it has its own reg. guide, 5.71, to support that.

MEMBER BROWN: Just let me clarify and make sure I understand something, then. I'm trying to touch base between what you talked about, cyber security, addressed programmatically; in other words, malicious insertion or what have you or access to the systems.

Is there some communication during the development of the equipment or design for this? I mean, if you don't build in barriers that they can depend on, they can't come in after it's designed and say, "Gee, you haven't built in barriers." I mean, I guess I don't understand totally the interface.

MR. CARTE: It is a little bit of a division of responsibility issue. So the new regulatory requirement for cyber security requires that there is a program and that the site have a cyber security program and it is reviewed by the reactor oversight process through inspections.

So if you have a cyber security program, it must in my opinion generate some requirements on

the system. So those requirements would be incorporated in a requirements bank or purchase specification or system specification of some sort.

Now, as requirements, as all other requirements, there, we would consider looking at those. We don't validate that all requirements are implemented, but we do sample. And we could consider those.

What we would not do is assess the adequacy of those functions for protecting against malicious acts. That would be programmatic. We are not doing an adequacy of the function, an evaluation of the adequacy of the cyber functions. We would just look at this is a requirement that comes in, yes, to implement it.

MEMBER BROWN: If it is implemented but it is not adequate, what good does it do?

MR. CARTE: It is a division of responsibility. So NSIR is responsibility for addressing that programmatically.

MR. MILLER: Bill, do you have something to add to that?

MR. KEMPER: Yes. Again this is Bill Kemper. The arrangement that we have with NSIR is -- and we communicated this to licensees in public

meetings and so forth. In fact, I just went down and spoke at an INPO digital working group about a month ago on this very topic.

If a licensee imposes features in the design of the system, intended to report malicious acts, we would review that for its impact on the safety system's ability to perform its safety function solely. That's how that would be written in the safety evaluation. We would not render any judgment on the efficacy of that feature importing off of cyber taxes.

You make a point. It could be done, but that is not the way our division of responsibilities is established. And, of course, NSIR would follow it up under their review, which is an in situ review.

And reg. guide 1.152, rev. 3, by the way, is going to be issued soon. And you all will be looking at that here pretty soon to try to clarify this in great detail.

MEMBER BROWN: Reg. guide?

MR. KEMPER: 1.152, rev. 3.

MEMBER BROWN: Oh, rev. 3? Okay.

MR. KEMPER: Yes, rev. 3. We are changing that specifically to try to clear this up. And we're just positioning in for comments on it right now. So

hopefully you'll see it in about a month or so.

MEMBER BROWN: I guess the point for the Committee is we had an interesting discussion on this subject. And it's not real clear. That's what I got out of the discussions, Dennis and John. It wasn't real clear how this interface really worked.

It's kind of hard to ignore it when you are designing the system, but, yet, it's not a site cyber security program. It's just it's not a good interface right now. So something has to go somewhere. We didn't push it much more than that, if my memory serves me. I don't remember.

MEMBER STETKAR: I think that's right.

MEMBER BROWN: Okay.

MR. CARTE: But I would posit that the interface is not unlike other interfaces. When digital instrumentation and control looks at a reactor trip system, it does not evaluate the adequacy of the trip functions for protecting the health and safety of the public.

MEMBER BROWN: No, but --

MR. CARTE: Reactor systems does.

MEMBER BROWN: Yes.

MR. CARTE: So we trust that they have done that and that is mapped in.

MEMBER BROWN: Well, I understand that, but the point of the security is, is there a barrier? Can an outside entity through common communications from the main control room have access via some vehicle because you've got a connection, because you're sending data up to a set of BDUs or other data to display information or is there access from that main control room to actually incorporate software downloads, as opposed to going down to the cabinet, taking a key, opening the door, and sticking, you know, connecting a laptop, which is a pretty -- I mean, you can put a guard by the guy if you want to to make sure he doesn't do something.

So there is a difference. It probably wouldn't help, would it? Bad example. My point is that the fundamental design of the system communicates outside the area of its protection system functionality, sets it up for being attacked if it's not done in what I would call a data diode one way, solid one-way communications, like one individual said, "Yes, we're using these gates. And they're programmed to be one way."

Well, as soon as somebody says, "programmed to be one way," that means somebody can get in and hack it and turn it around necessarily.

Okay. Now, if -- somebody is trying to --

MR. ARNDT: Yes. Just to clarify a little bit -- I'm sorry. Steve Arndt. Just to clarify a little bit, as Bill mentioned, we look at those issues associated with the system's ability to perform its safety unction.

There is an entirely separate function in NSIR that looks at those specific issues, particularly associated with communications, the ability of systems to propagate errors or propagate attacks.

MEMBER BROWN: Steve, I understand that, but is NSIR involved in the license amendment review?

MR. ARNDT: No.

MEMBER BROWN: Okay. I'll rest my case.

MEMBER STETKAR: I think a little bit of the concern, kind of listening to this, is that there are protocols set up for integrated reviews of plant hardware changes, "I want to change a door," you know.

And it says that changes to the plant need to be reviewed in an integrated sense such that if I decide I want to make this door a revolving door without a lock on it because the operators need to get to that valve over there because it is the most important valve for the safety of the plant, but the safeguards folks, security folks need to be involved

in that process to make sure that that doesn't subvert any of the plant safety, you know, security assessments.

What I am hearing here is the same type of integrated thing needs to be thought about when you are looking at initial licensing of a platform, a set of software, whatever.

In principle, it's all thought about. It's not clear that going forward, those same types of cautions are there because I'm hearing that, well, the NSIR folks look at things from their perspective and the licensing folks look at things from their perspective. Are there collisions or diversions that are missed in the gaps?

MR. KEMPER: Again, this is Bill Kemper. Yes. There is one common point where they all come together. And that is the licensee's submittal.

MEMBER STETKAR: Yes.

MR. KEMPER: Okay? So, as you all know, reg. guide 5.71 is out there. It's been reviewed and issued for some time. It has specific design criteria recommendations in that in one of the appendices. I think it's appendix C.

MEMBER STETKAR: Yes.

MR. KEMPER: So licensees, being the smart

folks that they are, will build those requirements into their procurement spec. So those will be built into the new safety system. All we're saying is the division of responsibility is such within the staff that we wouldn't review those cyber-related features for their efficacy for thwarting off cyber attacks because we don't know. The term NSIR uses is we don't have an appreciation for all the vectors, cyber attack vectors, that a bad guy is going to think of once the system is actually installed in the plant.

We understand the configuration because it's going to be installed in because that is part of LAR. But we don't know once it's installed what availability people have to it and those types of things.

MEMBER BLEY: I guess we have got an SRM from three or four years ago urging all areas of staff to try to integrate safety and security and new designs.

I haven't seen much in anything we have look at where that integration is actually beginning to recur. And what you guys are saying is pretty much what we have heard all along, that you can keep these separate.

But I think there are things those folks

need to think about that are more systems-related that might not always fit the vectors they looked at and some kind of integration might really be helpful. I get it that it's not here, but it seems to me --

MEMBER STETKAR: Yes. If some department is struggling with it, I don't know how to --

MEMBER BROWN: I didn't say I had a solution.

MEMBER STETKAR: Yes, yes.

MEMBER BROWN: I just said it's a giant hole. That's all. There's not an interaction there at the time, not a giant hole. I mean, that's --

MEMBER STETKAR: It's a reliance. As Bill said, it's a reliance on the fact that the licensee applicant must show -- well, their assertion that they have satisfied the requirements of reg. guide 5.71, that's the reliance that can happen.

MEMBER BLEY: If we begin to start saying that stuff needs to be integrated everywhere we write things down, maybe we'll get there at some point. But as long as we keep saying, "No. They do separate stuff" and "We do separate stuff," I think there's a little hole in the middle that might hurt us one day. And I would sure like to see us begin to do that.

Go ahead.

MEMBER BROWN: Yes. Let's keep moving.

MR. CARTE: Thank you. Question number 8 was, how did the licensee demonstrate deterministic performance, and how do we reach reasonable assurance of this?

We break down that process in general into a two-step process: a platform process and then an application process. So when a platform topical report comes in, we review the platform characteristics using the guidance in the SRP and assess the platform's ability to support deterministic behavior.

Then when an application comes in, we look at the application. And it assures that it uses the features correctly, such as cyclic processing, no dynamic memory allocation, failsafe behavior, and we use those to assure the application deterministic behavior.

One of the things that we look at and that has come up before is the difference between interrupts and poling. So in general our systems are poling the inputs, performing calculations, the same calculations, and then there are no process or state-based interrupts for the protective functions.

And data communications is cyclic, not

event-based. And those are the criteria that we use.

MEMBER BROWN: Let me just ask a question, make a point in that I have seen all of these in terms of that is what you look for. And, yet, we have got at least two or three applications that are on the plate which are interrupt-driven.

I am not arguing against poling data. I mean, it is when you interrupt the main computation cycle process. And that's what they do. And, yet, they were accepted for various reasons right now.

So I see the statement. But, yet, the application of those when you're looking into design seems to be disparate.

John?

MEMBER STETKAR: Is this for changes to currently operating plants or new systems?

MEMBER BROWN: This ISG is only for operating plants, but they're selecting platforms and stuff that they have a choice. they have a choice of the architecture and approach they are going to take. We have seen two different architectures.

MEMBER STETKAR: I think the things you have seen are for new reactors.

MEMBER BROWN: Yes. But one of those new reactors has also got the cyclic processing. It's a

program cycle architecture, which is fairly easy to deal with.

MR. CARTE: The topical report --

MEMBER BROWN: I am just making an observation. I am just saying I see the words and how that gets translated into the acceptance of the particular architecture that's presented.

You don't need to do anything more with that. I just am making an observation as to what we've got versus what is in the guidance.

MR. CARTE: Okay. Question number 9, how does the staff determine the complexity of a platform? And does that influence the depth of the NRC review? Are there any metrics to measure the level of complexity of a platform?

Staff guidance requires comprehensive review of all system attributes. Complex systems require more efforts because there are more things to review, there are more aspects to review. And currently there are no generally effective measures for complexity.

MEMBER BROWN: That was a rhetorical question.

MS. JAMES: Well, we thought about it.

(Laughter.)

MEMBER BROWN: Going to town.

MEMBER STETKAR: And the last bullet there is accurate.

MEMBER BROWN: Yes. I agree with that.

MR. CARTE: So question number 10, why is there no requirement to perform and submit an FMEA, a failure modes and effects analysis, for software? How are software failure modes reviewed by the staff?

Typically an FMEA is performed to demonstrate single failure criterion is satisfied. So there is a regulatory requirement in several places that certain safety systems be single failure proof. And an FMEA is used to demonstrate that.

A systematic failure of the software is addressed by diversity and defense-in-depth analysis. Individual software failures would be addressed, would be similar to individual hardware failures.

Branch technical position 7-14 has a section for software safety plan. And that requires that a software hazards analysis -- well, that you develop a plan, but typically a software hazards analysis is performed.

However, there is no specific technique that is endorsed for performing a software hazards analysis. And software FMEA could be one of them,

although I personally have not seen any.

In addition, there is no guidance on software failure analysis. Oh, in addition, guidance on software failure analysis may be addressed by the research program.

MEMBER BROWN: In other words, you would like them to look at it?

MR. CARTE: They are looking at it.

MEMBER BROWN: Yes. I guess my comment, I understand what you are saying. An observation that can be made based on the programming language and approach taken by a vendor, there are programming characteristics, functions. Obvious ones are global variables, friends, inheritance.

Those things which have associations across routines; in other words, they have the ability if they're implemented in the software to modify other routines, other functions based on the data they're receiving, that is a very risky programming practice for this type of an application.

So there are varying levels of software review; in other words, FMEA-type approaches, to doing that. Some of those could embody looking at functional aspects of programming, what should be used, what should not be, see what -- not that they

don't use it but that it's used properly and controlled.

That's a different type than trying to look at eery line of code and saying, "Can that get me in trouble or not?"

MR. KEMPER: This is Bill Kemper.

MEMBER BROWN: Yes?

MR. KEMPER: If I can just add two sentences here? We do reference in the ISG-6 that we have a reg. guide of recommended practices for software programs. And it covers a number of different languages. And so what we ask the licensee to do is in the submittal explain to us if they deviate from those practices.

So it's sort of an end-around way of kind of getting to what your observation is addressing here, we believe, Charlie. So we don't do a line-by-line code, but --

MEMBER BROWN: Oh, no. I would never indicate a line --

MR. KEMPER: I understand. I understand, yes. But if they deviate from commonly accepted software practices like you're talking about, then we would expect them to address that in the licensing amendment. And then we would talk about it.

MEMBER BROWN: Well, those are the people C++ loves some of these associations or the -- what is it, the friends and the inheritance and other type things. They love those or the programs. And that is a commonly accepted practice.

So I am just saying other than -- there are different types of FMEA to be looked at. That's all. So it's just --

MR. MILLER: Okay. So one of the questions that came up last time --

MEMBER BROWN: Hold on.

MR. MILLER: Sorry.

MEMBER BROWN: John, you and Dennis both had some comments on this during the Subcommittee meeting. Did you all have anything else to say?

MEMBER STETKAR: I mean, it is difficult. There are vague references in the ISG to software FMEAs. If you look at the references back in D.10 to some of the IEEE, conformance with some of the IEEE, you don't have the references at sections -- hold on a second. I need to get the appropriate distance from the screen here -- D.10.4.2.5.3 --

MR. MILLER: Got it.

MEMBER BROWN: Say that again.

MEMBER STETKAR: 10.4.2.5.3 and 10.4.2.7.

They make vague references to elements of software FMEAs. I didn't go back and look at the IEEE guidance to see what is done there. They seem to address focus-type applications, focus concerns.

I think one of our discussions during the Subcommittee meeting focused on a more integrated sense of failure modes and effects analysis for hardware and software.

The requirements for people to do, as you said, primarily focused on single failure analysis but a kind of traditional hardware-based FMEA for a platform, these days people say, you know, it's really difficult to sort of separate the software from the hardware.

I don't have an answer. I mean, that was sort of the sense of the discussion. The guidance does mention, as I said, in those two sections the notion of software FMEA.

MR. KEMPER: Again this is Bill Kemper. Actually, what we're trying to communicate there is, you know, this particular phrase talks to code diagnostic failures. What we're saying is from a system level, the FMEA should include lock-ups of the system basically or the software's failing to perform some of its intended functions.

So we're not proposing that you go do an FMEA of the software itself. It's at a higher level, at the system level.

MEMBER STETKAR: Okay. I mean, that's at least --

MR. KEMPER: We're not trying to integrate --

MEMBER STETKAR: That's sort of getting to what we're talking about, though.

MR. KEMPER: Yes. That's correct.

MEMBER BLEY: Now, I didn't look at the specific pages, but it's in there, though.

MEMBER STETKAR: It doesn't say don't do. It's --

MEMBER BLEY: I don't know. Maybe a little clarification there would help, that, really, it includes things at the higher level that might have been caused by problems in the software. And I don't think that jumps --

MEMBER STETKAR: I mean, these two specific sections, what it is is this section of the guidance is kind of a laundry list of summarizing different elements of IEEE guidance that you need to make sure that you have satisfied.

So I mean, in a sense, it's part of the

guidance, but it's sort of a tick list that discusses those things. It may be there a little more discussion, I thought, but I don't know. It's an admittedly difficult topic.

But, again, in the same sense of this security, cyber security, verses kind of protection function integration, rather than ignoring the issue, you know, just starting to at least mention it gets people thinking about it anyway, even if there isn't a clear-cut solution. That's up to you. You read the guidance.

MR. MILLER: Okay. One of the things that came up last time was we deleted a phrase -- and this gets back to one of your comments about a licensee may delegate responsibility or actions but still retains ultimate responsibility.

So we went back to look at it. And what happened was we relocated it to another section or found that it was duplicative in another section.

Additionally, too, appendix B at 10 CFR establishes this. And, regardless of what we have in there, they are still beholding to that. They are responsible for safe operation.

MEMBER BROWN: So the appendix B allows the delegation?

MR. MILLER: Yes, delegation of activities, not responsibility.

MEMBER BROWN: Okay. So your statement was that they -- all right.

MR. MILLER: If I --

MEMBER BROWN: No, no, no, no, no. That was my question that I asked during the meeting.

MR. MILLER: Okay.

MEMBER BROWN: And I saw the comment about retaining responsibility --

MR. MILLER: Yes.

MEMBER BROWN: -- was deleted, which triggered me. And I did not -- I guess you probably told me at the time and I --

MR. MILLER: We wanted to make sure that that was what it was, too.

MEMBER BROWN: Okay.

MR. CARTE: Question number 12 was section D.6.4.1, adequate system diversity and manual action should be rewarded to emphasize that we do versus --

MS. JAMES: To emphasize what we do versus --

MR. CARTE: -- those documents. Right. Okay. So basically this guidance was being developed at the same time that the ISG on D3 was being

developed. And so it was short on that to allow that to be developed independently. We will reference the criteria for D3 analysis. D3 analysis is reviewed by the staff. And that will be clearly stated.

What the current section seems to say is that there are basically three favorable outcomes of a D3 analysis. And that is that sufficient diversity exists in the platform itself, that diverse manual actuation system is provided, or that manual actions are credited.

Typically those manual actions are addressed by a human factors review to assure that they have reasonable time to perform those actions.

MR. MILLER: Okay. One of the main comments we got last time, too, was that I believe you had some interest in seeing the ISG-6 again before it was finalized.

I think at that time Steve brought up that there were some previously agreed-upon protocols. I leave that to him to go over. We would note, though, that any incorporation of the content of ISG-6 and any durable guidance, such as an SRP update, will certainly go back before the Committee as well at that point.

Next slide. Okay. So --

MEMBER BROWN: Are you going to want us to look at it again before you issue it? I am just trying to put this in English.

MR. ARNDT: Steve Arndt.

MEMBER BROWN: Do you want to say that again?

MR. ARNDT: We are always happy to have your input, both as a member and as the Committee as a whole. The process for ISGs that we discussed earlier with Committee and agreed upon a number of years ago was that we would bring the ISGs to you during development so we can get the insights during development and that before we turn the guidance into final regulatory products, we would put it into the normal regulatory process, which would include coming to the Committee to formally review the final regulatory products.

MEMBER BROWN: So if I want something else, I have to stay on long enough to see it gets there. Is that the point?

MEMBER STETKAR: Twice, rather than three times, Charlie.

MEMBER BROWN: Okay.

MEMBER STETKAR: Another thing, recognizing this process, do you currently plan to

issue a formal reg. guide that will evolve from this guidance? And, if so, do you have any sense of timing of when that might happen or --

MR. ARNDT: We absolutely plan on putting it into a formal program. Whether it's with the SRP, with the next data of the SRP, or as a stand-along review guidance, it's not quite clear yet, but we're going to do that. And we'll probably do that after we do the pilot.

MEMBER STETKAR: Yes. Okay. Certainly after you do that.

MR. CARTE: Yes.

MEMBER STETKAR: Do you have any sense of the timing on -- I mean, are we talking a couple of years or --

MR. CARTE: A couple of years.

MEMBER STETKAR: A couple of years? Okay.

MR. MILLER: And we've got a slide at the end, too, that will go through that.

MEMBER STETKAR: Okay. I'm sorry.

MEMBER RYAN: And that's in your timing to have a separate document based on how well the standard review plan is at that point in time?

MR. MILLER: Yes.

MEMBER RYAN: Okay. I mean, you wouldn't

wait a year to get this out, as opposed to wait for the standard review plan, that kind of thing? Okay.

MEMBER BROWN: I think they intend to issue this in this form, whatever form it makes. The other comment they make that they were going to try to do, what was it, a review standard 002, which was similar to ROS-01. There is only one other one that exists.

Okay. Go ahead.

MR. MILLER: Okay. So some of the discussions from last time, too, focused on what we call portal technology. And, just for everybody's benefit, too, portal technology is using some kind of a computerized database of information that the staff can access, but it's not on the docket.

So it does present a couple of unique challenges in that we regulate what is on the docket, why is this licensee under oath and affirmation. So how do we use this information? And how do we use it in a way that doesn't put us in a bad light with our obligations to regulating in a public manner?

So we didn't solve that problem with ISG-6, but we acknowledged in ISG-6 that it could be a very useful tool, basically allowing us to refine our information request we do need to see on the docket to

come to our conclusion of reasonable assurance.

So, like I said, we put a placeholder in the ISG, acknowledging its use that it could be beneficial to the process, but we wanted to develop it as a larger applicability procedure because we can use this in a number of other reviews as well.

I believe they have even piloted a few of these applications in license renewal, things like that. And maybe even for NPFA-805, I think they might have had use of a small system like that in that case.

So, again, we plan on using it in the future when it comes around, but until then, we just acknowledge that it exists.

MEMBER SHACK: I mean, isn't this sort of an electronic version of an audit --

MR. CARTE: Exactly.

MEMBER SHACK: -- where you go look at documents, but they're not docketed?

MR. CARTE: Right.

MEMBER SHACK: Did you just save you the trip?

MR. CARTE: Yes. Sometimes also what happens is an applicant will submit information that we don't find very useful. We think we ask a clear description.

And one example is please provide a description of your plant computer. And they may feel that they have provided a sufficient answer, like the server manual for one of the computers that they're using. But that's not really their plant computer.

So, rather than waiting a month and having that on the docket, seeing that through a portal and saying, "Oh, no. That's not what we want" --

MEMBER SIEBER: Do you find any kind of conflict between what you want docketed and issues of cyber security? For example, you could put a lot of stuff on the docket that would help a cyber attack or getting to the machine? Are you sensitive to that?

MR. MILLER: It's interesting. That angle that you just brought up, I don't know that we have considered that before, but using this tool to refine our information request would actually further that goal that you just brought up.

MEMBER SIEBER: That's right. That's what I --

MR. MILLER: That's an interesting goal.

MEMBER SIEBER: My thought process -- and I think you ought to keep that in mind -- is --

MEMBER BLEY: But maybe not unless security and the other signs are somehow integrated.

MR. MILLER: Good feedback. Good feedback. Another question that came up was why we dropped requiring the FMEA to be submitted during phase zero and moving out to phase two.

What we had found is that it changes so much between that time frame that the staff effort expended upon reviewing it initially and do something beneficial. We take a look at it during phase two, in its more final form. And that's the best application of our resources.

And from a reviewer's point of view, one of the things we do is we assess quality when we look at a document. And any time you have a draft document, it is very difficult to assess quality. So preferably we would want things in final form.

MEMBER STETKAR: Before you wrap up because this will be a quick one, sitting here -- I wanted to ask it earlier, but I wanted to make sure we had enough time to get the discussion through all of the questions.

Back when we were talking about the inspection process and looking at changes to things and, in particular, under the 50.59 process or however they're implemented -- and this is just for personal education, I hope. What type of process is in place

to assure confidence that the cumulative effects of individual changes to software -- we're all familiar with software patches -- don't introduce problems that each individual assessment didn't evaluate?

In other words, well, you know, a small change to a few lines of code or a something, set point may have been evaluated as an insignificant change under the 50.59 process within the defined boundaries of that. But after the second or third patch revision, something has crept in that people didn't recognize originally that they might have if it had been there in the original integrated design when you look at it.

We have seen a couple of examples I think of things like this that people have made changes to software in response to a particular problem, made another change in the software related to another problem, things like integrated feedwater controllers or integrated steam relief and turbine controls, that sort of thing.

MR. MILLER: Well, yes.

MEMBER STETKAR: What part of the process looks at that?

MR. MILLER: You mentioned --

MEMBER STETKAR: I mean, in principle, I

guess the licensee is supposed to be doing this.

MR. MILLER: They are. And you mentioned 50.59. In the guidance we have endorsed to do that, you are supposed to take that holistic look to make sure that, yes, I fixed problem A. I also didn't create problem B. But in implementing that, especially in the situation you describe, there are so many different nuances that can happen.

I think there is a lot of discipline in doing those updates or implementing those patches necessary to ensure that that does not happen.

MEMBER STETKAR: Well, but we have seen examples were it does.

MR. MILLER: Right.

MEMBER STETKAR: That's the problem. And the problem is people doing the evaluation very often get tunnel vision. They look at, yes, indeed, this will fix the problem that we had six months ago and, indeed, we should install it because we don't want that problem to happen again.

MR. MILLER: Steve, did you want to add to that?

MR. ARNDT: Yes. There are two really things you need to look at in answering that question. And is it perfect? Probably not. But from a

technical standpoint, the concept of detailed regression testing of the software, not just testing the fix but also testing all of the requirements, with the new set of code, which is referred to as regression testing, is one of the big areas. From a 50.59 standpoint, one of the big issues is, are you introducing --

MEMBER STETKAR: Right.

MR. CARTE: That really gets at, has this --

MEMBER STETKAR: Okay. This --

MR. CARTE: -- part of it done something that's introduced different the way the system --

MEMBER STETKAR: That's the way it is supposed to work?

MR. ARNDT: It is supposed to work into it.

MEMBER STETKAR: Okay. Thanks.

MEMBER SIEBER: In a very vague sense, it's really covered by 50.59.

MEMBER STETKAR: Well, but that's what I was trying to get at is --

MEMBER SIEBER: The question is --

MEMBER STETKAR: -- essentially what protection does the 50.59 process --

MEMBER SIEBER: Well, that's --

MEMBER STETKAR: -- formally provide in the sense for that type of --

MEMBER SIEBER: That's a gross overall regulation. The licensee should have if they are doing the job right a detailed procedure as to how you integrate software changes, keeping in mind that you should have a record of all previous software changes and how does it all fit together.

And I think you're going to find some variability throughout the industry as to how well that is done. And they may rely on a vendor to do it, but that is difficult because a single vendor does not build every part.

MEMBER STETKAR: Yes, but is there guidance for the inspectors who are out there who periodically go in and look at -- you know, if you are going to do an audit at the end of a year and look at cumulative changes in software, for example, that they're at least sensitive to that.

MR. KEMPER: This is Bill Kemper again. Let me try to answer that in a couple of different phases here. First off, the industry has guidance called NEI-0101, which the staff has endorsed by virtue of a RIS, RIS 2022, in fact, which gives them

guidance on how to do digital upgrades and also modifications to digital safety systems under the 50.59 rule. So it's copious amounts of detail in that.

And that document is due for an update. In fact, I just talked with Gordon Clefton before this meeting. We're trying to commiserate -- I mean, commiserate, wrong word.

(Laughter.)

MR. KEMPER: Excuse me.

-- communicate -- Freudian slip -- I don't know. We are trying to get this effort started because it's outdated. It's been several years since it has been updated, and we learned a lot in that time.

Now, with regard to the ROP process, the inspectors will write an inspection procedure where they'll go out and they'll look at the basis for the 50.59 safety evaluation that a licensee creates in order to answer those 8 questions in the 50.59 rule itself.

And sometimes we're called in, my staff is called in, to support them. We actually send our people into the field from time to time to --

MEMBER STETKAR: But I guess what I was

asking is, you could write that guidance such that the inspector goes in and examines each one individually of a half a dozen 50.59 evaluations and hope there is nothing to trigger the effect that the inspector needs to also think about the integrated effects of all of those things.

MEMBER SIEBER: Yes.

MS. JAMES: If I could interject here?

MEMBER STETKAR: If, indeed, as Jack said, if, indeed, there is variability in terms of the way the licensees are implementing it --

MS. JAMES: If I could interject here? The inspectors look at 50.59s in 2 different ways. One, there's a requirement for residents to look at 50.59s. So that would get at the piecemeal that you're talking about.

MEMBER STETKAR: Yes, yes, yes.

MS. JAMES: And then on a periodic basis, the regional inspectors, who are more specialized in certain areas will come out and do the design inspections. And we have done them several different ways over the years, where we'll look at a system kind of from top to bottom, look at all of the changes that were made. And that's where we would have the opportunity to look at the more global impacts of all

the changes that have been made.

MEMBER STETKAR: Thanks. That's --

MS. JAMES: So we have it two different ways to get at changes in looking at how licensees made changes.

MEMBER STETKAR: And that second type of --

MS. JAMES: That's the inspection that over the years, we have included contractors on if we wanted a specialty on it. We have included headquarters people. We have included regional people. We have borrowed from other regions to make sure we have got the right complex of individuals on those inspections.

VICE CHAIRMAN ARMIJO: Doesn't the licensee have the obligation to look at the cumulative effects?

MS. JAMES: They do. They do.

VICE CHAIRMAN ARMIJO: And you ask them what they have done, and they tell you. And then you do a separate review or an independent review.

MS. JAMES: Trust the verifier, right? You know, I believe everything they tell me, but I want to see the calculation. And I want to see the 50.59. And I want to look at those questions and see

if I agree with their answers or if I have anything else I want to ask.

MEMBER STETKAR: Okay.

MS. JAMES: So yes. It's ultimately the licensee's responsibility, but I think the question was, how are we going to try to poke at that?

MEMBER STETKAR: That's right. I mean, it's basically, you know, are those questions being asked from that integrated standpoint, recognizing that the licensee if they're doing what they should do should be performing those evaluations? But are the inspectors actually tasked to go think about that and --

MS. JAMES: I think, you know, if we look at individual 50.59s, we won't look at the cumulative.

MEMBER STETKAR: No. That's right, but that's our understanding of it.

MS. JAMES: Then we have the periodic engineering inspections, which will go out and look at it a different way.

MEMBER STETKAR: Thank you. That helped a lot.

MR. MILLER: Okay. So where do we go from here? Our next step is to bring this to the Digital I&C Steering Committee for their review.

MEMBER BROWN: Before you start this one, let me hit two points. Number one, you all have incorporated in the various phases a lot of information that you desire to see that you consider required in order to make your licensing assessment. It's an equi-satisfactory architecture and design. This is in the operating plants world.

What type of -- do you all do any integration or any work with new reactors? I mean, based on looking -- based on new designs, there has been an issue with the level of detail that we're receiving on those. You have covered a bunch of those areas in terms of requests for documents and other stuff like that.

So people are going to see a divergence between operating plants and new reactors in terms of the level of detail you use.

MS. JAMES: We're going to take this question.

MR. ARNDT: Multi-part answer. There are a number of different areas where we try to work with our colleagues in NRO to --

MEMBER BROWN: The operative word "try"?

MR. ARNDT: No.

(Laughter.)

MR. CARTE: All the time. We work with our colleagues to both look at technical consistency, the same issues hopefully resolved in the same way between the two offices.

Now, the licensing process is a little bit different, as you well know. The issues associated with ITAAC and DAC and design certification are different from what we do. So we have to take that into consideration when we try and put together how we look at things and what level of detail we do and when in the process you look at.

The Committee is very well-aware of the DAC issue. And you have issued a letter on that. And I think NRC is in the process of sending a letter back to you discussing their views of your recommendations.

The Digital I&C Steering Committee takes this issue up on a regular basis. And we are continuing to work specifically on the issue of technical consistency on design review issues but also the issue of where in the process we look at various levels of detail.

The safety finding is the same sort of -- the amount of information we need to review at some point in the review process is the same. We come to a reasonable assurance finding, but the process from a

regulatory standpoint has us looking at different levels of detail at different parts of the process.

MEMBER BROWN: Are you done?

(Laughter.)

MEMBER BROWN: Okay. I just wanted to hear if people are at least communicating. We obviously had not come to total -- total resolution has not been reached, but you all talk?

MR. CARTE: We talk a lot.

MEMBER BROWN: Okay. All right. One other point on the technical side is that -- and this is my opinion from reading this thing page to page in terms of the tone part. You have addressed that in question 1. And one of my specific major concerns was the apparent total emphasis on process, pretty strong statements, although you have explained that is not what you meant in that whatever you all do, this laying out of the emphasis and the introduction; in other words, setting the tone, the message you send to the public and everybody else, process is not a substitute for understanding the details of what you're getting for determining whether you need a process. But what you get is what is important, what is the end result, and if you get enough detail to know what you are doing.

MEMBER STETKAR: I think some of the comments, though, Charlie, in fairness, -- I see scowls -- if you actually look at the guidance, there's --

MEMBER BROWN: Tons of it.

MEMBER STETKAR: -- there's tons of substance.

MEMBER BROWN: Right. This is a message. It's a tone issue.

MEMBER STETKAR: I think our comments were to make sure that the front part --

MEMBER BROWN: I'm just re-emphasizing that. That emphasis has to be on the technical aspects of the thing because you asked for it, you need it, you recognize it, but, yet -- and I agree you have said you are going to do it. I'm just adding a little comment.

MEMBER STETKAR: I think during the Subcommittee meeting, we went sort of through a body count of the actual guidance. And the vast majority of it very explicitly --

MEMBER BROWN: Yes.

MEMBER STETKAR: -- addresses, you know, what I would call substantive guidance, rather than the process, only a few --

MEMBER RAY: John, how does that get reflected in a DAC?

MEMBER STETKAR: This is not DAC-related. This is irrelevant to DAC.

MEMBER RAY: All right. Sorry. I thought you were talking about guidance in --

MEMBER STETKAR: It is irrelevant.

MEMBER BROWN: This is for operating plants, not --

MEMBER SIEBER: Not for existing --

MEMBER RAY: You made a transition.

MEMBER STETKAR: I just want to make sure for the record.

MEMBER BROWN: I can multi-task and actually know what I'm doing.

MEMBER RAY: Well, I thought I heard a response over there about that DAC issue. And then you started talking. And I didn't know your --

MEMBER BROWN: Okay. Yes. The purpose of my comment was just to make sure that that is emphasized at a very strong level relative to the need for a real understanding of what you are looking at in order to draw it.

You need a good process. There is no question about that. And you've got to look at the

process. If all you do is 95 percent process and 5 percent other, you know, you're not going to get the desired end result. So that's just a little preaching.

MR. MILLER: Well, we consider it very valuable feedback, too.

MEMBER BROWN: Okay. You can go ahead and finish now.

MR. MILLER: Okay.

MEMBER BROWN: I can be complimented for finishing early.

(Laughter.)

MEMBER BLEY: You're not.

MEMBER BROWN: One more slide.

MR. MILLER: We are hopeful to get the ISG-6 issued for use in November. Thereafter Diablo Canyon will be the pilot plant to use the newly issued ISG-6.

They are planning on docketing the amendment request in the Spring of 2011, 2-year review thereafter, 2013, with installation of the system in the plant in Spring of 2014.

MEMBER STETKAR: Remind me real quickly. What are they doing? Are they doing a full digital upgrade like Oconee or --

MR. CARTE: Well, I wouldn't call it a digital upgrade. They already have an Eagle 21-based system.

MEMBER STETKAR: Okay.

MR. CARTE: So they are replacing one digital system with two digital systems.

MEMBER STETKAR: Fine. Thanks.

MEMBER SHACK: Now, you said, though, that they are tier one. So they won't fully exercise the guidance.

MEMBER SIEBER: No.

MR. CARTE: Correct.

MEMBER SIEBER: Well --

MR. CARTE: Triconex and Westinghouse are in the process of updating their topical reports. Those should be completed before the license amendment comes in. So they will be referenced, current topical reports. And, yes, it will not exercise the full guidance.

MEMBER SIEBER: But there may be fingers into tier two and tier three.

MEMBER BROWN: I would expect depending on -- how you use the Triconex and how you use -- whatever other platform they're using can make a difference.

MEMBER STETKAR: Best guess is they will probably exercise a reasonable fraction of --

MEMBER BROWN: Yes. If they do the whole thing, then that is easy. That is easy. All right.

MR. MILLER: So as we go forward, we certainly hope to learn from that experience as well. We may update the ISG-6 as a result of that or that update may be preserved for when it's transitioned to durable guidance.

MEMBER BLEY: Do you expect you will be bringing some of this to us as the process goes along on the Diablo location or have you even thought about --

MR. MILLER: We hadn't at this point, but we can take that away.

MR. KEMPER: This is Bill Kemper. No. We really hadn't thought about it, but if you all would like to, we certainly would be glad once we get into it to come talk to you, just like we did with Oconee. Everybody was here. We came to talk to you about that.

MEMBER STETKAR: That could be useful. I think it would be helpful for us.

MR. KEMPER: Sure. Yes, perhaps so.

MEMBER BROWN: Anything else? Any other

questions from the members?

VICE CHAIRMAN ARMIJO: I had one question. This is an improved ISG, looks very comprehensive. But a question I would like to ask is, looking back at things that you have already approved, upgrades you have already approved, how would they fare if they had been run through this review process? Is there anything that is significantly troubling to you that you might have missed in the -- that you would catch in this kind of a -- using this ISG?

MR. MILLER: I think the ISG being out would affect, really, the effort expended on the review, not necessarily the conclusion reached.

VICE CHAIRMAN ARMIJO: All the issues, determinism, complexity, independence, defense-in-depth, you believe you have covered that adequately in the prior review. So this is really more an efficiency kind of improvement?

MR. MILLER: Yes, if not having to go through more iterations of staff interaction with the licensee to get to that conclusion. All we did with the ISG-6 is just document the endpoint, how we get to the endpoint we need to get to.

VICE CHAIRMAN ARMIJO: Okay. Thank you.

MEMBER BROWN: Something I did not

realize, we do have Gordon Clefton here from NEI. I didn't realize that. I apologize for the omission. Do you have any comment or did you want to make any comment? You're welcome. We even saved you some time.

MR. CLEFTON: This is Gordon Clefton. I'll keep you on schedule.

MEMBER BROWN: That's bad news.

MR. CLEFTON: I attended the Subcommittee meeting and today just wanted to thank the NRC for the cooperation that you have had with the industry. The collaboration I think has resulted in a much better product than we would have had to try to be issued as it was originally proposed.

We have had a considerable amount of interest from the industry in making this a good document. And we, as you saw earlier in the slides, had nine or ten public meetings, subcommittees, participation.

And the way we have submitted comments was in a tabular format and with a response coming back of showing how each of our comments -- we had, what, over 200 that were in there -- showing in the right-hand column of how each comment was addressed certainly makes it easier for me to go back to our members and

explain why a comment was accepted, what changes are occurring.

And that represent a significant amount for Norbert, Ed, and Lois to make sure that we understood the decisions that were being made from here. So we appreciate that.

When you come to the last slides that you have up here, those last couple items, where you say you are going to update this one based on the pilot, Scott Patterson from Diablo Canyon is very cooperative with us and will make sure that we get good feedback about where each part works in this.

We're trying to use as much of the guidance document as we can. It's there to show us what is needed when with an explanation of why. And, as we have all tried to do, it is a guidance document for both the NRC and for the industry so the industry can provide better applications.

The path down the road is better explained. We're trying to reduce some of the barriers so that we can actually solve this obsolescence problem with analogue, get into the digital world and start catching up.

So thank you for your time. And we're looking forward to continued performance and

collaboration with the NRC as we make this into a permanent durable guidance and as we upgrade the existing guidance document with the pilot. Thank you.

MEMBER BROWN: Thank you, Gordon. I wanted to thank the staff for a very good presentation, also for a very good Subcommittee meeting that we had a couple of weeks ago.

And, with that,I turn it back over to you.

CHAIRMAN ABDEL-KHALIK: Well, thank you, Charlie.

At this time, we will go off the record. Our schedule calls for us to go on a break at 10:30. So we have a 15-minute window, which I would like to use to go over John's modified letter, the changes that are relatively small. And we have copies of the letter for people to look at fairly quickly. We're off the record. Thank you.

(Whereupon, the foregoing matter went off the record at 10:15 a.m. and went back on the record at 10:49 a.m.)

CHAIRMAN ABDEL-KHALIK: We're back in session. The next item on the agenda is staff efforts to address containment liner corrosion. And Dr. Armijo will lead us through that discussion.

VICE CHAIRMAN ARMIJO: Thank you, Mr.

Chairman.

9) STAFF EFFORTS TO ADDRESS

CONTAINMENT LINER CORROSION

9.1) REMARKS BY THE SUBCOMMITTEE CHAIRMAN

VICE CHAIRMAN ARMIJO: This morning the Committee will be briefed by Paul Klein of NRR and Darrell Dunn of RES on the issue of container liner corrosion.

The last ten years roughly, there have been five instances of significant container liner corrosion in U.S. plants. We addressed this issue in some detail in our review of the Beaver Valley license renewal application last year. And in the course of that, I believe in our letter, we requested that we be kept informed of the progress in resolving what might be a generic issue.

And so, with that, I will turn it over to Mr. Dunn or Mr. Klein. We can go from there.

MR. KLEIN: Thank you.

9.2) BRIEFING BY AND DISCUSSIONS WITH

REPRESENTATIVES OF THE NRC STAFF

MR. KLEIN: Good morning, ACRS. I'm Paul Klein from NRR. And seated off to my left is Mr. Darrell Dunn from the Office of Nuclear Regulatory Research. It is our pleasure this morning to have the

opportunity to give you an update on staff efforts related to container liner corrosion.

Next slide, please. The purpose of today's presentation is to provide a status update of some of the activities the staff has undertaken since you last heard about the Beaver Valley incident last September.

Our presentation this morning is really broken into four parts. I'll be covering the first two bullets shown on this slide. And Mr. Dunn will discuss the second two bullets. The bulk of our presentation is going to talk about what NRR and Research have been doing.

Next slide. By way of background, I think you are all familiar with the Beaver Valley incident. There have been a few cases of through-wall liner corrosion initiating from the liner to concrete interface; in other words, from the outside surface in. The most recent occurrence of that was Beaver Valley in April of 2009.

This Committee was briefed on that several times. The latest briefing was in September of 2009. Later that month, we received a letter from Ed Hackett to the EDO requesting a brief on staff efforts related to liner corrosion.

Next slide. First question I guess one can ask is, why does steel corrode in the presence of concrete? We know that the water in concrete is typically very high pH, on the order of 12 and a half to 13 and under that type of environment would expect that the carbon steel materials would be acting very passively, have very low corrosion rates.

So in the occurrences of OD liner corrosion, there's been disruption of the basic environments that are typically created at the liner-concrete interface. And that can lead to increased corrosion susceptibility, not unlike cases where rebar in concrete for bridges or other structures corrode cone you get ingress of chloride or other contaminants.

Next slide. So there have been occasions of both corrosion of the liner from the OD and also from the ID. Typically the ID corrosion has occurred at floor to wall joints, where moisture barriers have failed. And there's been moisture that accumulates and causes corrosion of the ID. The staff, however, thought we would focus our efforts on the OD-initiated liner corrosion for a couple of reasons, and it mostly related to the challenges associated with finding that.

Licensees perform visual exams according to section 11 of the code, but, unfortunately, when you have NDE-initiated corrosion, those inspections really don't detect liner corrosion until you have perforated the wall, which is not a good situation.

With respect to different NDE techniques, it is very difficult with the current technology to try and do large-scale screening to look for the type of foreign objects that might be present, such as wood or other things that would cause increased susceptibility.

UT sampling can occur. And that is helpful for interrogating small areas, but there is really not a good technique that would look at the large surface areas associated with containment liners.

Next slide. Thank you. So we have taken a number of steps since last fall, and I would like to cover those in these slides. We issued information notice 2010-012 to inform the industry about the occurrences at Beaver Valley. And also there were two other cases of liner corrosion, one of which was from the ID. So we have been trying to make sure industry is aware that liner corrosion is occurring and is something that needs to be considered.

Staff has also discussed at the ASME code section meetings the Beaver Valley incident. And that is currently being tracked under generic containment issues. And we will continue to engage the ASME code, as appropriate.

We also went back and enhanced the NRC refueling and outage baseline inspection procedure, mostly to heighten awareness for the inspector that they should be looking for things such as blisters or rusting or other things that could be indicative of a more larger problem.

MEMBER RAY: Question. Give us any insight to the section 11 discussions. Do you have any idea what stage they are at, what people are thinking about?

MR. KLEIN: I think there was a fair amount of discussion after Beaver Valley. And I think that the code committee at this point decided not to pursue any immediate action. So it's something that's more being tracked in a database at this point. And I think should there be additional experience of liner corrosion, those things will be revisited.

MEMBER RAY: Okay. Well, that's fine, but we shouldn't imagine that there is some active --

MR. KLEIN: Yes. I --

MEMBER RAY: -- search for further action or requirements taking place now, then?

MR. KLEIN: I don't think there's any further immediate action code-wise. We'll talk about some other things that are going to be going on.

We also issued a user need. NRR issued a user need to research to reflect some support. And we'll talk about that in more detail in the following few slides.

Of course, we are also monitoring the results of Beaver Valley UT inspections that they committed to following their instance of liner corrosion.

Next slide. This slide really talks about the heart of the user need that NRR sent over to Research. It's broken down into three main tasks.

The first task was to ask Research to take a comprehensive look at all the information that might be available in the area of liner corrosion. And that involved a pretty large effort to look at a number of sources. And Darrell will discuss that in much more detail in a few slides here.

We also wanted them to try and identify the corrosion mechanism related to through-wall liner corrosion. So a number of discussions were held with

the licensee when Beaver Valley had their corrosion -- were very interested in what type of conditions are needed to initiate attack, what key parameters may be affected in a corrosion mechanism. Are there things that are all day one issues that guard -- that determine the corrosion mechanism or there are things that might be done on an operational basis that affect the corrosion mechanism?

And the final task that we asked them was to take all the information that they compiled from the earlier tasks and then tried to determine if there were either certain plant designs or construction practices that would result in greater liner susceptibility.

MEMBER RAY: On the first sub-bullet under the second, is a foreign object needed, the implication of that -- I'm asking a question, I'm trying to ask a question anyway -- would be that, well, no. Maybe there are some design aspects that have the same potential.

I'm thinking of seals, where there is not concrete for the steel but there may be some other medium. Is that included, for example, in that question?

MR. KLEIN: I think so. Part of

identifying the mechanism, really, is to look at all possible things that could drive that and try to determine which things are key and which ones are not.

MEMBER RAY: Yes. Well, I would have assumed that. I just want to be sure that spaces that are there for thermal expansion or whatnot that may result in lack of contact with the concrete, those would be included in this mechanism identification, I would thin k.

MR. KLEIN: One of the items that was in the information notice that I referenced a few slides back was a personnel air lock penetration and corrosion that occurred there. So we are mindful of those things.

And there was -- and Darrell will talk about this more, I think, but there was a lot of discussion with an expert panel about conditions that could initiate corrosion.

MEMBER SHACK: In that particular one, were you missing the concrete behind the steel, as you occasionally do in things like air locks?

MR. KLEIN: No. They actually had a felt layer that became --

MEMBER SHACK: Spacer?

MR. KLEIN: Yes. It became wedded and sat

there on top of the carbon steel.

MEMBER BANERJEE: Paul, I have a question. Is there a task or something that you're thinking about to find out how good inspection is in detecting these things? These are the inspection procedures that people are undertaking.

MR. KLEIN: That's one of the things we have talked to Research about, but it hasn't been really a focus because our thought was we really needed to understand the mechanism before we diverted our attention and started looking at NDE techniques.

MEMBER BANERJEE: Maybe Research is not the right people to answer that question.

MR. KLEIN: We have had discussions with industry. And I think Darrell will maybe mention some of the discussions that we have had with EPRI. They sat in as a nonparticipating panel member. And they are proposing to the utilities a program to evaluate this type of thing with new NDE techniques. That's one of the things that we will be tracking.

MEMBER BANERJEE: Can these new NDE techniques give you wider coverage of area than the current techniques?

MR. KLEIN: That is the hope, but, you know, just based on the discussions that I heard

during the expert panel workshop, I don't know that there is a silver bullet in the near term that would allow you to go out and inspect massive areas in a reliable way.

MEMBER SHACK: Guided waves?

MR. KLEIN: Perhaps. Well, at this point I --

MEMBER SHACK: Great white hope.

MR. KLEIN: At this point I would like to turn the presentation over to Darrell Dunn.

MEMBER BANERJEE: So you managed to escape from GSI-191, I noticed.

MR. KLEIN: This is a temporary break from effects from GSI-191.

(Laughter.)

MR. DUNN: Okay. While Paul was on break from GSI-191, actually, during the development of the NRR user need request and in our subsequent work in this area, the staff from NRR and Research had meetings where we exchanged information, reviewed progress on the different tasks. And in the case of task 1, where we were trying to summarize the historical information, we also identified in our discussions the types of documents that needed to be reviewed.

So I have listed a few of them here on this slide. We looked at probably more than 250 licensee in-service inspection reports for nuclear power plant containments that had a liner in contact with carbon steel.

We also looked at licensee event reports, where we knew there was some documentation of the through-wall or external corrosion events. We looked at NRC inspection reports, where there were pressurized water reactors that had undergone changes in the reactor pressure vessel head or steam generator replacements through temporary openings in containments, as Beaver Valley did in 2006, where they identified the three areas of corrosion. And there are actually 21 plants that had changed either reactor pressure vessel head or steam generator or both that have a containment liner. And they made a temporary opening in the containment to facilitate that.

And, then, finally, we look at some NRC inspections that were created for license renewal applications.

CHAIRMAN ABDEL-KHALIK: On the second bullet, how many LERs have been issued related to this?

MR. DUNN: I don't have the number of

that. In addition to the LERs, we also looked at the International Incident Reporting System. That's how we found one of the later cases that I will describe. I am not sure how many we actually looked at there.

CHAIRMAN ABDEL-KHALIK: Okay.

MR. DUNN: We looked at also the foreign experience. There are some reports that are generated by either IAEA or NEA. And we have some colleagues in France, Japan, and Sweden. We asked them for information about their experiences in container liner corrosion. And all of this was assembled in a summary report that was issued in June 2010 in response to the first task.

So, just to give some idea of what plants we were looking at, the table here shows the number of boiling water reactors and pressurized water reactors that are currently operating in the U.S., so 35 boiling water reactors, 69 pressurized water reactors, 104 reactors operating. Thirty-eight of those plants have freestanding steel containments. And that is not the focus of what we were looking at here.

Twenty-eight of those plants have reinforced concrete in contact with the steel liner. And 38 have post-tension concrete construction in contact with a steel liner. So those 66 plants with a

steel liner were the focus of our work.

Just to kind of summarize the history of previous events. We documented this in our summary report. In Brunswick 2, unit 2, in 1999, there were actually three areas where there was identified wall corrosion. One of these was determined to be initiated from the inside to the outside. One of these was determined to be initiated from the outside, or the concrete side, to the inside. And there were a couple of pieces of debris that were found in the concrete wood in a worker's glove.

For North Anna-2, 1999, there was a blister found in the containment liner paint, in the dome of the containment. And when that blister was removed, corrosion products were discovered. And ultimately what was found was a four-inch by six-foot piece of lumber that was left in the dome of the containment. That piece of wood was removed. Concrete was grouted. And the liner section plate was replaced.

D.C. Cook had also a through-wall hole in their containment. It was very small, 3/16 of an inch. It was determined by the licensee to actually be an accidentally drilled or improper repair of an accidentally drilled hole, but when they removed that

section of liner pipe, they found some corrosion on the back side of the liner.

And also in the vicinity, they found a wood-handled wire brush, which they determined was not the cause of corrosion of the containment. And that piece of liner plate was replaced. And, of course, the concrete was grouted prior to the liner plate being replaced.

Beaver Valley 1 in 2009 I think is probably familiar to everyone here where there was a blister found in the paint. And once the blister was removed, corrosion products were discovered. There was a hole approximately one inch by three-eighths of an inch in the containment liner and a piece of wood that was found. On the back side of the containment, there was a two-by-four that was approximately six inches long.

We did in our search for information find one international incident where there was a through-wall container liner corrosion identified. This was actually a plant in Sweden. It's Barsebeck-2. This event was actually 1993, instead of 1999, as the slide indicates.

In this particular case, there was an electrical penetration going through the containment.

The containment design is different from what we have in the U.S. It actually has about a 900-millimeter thick layer of concrete on the outside, a 7-millimeter liner that is embedded in the concrete. And then on the incise of that containment, there is another 200 millimeters of concrete. So the liner itself is not actually exposed on the inside of the containment.

They had this electrical penetration with poorly consolidated concrete in the area of that passthrough that allowed water to go inside of the concrete, contact the liner, and cause corrosion. This was identified by actually a failed integrated leak rate test. And subsequently they removed the concrete and found in the area of this electrical penetration the corroded liner.

There is, of course, the Beaver Valley 2006 case, where external corrosion was identified after the concrete was removed for steam generator replacement. The root cause analysis indicated this was an oxygen concentration cell for a localized corrosion process.

MEMBER BLEY: I'm just trying to understand the Barsebeck one. With this thing covered by concrete on both sides, how did they find it?

MR. DUNN: Well, they failed the leak rate

test.

MEMBER BLEY: Well, yes, but that could be anywhere inside the containment.

MR. DUNN: Right. I believe that they --

MEMBER BLEY: -- this thing buried in concrete.

MR. DUNN: Yes. I believe they did local testing of penetrations to identify --

MEMBER BLEY: Okay.

MR. DUNN: -- to meet what is likely occurring.

MR. DUNN: For the Beaver Valley 2006 case, the root cause analysis, again, was oxygen concentration cell corrosion. There were, however, pieces of wood that were found in the debris pile where the concrete was removed. Licensee had determined that the wood was not embedded in the concrete, even though it did have some evidence of water damage and where there was no analysis of wood conducted, as there was in the 2009 Beaver --

MEMBER SHACK: That was a very limited corrosion in that case, right? I mean, it wasn't very deep.

MEMBER SIEBER: Through-wall.

MR. DUNN: It wasn't through-wall, but the

maximum depth of corrosion in that --

MR. KLEIN: 50 mils or something?

MR. DUNN: No, no, no. Maximum depth of corrosion was 220 mils, so more than halfway through-wall.

MEMBER SHACK: You took a lot of it, yes.

MEMBER BANERJEE: What type of corrosion was it? Was it sort of pitting over a large area or --

MR. DUNN: Three different areas of corrosion were identified. One of them looked to be a large area of pitting corrosion. One area was quite interesting in its appearance because it had a shape that appeared to be rectangular, where there was a fair amount of metal that had been removed. And another area was maybe only shallow pitting corrosion that had occurred on one particular part of the line.

The licensee did provide good pictures and analyses of those areas in their 2006 report.

MEMBER BANERJEE: And the area that you said was rectangular, what was the nature of the corrosion?

MR. DUNN: Well, the rectangular area was the area where the steel was reduced in thickness. So it appeared as though there may have been something

there that was causing a loss of section thickness there in that area of the containment wall or the liner wall.

MEMBER BANERJEE: But the mechanism or what caused the corrosion wasn't --

MR. KLEIN: I think it's difficult sometimes to know the mechanism because of the possibility of corrosion during construction, post-construction. So I don't know that mechanism was identified in that case other than three areas were noted that were relatively close to each other.

MR. DUNN: There was no -- again, there was wood found, but it was determined not to be the source of the corrosion initiation of the liner. The root cause analysis conclusion that it was oxygen concentration cell corrosion essentially means they have a localized corrosion process where there is active corrosion of the liner in certain areas of the liner. And then some other parts of the liner are effectively acting as cathodes to support that, the corrosion reaction.

VICE CHAIRMAN ARMIJO: That root cause analysis was done in the 2006 time frame. Did Beaver Valley people reconsider that after the 2009 event? It seemed like a weak root cause.

MR. DUNN: Well, in the 2009 event, they obviously found wood right behind the hole in containment.

VICE CHAIRMAN ARMIJO: Smoking gun.

MR. DUNN: But, to answer your question, there was no review of the wood that was found in the debris pile in 2006 after the 2009 event.

VICE CHAIRMAN ARMIJO: Yes. Okay.

MR. DUNN: Okay. So this slide 11 has additional cases where wood was found embedded in the concrete without liner corrosion. Two of these plants, Arkansas Nuclear One and Point Beach, are actually post-tension plants. They're the only post-tension plants that we found that had embedded wood in the concrete.

For Arkansas Nuclear One, the small pieces of wood were found that were very near the surface. This was found during an inspection of the outside of the containment surface. The wood was essentially five inches by two inches by two and a half inches.

There was some cosmetic repair of the concrete done after the wood was removed but none of the outer rebar. There is a layer of rebar in the post-tension plants. None of that rebar nearest the surface of the containment was exposed.

For Point Beach, the licensee determined that the wood was dry. That particular containment building has a facade around it. And, from what we can see from the licensee's report, that wood may have actually been left in place. Again, it was determined not to be of consequence to the container.

North Anna-1 -- of course, North Anna-2 had a through-wall. North Anna-1 after NRC inspections were required found six pieces of wood in their containment. One piece was in the dome, was visible from the outside, but actually penetrated all the way through the concrete of the dome and touched the liner. They did some UT of the area of the liner where the wood was in contact with it and determined there was no loss of section thickness.

All six pieces were removed. And where three of those pieces were removed required repair of the concrete. In the case where the piece of wood was going all the way through the dome, the licensee determined that there was no exposed rebar that was found when the piece of wood was removed.

There is, we also found, one additional case. It doesn't show up in the licensee's in-service inspection reports, but D.C. Cook 1 -- D.C. Cook 2 had an improperly drilled hole, but D.C. Cook 1 in 2002,

there were two pieces of wood found near the external surface of the concrete and also one piece of plastic.

So during our analysis of the historical events for liner corrosions, there were discussions held between NRR and RES. And we determined that the best way to address as to determination of the liner corrosion mechanism was to see if we could assemble an expert panel.

So Research contracted with Sandia National Labs to assemble an expert panel and conduct a workshop on containment liner corrosion. Sandia National Lab has a history of doing containment research for the Nuclear Regulatory Commission, and they have experience in nuclear power plant containment design and operation, effects of containment corrosion and degradation, and also non-destructive examination. Of course, they have done some modeling and scale testing of nuclear power plant containments.

During our discussions with NRR, we determined that there were several areas of expertise that would be necessary to arrive and to get an idea of the containment liner corrosion mechanism. So I have listed those areas of expertise here in the order in which they were ranked.

So the top priority was understanding the corrosion of steel in concrete; closely followed by nuclear power plant containment structure design, construction, and operation. The third area of expertise was concrete aging and degradation, followed by concrete and steel non-destructive examination, characterization testing, and sampling of concrete well. And the final area of expertise that was desirable was concrete repair and corrosion mitigation.

We contracted with Dr. Jason Petti, Sandia National Laboratory, to head our expert panel. Dr. Petti is a principal member of the technical staff at Sandia in the Structural Integrity and Licensing Support Department. He has experience in assessment of structures and components related to nuclear power plants and also age-related degradation in nuclear power plant containment vessels.

The expert panel consisted of five members. Bryan Erler is currently the Chairman of the ASME Board of Nuclear Codes and Standards. He is President of his own company, Erler Engineering, but prior to that, he worked for Sargent and Lundy and was responsible for the design of 19 containments.

Professor Alberto Sagues is a

distinguished professor in the Department of Civil and Environmental Engineering at the University of South Florida. His expertise is in corrosion of steel and concrete and corrosion protection. He was formerly a member of the Nuclear Waste Technical Review Board.

Dr. Dan Naus is a distinguished research staff member at Oak Ridge National Laboratory. He has experience in nuclear containment vessels, aging and degradation, and also non-destructive examination of concrete structures.

Professor Richard Weyers from Virginia Tech brought experience in corrosion aging mechanism, rebar corrosion, and concrete repair and rehabilitation.

And our final panel member, Dr. Neal Berke, is a research and development fellow in the innovative research group at W.R. Grace Construction Products. And his expertise is concrete durability, corrosion, concrete chemistry, and cement technology.

In addition to those five panel members, we also had two representatives from EPRI in the workshop. Mr. Henry Stephens is senior project manager at EPRI's NDE Center. And he has experience in quality assurance, non-destructive examination, and in-service inspection for the electrical utility

industry.

And, finally, Mr. Nathan Muthu at EPRI is currently involved in the development of NDE methods for containment liners.

The workshop for the expert panel was held on September 2nd and 3rd, 2010. We provided the expert panel with the summary report that was completed in June 2010. And we asked the expert panel to provide input on a number of different areas that I have listed here on slide 14.

First, of course, was identification of the liner corrosion mechanisms, aging environmental factors that affect concrete degradation and containment structures, and corrosion of steel, methods to evaluate aging effects and degradation of concrete structures, non-destructive evaluation methods to detect both construction defects in concrete, as well as corrosion of the liner, contact with the concrete. And our interest here was really methods to affect externally generated corrosion or corrosion at the liner-concrete interface.

We also looked for a summary of industrial experience using methods to prevent or mitigate concrete degradation and corrosion of steel and concrete.

And, finally, we asked the expert panel for their input on possible future research needs to evaluate the containment liner corrosion mechanisms.

MEMBER RAY: Great. Before you go on, I have looked ahead. So this is the place I want to ask the question, same question I asked before. In the first bullet up there, "Identification of corrosion mechanisms," what it looks like is that it's only defects that are addressed later. Did this identification mechanisms include designs that absent the defect, even, would create conditions or allow conditions to exist that would result in corrosion or not?

MR. DUNN: Yes. In your previous question, you asked about the gaps between the concrete and the --

MEMBER RAY: Yes. Typically they are filled by something like felt or something like that.

MR. DUNN: Well, in the reinforced containments and maybe in the subatmospheric containments, too, one of the questions would be, is there a gap between the steel and the concrete? And what effect does that have on corrosion?

We would expect that if there was water there, that if it was a equilibrated well with

concrete, that it would be basic and you would still have passivity to the --

MEMBER RAY: I'm thinking more at the interior surface was below the refueling floor, some place like that, where you have a seal typically around on the inside surface.

MR. DUNN: Our focus here in this work was only liner corrosion that's generated externally, --

MEMBER RAY: Right.

MR. DUNN: -- so at the concrete-liner interface,

MEMBER RAY: Right.

MR. DUNN: -- not any moisture barrier --

MEMBER RAY: Well, I think that is important. And that is why I am sort of belaboring it. That's fine. I just want to make sure that this doesn't include conditions that may exist -- I'm not saying they do -- may exist where there is a deliberate gap, which typically there is between internal concrete structures and the inside surface of the steel, which is not in contact with concrete but which also cannot be inspected. You didn't include that I think you said.

MR. DUNN: No. Our focus was --

MEMBER RAY: All right.

MR. DUNN: -- corrosion of the liner that would be initiated at the liner-concrete interface or where you should have a liner-concrete interface.

MEMBER RAY: Right, right, right. But because you say, "corrosion mechanisms," it could have included mechanisms that exist in places like I mentioned as well. But you're saying you didn't look at that?

MR. DUNN: No. That was not the focus of our --

MEMBER RAY: All right. That's fine. Because that will be an item of interest at some point I judge. I just want to make sure that we all understand that that wasn't looked at here.

MR. DUNN: No.

MEMBER RAY: Okay.

MEMBER SHACK: But did you talk to them about the case where you have the shell buried in the concrete and there may, in fact, be a lot of water in that?

MR. DUNN: Yes. In the summary report, this information is included in there. We tried to have a complete picture of what has happened before for liner corrosion events, but our focus here was to understand the mechanisms for corrosion that should

start at or have been started at the liner-concrete interface.

MEMBER SHACK: Well, in the buried one, of course, both sides count.

MR. DUNN: Well, that's right. Both sides are buried. But in those cases, a lot of times what happens is you have contaminants from water inside the containment, goes through your joints in the concrete or ineffective moisture barrier seals and --

MEMBER RAY: Well, I am not worried about the region right up near the seal. We're talking, you know, the underneath down low.

MR. DUNN: Right.

MEMBER RAY: Well, I am worried about the other part.

MEMBER SHACK: But that is a different sort of --

MEMBER RAY: I understand. I'm not trying to pursue something off course here. I just want to be sure that scope we're talking about. And, to be honest, we have had some evidence of corrosion in that area. And as long as we're not addressing it here and we all understand that, that's fine.

MEMBER BANERJEE: Why did you limit the scope?

MR. DUNN: The previous events were moisture barrier degradation, degraded coatings. It was felt that those had been addressed in previous information notices and for the current inspection requirements for IWE for the containments.

MEMBER BANERJEE: So you knew what was going on there?

MR. DUNN: Oh, yes. Oh, yes. And when we reviewed the more than 250 in-service inspection reports, we tabulated plants where the licensee documented that they had corrosion in the area of the moisture barrier seal or they had degraded coatings or degraded coatings and evidence of corrosion at the liner.

MEMBER BANERJEE: So the rationale was you didn't understand the mechanisms very well as to what was going on with the --

MR. KLEIN: I think the other rationale is with a lot of the previous incidents of moisture barrier degradation and corrosion, it's easier to detect. There's usually evidence of rusting or some other thing. Licensee should be looking for that type of thing already.

So our concern was more on something that isn't readily detectable and you find that when you go

out and do an inspection, you have a hole in the liner.

MEMBER SIEBER: I think the issue of subatmospheric containments, that the liner separates from the concrete just from the vacuum that's inside containment is factual. That has been measured in plant and was recognized at least 25-30 years ago.

But it also appears that the presence of wood is a really bad actor in accordance with the liner surface. And that has -- I noticed when I looked at the list of plants that there was a commonality of the constructor for several of them.

MR. DUNN: Right.

MEMBER SIEBER: And it may have been a practice which later plants I think ceased to use wood as a way to crop up rebar away from the liner. And that probably occurred in the early 1980s, where they quit doing that.

MEMBER BANERJEE: They have several plants where the wood in contact maybe didn't get corrosion, right?

MEMBER SIEBER: Yes.

MR. DUNN: The only case where we had wood in contact with the liner that we could find where there was no corrosion was North Anna-1.

MEMBER SIEBER: Right.

MR. DUNN: And that is an unusual case because you have a very long piece of wood that is visible from the outside surface of the containment going all the way through the concrete and contacting the liner. All the other cases where wood has been found in contact with the liner --

MEMBER SIEBER: Correct.

MR. DUNN: -- there has been a need to remove a section of the liner and see what happened.

VICE CHAIRMAN ARMIJO: I think we had better move on here.

MR. DUNN: Okay. So the schematic that I have here is our cross-section of a reinforced concrete containment. It's not exactly to scale, but it is probably pretty close and gives you an idea of some of the challenges that we're looking at.

So we have this small piece of wood shown here as the yellow block against the blue steel liner. And that piece of wood is used to space the rebar. And I have shown this as number 18 rebar. So this rebar is about two and a quarter inches in diameter.

If you were to space that rebar away from the liner when the rebar is being placed and prior to the concrete being poured, you can see that there are

actually two layers of rehab, some horizontal and vertical pieces near the liner. I've shown the Nelson studs that you have in the case of, say, Beaver Valley, where you have the studs actually welded to the liner and are designed to promote integration of the liner with the concrete.

And then near the outside surface of the containment, there is another layer of rebar. And I have shown this as some horizontal and vertical as well as some 45-degree rehab placements.

What I haven't shown in this containment is there are some tie bars that actually connect and would actually go horizontally through this structure.

MEMBER SIEBER: Right.

MR. DUNN: And those would effectively electrically connect the layers of rebar and even the liner in reinforced concrete containment.

MEMBER SIEBER: They go horizontally from between the vertical sections.

MR. DUNN: Right.

MEMBER SIEBER: And they're pretty extensive.

MR. DUNN: Oh, yes.

MEMBER SIEBER: They're thick, I mean, a lot of them.

VICE CHAIRMAN ARMIJO: Darrell, another thing you haven't shown is microcracking of the concrete itself because you've got to have an electrolyte and you have to have oxygen. And the thing that bothered me about Beaver Valley is how could a piece of wood that's been buried there for many, many, many years contain sufficient water to cause that much corrosion unless it had a replenishment in some way?

MEMBER SIEBER: Well, maybe I can address that partially. The Beaver Valley containment after the first containment pressurization test, what they did was they went over the outside of the containment. They painted stripes on all the cracks they found. And there are through-wall cracks that occurred in that containment and I imagine in every other containment, which is the reinforced concrete liner design because the design pressure test --

MR. DUNN: Sure.

MEMBER SIEBER: And the concrete itself is pretty brutal, even though the rebar and the liner are not. And so there could easily be pathways through the concrete to the liner.

MR. DUNN: Our discussion on our expert panel workshop, the ideal water-cement ratio is about

.45. It was felt that most of the containments that were built in the U.S. probably had higher water-cement ratios. And, really, the panel felt that there is enough water in the concrete to support the electrochemical reactions or provide the ionic connectivity necessary to have the electrochemical reactions, particularly when you have these large areas of rebar that are connected.

There are also cold joints in the pores. And depending on how those cold joints are positioned and how, whether or not they're only horizontal or vertical, they may also be sources of ingress.

MEMBER SIEBER: Well, if the amount of water is excess to that required to solidify the concrete, that stays in there for a long time.

MR. DUNN: Yes.

MEMBER SIEBER: I mean, it could be decades before that eventually comes out.

MR. KLEIN: The expert panel clearly thought that you would not need a scenario where you had a through-wall crack supplying additional moisture --

MEMBER SIEBER: Right.

MR. KLEIN: -- in order to dry the corrosion through-wall.

MEMBER SIEBER: Right.

MR. DUNN: This diagram on slide 16 was actually provided by Professor Alberto Sagues. And what it describes or what it shows is the macrocell corrosion that is envisioned to take place when you have a foreign body in contact with the liner and embedded in the concrete. So the foreign body basically just ruptures beneficial alkaline concrete, contact with the liner.

And we have since learned that there was some discussion in the previous meeting in September 2009 on why was this piece of wood found at Beaver Valley so acidic? There was some discussion about the use of boric acid as a treatment. And that may have made the wood more acidic.

Saturated solution of boric acid is about pH 3.7. So it seems unlikely that the boric acid alone would get you that pH. However, soft woods because they naturally produce acidic and formic acids are quite acidic.

And depending on the type of soft woods you have, those pHes can be three and a half to five. So, even if you don't have boric acid treatment of the wood, the wood itself can be acidic and would disrupt the beneficial contact or the concrete with

the liner and also disrupt the passive film on the carbon steel. The passive film on the carbon steel is not going to be stable at a pH of less than seven or eight.

So in this case, what the diagram shows is in the center here, there is a piece of wood that promotes the corrosion initiation. And those corrosion reactions also result in hydrolysis. And so those areas where this wood in contact with the concrete actually becomes more acidic because of the hydrolysis of the iron corrosion products, as we discussed in our previous slide, the concrete here has enough moisture needed to have the macrocell where you have corrosion at one part of the liner and then you have both the reinforcement in the concrete and as well as other parts of the liner act as the cathode to support that anodic reaction.

Because you have these tie bars going through the concrete and no very large amount of rebar, there is ample surface area to support to have the cathodic reaction, even with a low amount of oxygen present actually at the liner-concrete interface.

Professor Sagues did some calculations, some initial calculations. And his calculations

basically agree in terms of corrosion rates with what had been seen for the through-wall corrosion event. So he was able to calculate corrosion rates that were probably in excess of 200 microns per year for this particular scenario.

VICE CHAIRMAN ARMIJO: Locally, --

MR. DUNN: Yes.

VICE CHAIRMAN ARMIJO: -- in that local region? But did he give you a report or anything like that?

MR. DUNN: We will get a report from the expert panel that will be done at the end of November.

VICE CHAIRMAN ARMIJO: Okay. I think I would like to see it and probably members of the Committee might.

PARTICIPANT: Definitely.

MEMBER SHACK: They think, though, that the concrete is intact enough that there is, in fact, a limited oxygen present. My guess would have been the example oxygen.

MR. DUNN: Yes. Certainly if you have cracks in the concrete, even if they didn't go all the way through wall and you had cracks, even to the outer layers of rebar, because you have connection between the inner and outer layers of rebar and to the liner,

you clearly aren't oxygen-limited there.

So you have the oxygen reduction reaction taking place in the upper layers of containment supporting the anodic reaction underneath a piece of wood that is causing corrosion of the liner.

MEMBER SHACK: But it is not oxygen-limited, then. It's --

MR. KLEIN: Yes. I don't think they intended to exclude that you could get additional oxygen from cracking, but the point was --

MEMBER SHACK: It's still much --

MR. KLEIN: -- that, even if you didn't have that supply, it doesn't take a whole lot, given the anodic issue.

VICE CHAIRMAN ARMIJO: Okay.

MR. DUNN: So the preliminary insights from our expert panel are that construction defects create localized conditions that can easily result in corrosion of the liner. And there are a number of reasons that we discussed why that could be the case. The wood tends to be acidic. As far as it being a source of moisture, that is probably also true. But certainly it acts as a crevice former when it is in contact with a liner.

We had some discussions with the expert

panel about aging and degradation effects or the effects of local environmental conditions where the plant was at. And they really felt that the local environment at the liner and not the global conditions were really determined the corrosion susceptibility.

And also, as we mentioned before, the reinforced concrete plants have a very complex structure. They have multiple layers of rebar. And just the amount of rebar congestion in those plants make it easy for pieces of wood to be embedded in the concrete. And if those pieces of wood are in contact with the liner, that can be an area where localized corrosion can initiate.

MEMBER RAY: I would tell you that, even on a post-tension containment, if it's high seismic, it's going to have that same rebar density, which is really, really dense.

MEMBER SIEBER: And the other issue is --

MEMBER RAY: Yes. It's just a little bit of concrete and a whole lot of rebar.

MR. DUNN: Yes.

MEMBER SIEBER: There are instances where there are voids. And that is why constructors usually would use a wetter concrete than normal to try to avoid the voids within the concrete structure itself.

MR. DUNN: Right. In our discussion, placement of concrete in the reinforced structure was identified as challenging.

MEMBER SIEBER: Yes.

MR. DUNN: And one of the insights from Neal Berke, who does concrete chemistry, is that the concrete chemistry now uses plasticizers so that you can get flow and placement of concrete much more easily than increasing the water-cement ratios.

MEMBER SIEBER: Yes. The difficult areas were where penetrations like air locks and equipment hatches and piping would come through because they tend not to fill up to the bottom of the penetration. So if you are hunting for places to look, that is a good place to look.

VICE CHAIRMAN ARMIJO: Well, these are these. I guess they're called self-consolidating concrete mixes or something like that. And the issue there is whether we're putting stuff in there that is more aggressive for corrosion on a general sense than the normal concrete, which is fine, but for debris, you know, organic debris, like wood, gloves, and so on.

MR. DUNN: We did have a discussion of the concrete chemistry. And there was no thought that the

chemistry that was used or chemistries that would be used would be problematic for corrosion of the rebar or corrosion of the steel liner.

VICE CHAIRMAN ARMIJO: Well, I just suspect that people address that issue by experiments and some qualification programs. But if it's really new and we're starting to use it on a large scale, that's where you start finding problems that you might not have found in a limited qualification program.

MR. DUNN: I understand. We had a discussion, particularly with the EPRI staff, about the methods for non-destructive examination for detecting defects in the concrete or corrosion at the liner-concrete interface. One of the challenges is that it's a very complex structure in the reinforced concrete containments. And, even if it's a post-tension plant, this is a very thick layer of concrete.

And so methods to detect construction defects, such as wood debris left behind, really isn't a method for doing that. As we mentioned, there is some interest by EPRI to look at methods to detect corrosion of the liner at the concrete-liner interface. And we're going to follow that activity.

Aging and degradation of the concrete were

determined not to be important for the events that have been witnessed to date. But I will point out that the Japanese are actually quite concerned about this particular scenario, so carbonation of the concrete. Chloride ingress of the concrete is something that Japanese are actually looking at. It was never determined to be a problem or a factor in any of the events that have been observed in the U.S.

And, finally, there was no condition found that resulted in the containment failing to meet the 10 CFR 50 appendix J integrated leak rate test. The only one that was conducted, I believe, was North Anna. And, even with the condition they had there, the containment still --

PARTICIPANT: The hole was too small.

MR. DUNN: -- met the leak rate requirement.

MEMBER SIEBER: Yes. Actually, the hole size you would need is about two square inches to flunk the test. And with concrete backing, that impedes flow. And two inches is detectable by VT pretty easily.

MR. DUNN: The French plants that had corrosion -- I know you are familiar with where the liner meets the base mat. They have had holes about

one centimeter. And they also still passed the leak rate test.

MEMBER SIEBER: Yes. That's about two square inches.

MR. DUNN: So our path forward. The expert panel report is expected near the end of this year. And once we receive that report, the staff from NRR and Research will discuss the results of that report, the conclusions and recommendations. And we will use that to determine if additional research is necessary.

Certainly we will continue to monitor plant operating experience, both steam generator replacements, results of IWE and ILW inspections, as well as the UT inspections that are being conducted at Beaver Valley.

We are going to --

MEMBER SHACK: Have any of those been done yet?

MR. DUNN: Yes.

MR. KLEIN: Yes, they have. At this point they have looked at two of the eight non-random sites. And the results of that inspection were satisfactory. I think the thinnest measurement was more than a quarter inch above the nominal wall. And then in the

outage that just started within this past week, they have scheduled 20 random inspections, I believe.

MEMBER SIEBER: Okay.

MR. DUNN: We are, of course, going to stay cognizant of the potential EPRI program to evaluate NDE methods. This was, I believe, ranked as a medium priority. So we will see if that acts as initiated. And if it is, we will follow the development there and, then, finally, reevaluate, update the NRC regulatory positions as they are appropriate.

MEMBER BANERJEE: For the freestanding steel containments, have you found any corrosion on the outside?

MR. DUNN: We didn't specifically look at those containments. So the information that we have on that really has already been summarized in information notices and other generic communications or other assessments that were done for degradation and aging of containment structures.

There are reports. Oak Ridge National Lab has done a number of reports like that. So we don't have anything new in that area.

MEMBER BANERJEE: Are these painted in some way on the outside?

MR. DUNN: Re-stained, sure. Well, I would suspect the inside surface of the containment would be coated, and I would expect the outside surface to be coated, too. But I don't have knowledge of all of where those are --

MEMBER BANERJEE: Somebody wants to say something? Go ahead.

MR. ASHAR: I am Hans Ashar, user of license renewal. Steel containment corrosion, this is so widely disembodied in the ACRS during Oyster Creek years, which was the same year, 2000, in which it occurred. And it will be integrated so much. And the ACRS Committee members mostly thought they were annoyed because we had a whole meeting with ACRS on that particular aspect.

And another area was steel containment corrosion. We don't have many instances. We do have some type of containment corrosion in some plants, but they are being inspected by IWA examinations. And so far there has been no separation for us to figure out anything.

MEMBER BANERJEE: And are these coated, painted? What is done?

MR. ASHAR: The steel containments are coated from inside.

MEMBER BANERJEE: They're coated with what?

MR. ASHAR: Sometimes it is a zinc-related, you know, some type of zinc coating. And in some cases, there is an epoxy coating kind of. I don't know if that is on there.

MEMBER BANERJEE: Okay.

VICE CHAIRMAN ARMIJO: In your path forward, is there anything, additional requirements on construction, you know, where you built some new plants finally and construction debris seems to be the prevalent? And is there anything that NRO or yourselves are doing related to providing guidance to the licensees that say, "Hey, let's keep wood and gloves and this type of debris out of your" -

MR. KLEIN: Yes. I don't want to speak for NRO, but we are in communication with them. They are aware of the efforts that are under way. And we will keep them in the loop when we get back reports and make sure they're aware of the latest information that we have.

VICE CHAIRMAN ARMIJO: Any other questions, comments?

(No response.)

VICE CHAIRMAN ARMIJO: Well, I think we

are in good shape, Mr. Chairman.

CHAIRMAN ABDEL-KHALIK: Great. Thank you. Thank you very much. At this time we are off the record.

(Whereupon, a luncheon recess was taken at 11:51 a.m.)

Digital I&C Licensing Process

Task Working Group-6

Lois James, TWG-6 Manager
Norbert Carte, Sr. I&C Engineer
G. Edward Miller, Project Manager
Office of Nuclear Reactor Regulation

October 8, 2010

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Agenda

- Introduction
  - Purpose
  - Stakeholder involvement
  - Changes to ISG-6
- Licensing process
- ACRS comments (2009 & 2010)
- Path forward

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Introduction

- Purpose of ISG-6
  - Describe the Part 50 licensing process (per current SRP guidance)
    - Provide consistency in LAR submittals
    - Provide consistency in LAR approval
  - Describe the expectations for information to be docketed in order to address SRP criteria
  - Knowledge management
- Capture lessons learned from recent digital I&C reviews
- Modeled after RS-001 for EPUs
- “Fast Lane” approach

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Introduction - Stakeholder Involvement

- 9 public meetings held to develop ISG-6.
  - Held over the course of almost 2 years
- Over 200 industry comments have been compiled by NEI and resolved by the NRC staff.
- Comments received:
  - Clarification of description of information to be provided
  - Licensing process proposals retained for consideration
    - Reducing regulatory burden
      - **Level of detail required**
      - **Where does licensing stop**
    - Adopting license conditions to complete review
    - Portal technology

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Introduction - ACRS Review

- April 2, 2009 – Full Committee meeting
- April 21, 2009, recommendation

  "Draft ISG-6 should not be issued until Sections C and D are revised to specify that sufficient design detail be provided to ensure deterministic behavior and independence of each DI&C safety train."
- August 21, 2009 – Subcommittee on Digital I&C
  - Partially addressed ACRS recommendation
  - Focus on integrating various guidance documents
  - Independence, Determinism, Complexity, Defense-in-Depth and Diversity
- September 8, 2010 – Subcommittee on Digital I&C
  - Provided full draft of ISG-6, Including Sections C & D
  - Additional comments received

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Introduction – Changes

- ISG-6 changes include (since Aug 2009):
  - 3 new enclosures added
    - Sample SE,
    - LAR Table of Contents, &
    - Glossary
  - Cross referencing Enclosure B and body of the ISG
  - Addition of Table of Recommended Inspection items
  - Four software plans addressed by the regions (SInstP, SOP, SMaintP, & STrngP)
  - Significant detail added to the body of the ISG

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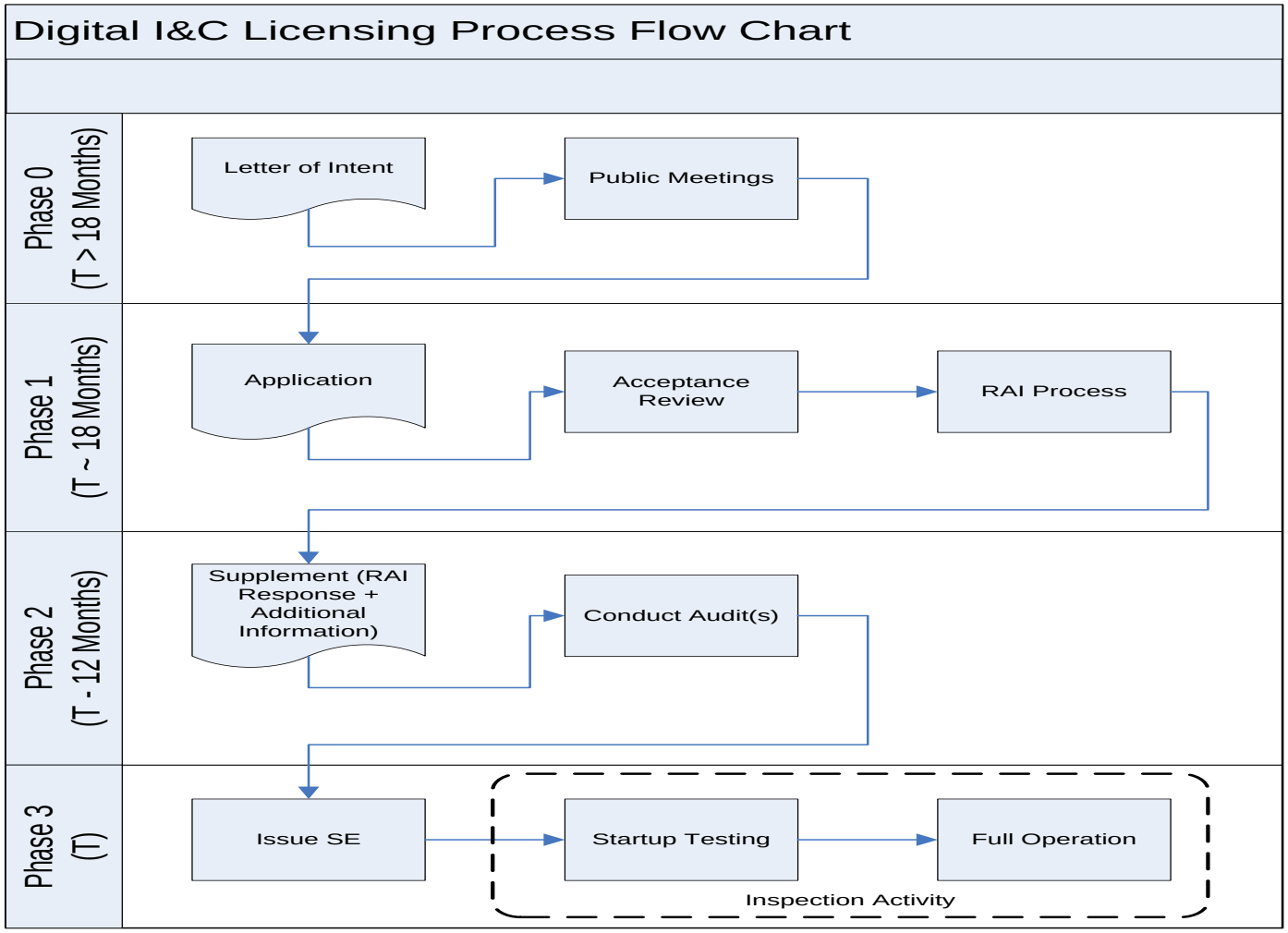
Licensing Process Overview



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Tiers of Review

- Each Tier corresponds to an expected review effort:
  - Tier 1: Previously approved system, no deviations from topical report, review to focus on plant specific aspects, least review effort expected.
    - E.g.: Diablo Canyon RTS & ESF
  - Tier 2: Previously approved system, with deviations, moderate review effort expected.
    - E.g.: Oconee RPS/ESPS, WBN2 Common Q PAMS
  - Tier 3: Totally new system, extensive review effort expected. Thorough review of all technical areas.
    - E.g.: Wolf Creek MSFIS

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ACRS Comments (2009)

- Defense-in-Depth and Diversity (D.6: D3)
- Independence (D.7: Communication)
- Deterministic behavior
  - D.4.4.3.2: “The [software architecture description] must explain how the software works, the flow of data, and the deterministic nature of the software.”
  - D.9.4.3.1: “The description should confirm that the system’s real-time performance is deterministic and known.”
- Redundancy (D.9.4.2.1: Single Failure Criterion)
- Complexity
  - Addressed in ISG-6 and discussed later in slides

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ACRS Subcommittee Comments (September 8, 2010)

Question 1

The tone of Sections B and C should be revised to match the review described in Section D

- The revision is in process to the following section
  - Section B.1, “Background”
    - Tone of Introduction will match the body of the ISG
      - » Significant detail required
      - » Review against licensing criteria
    - Examples of regulatory requirements will be expanded
      - » Defense-in-Depth and Diversity
      - » Independence / Redundancy
      - » Deterministic behavior
      - » Complexity
    - “While the NRC staff does not do an independent design review …there will be a detailed review done of the fundamental areas (e.g., Deterministic Behavior, Independence / Redundancy, Defense-in-Depth and Diversity. …).”

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ACRS Subcommittee Comments (September 8, 2010)

Question 2:

The ISG should make a clear distinction between software, hardware, and integration. Further, it should be clear that the NRC reviews more than just the process.

- ISG-6 addresses all regulatory criteria, e.g.:
  - Independence (D.9.4.2.6)
  - Redundancy (D.9.4.2.1)
- ISG-6 emphasizes aspects unique to digital I&C (software), e.g.:
  - Section B.1.1, “Principles of Review”
    - Explains basis for reviewing process
  - Review of the process is based on industry standards
    - V&V per RG 1.168 & IEEE 1012, 1028
    - Digital Computers per RG 1.152 & IEEE 7-4.3.2
    - CM per RG 1.169 & IEEE 828, 1042

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ACRS Subcommittee Comments (September 8, 2010)

Question 3

Since the licensing process ends at factory acceptance testing (FAT), how are revisions made after the factory acceptance testing controlled?

- The need for prior NRC approval is governed by 10 CFR 50.59
- Changes after approval are controlled and implemented by licensee programs which, in turn, are governed by 10 CFR Appendix B and other requirements
- HQ staff available to provide assistance to regional inspectors
  - Oconee RPS/ESPS SE had suggestions for inspections
- Regional inspections
  - Site Acceptance Testing
  - Installation Inspection
  - Site Configuration Management (under Appendix B)
  - IP-52003, Digital Instrumentation and Control Modification Inspection

ACRS Subcommittee Comments (September 8, 2010)

Question 4

Who reviews software configuration management and what is regional involvement?

- Vendor's CM reviewed during licensing process
- The licensee's control of software configuration management is governed by 10 CFR, Appendix B and other documents required in the license or Technical Specifications (e.g., Regulatory Guide 1.33)
  - Regional inspection staff review these programs and their implementation under Reactor Oversight Process
- HQ staff can review changes implemented without prior NRC review and approval (via 10 CFR 50.59), after being reported to the NRC
  - A sample of changes are reviewed
  - A digital I&C upgrade may be a likely candidate for further review by PM
  - Any problems identified are brought to the region's attention

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ACRS Subcommittee Comments (September 8, 2010)

Question 5

The discussion of Phase 0 only mentions defense-in-depth and diversity as a topic of discussion. This should be revised to clarify that there are other important topics and areas to be discussed during these meetings as well.

- All topics may be discussed during Phase 0 meetings
- List will be augmented to include other examples
  - Tier 1 – Application Specific Issues
    - Communication Independence
    - Diversity and Defense-in-Depth
    - Deterministic Behavior
    - Secure Development and Operational Environment
    - Enclosure B Documentation
  - Tier 2 – Description of Platform Changes
  - Tier 3 – Deterministic Platform Behavior

ACRS Subcommittee Comments (September 8, 2010)

Question 6

What would trigger a source code review?

- Deviation from NRC accepted approach that relied upon software
  - Oconee RPS/ESPS ISG-4
    - Software inhibit of communication vs. physical disconnect
    - Non-Safety-related data diode
  - Engineering judgment
    - If something isn't logical or understandable
    - Previous experience

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ACRS Subcommittee Comments (September 8, 2010)

Question 7

What is the division between Cyber Security and Secure Development and Operational Environment (SDOE)? How does this correlate to licensing and inspection?

- SDOE addressed during licensing review
  - Approved in SE
  - RG 1.152
    - System Integrity
    - Control of Access
    - Reliability
- Cyber Security addressed programmatically (NSIR)
  - Addressed via inspections
  - Addresses malicious actors
  - RG 5.71

ACRS Subcommittee Comments (September 8, 2010)

Question 8

How does a licensee demonstrate deterministic performance and how do we reach reasonable assurance of this?

- Review platform characteristics using guidance in SRP
  - E.g., deterministic behavior
- Application based on a deterministic platform
  - Cyclic processing
  - No dynamic memory allocation
  - Failsafe behavior
- Application poling vs. interrupts
  - No system-state based processing
  - Date communications defined by design

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ACRS Subcommittee Comments (September 8, 2010)

Question 9

How does the staff determine the complexity of a platform and does that influence the depth of the NRC staff's review? Are there any metrics to measure the level of complexity of a platform?

- Staff guidance requires comprehensive review of all system attributes
- Complex system require more effort for reviews (i.e., scope & resources)
- Currently no generally effective measures of complexity

ACRS Subcommittee Comments (September 8, 2010)

Question 10

Why is there no requirement to perform and submit an FMEA for software? How are software failure modes reviewed by the staff?

- Typically FMEA is performed to demonstrate that the single failure criterion is satisfied
- Systematic failure of software addressed by Diversity and Defense-in-Depth analysis
- Branch Technical Position 7-14, Section B.3.1.9, “Software Safety Plan”
  - Software hazards analysis are typically performed
  - No specific software hazards analysis technique is endorsed
- Additional guidance on software failure analysis may be addressed in the research program on failure analysis

ACRS Subcommittee Comments (September 8, 2010)

Question 11

Why was the phrase regarding the ability of the licensee to delegate establishing and executing the quality assurance program deleted from the section on reviewing the software quality assurance plan?

– The information was removed because it was duplicative of a statement in Section D.4.4.[1.]3. Additionally, this responsibility is codified in Appendix B to 10 CFR 50.

ACRS Subcommittee Comments (September 8, 2010)

Question 12

Section D.6.4.1, “Adequate Safety System Diversity and Manual Actions,” should be reworded to emphasize what we do verses those documents we don’t need to see.

- Will reference criteria for D3 analysis
- A D3 analysis is reviewed and addressed in SE
- ISG-6 summarizes favorable outcomes of the D3 analysis
  - Sufficient diversity exists in safety system
  - Diverse Actuation System is provided
  - Manual actions are credited

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ACRS Subcommittee Comments (September 8, 2010)

Question 13

The ACRS would like to see ISG-6 again before it is finalized.

- We will follow the agreed upon processes
- ACRS will be included as part of the formal review processes for final product (e.g., review standard or SRP update)

ACRS Subcommittee Comments (September 8, 2010)

Question 14

How will “portal” technology be implemented with respect to the ISG?

- ISG-6 acknowledges the potential for use of Portals
- Interest in using portal technology
- Develop this process outside of the ISG
- Basis of Safety Evaluation must be docketed
- Allows the staff to better focus information requests
- Reduce regulatory burden

ACRS Subcommittee Comments (September 8, 2010)

Question 15

Originally, the FMEA was required during Phase 0. Why has this been moved to Phase 2?

- Originally, the staff planned to review the draft/preliminary FMEA that was developed prior to the solidification of all the specifics of the platform.
- The staff would also review the final FMEA during Phase 2.
- Best application of resources is to only review the final FMEA in Phase 2.

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Path Forward

- Digital I&C Steering Committee will review ISG-6 after ACRS comments are addressed
- Currently scheduled issue date for ISG-6
  - November, 2010
- Diablo Canyon is the pilot plant for use of ISG-6
  - Docket LAR Spring 2011
  - Requested approval Spring 2013
  - Install system Spring 2014
- ISG-6 may be updated as a result of the pilot
- ISG-6 planned to become a permanent staff guidance

Containment Liner Corrosion

Darrell Dunn
Office of Nuclear Regulatory Research

Paul Klein
Office of Nuclear Reactor Regulation

Advisory Committee on Reactor Safeguards Brief
October 8, 2010

Outline

- Background
- NRR Activities
- RES Activities
- Path Forward

Background

- A few cases of through-wall liner corrosion initiating from the outside surface
- Most recent experience was Beaver Valley Unit 1, April 2009
- September 2009 ACRS letter requested a brief on NRC staff efforts related to liner corrosion

Steel in Concrete

- Concrete pH ≈ 12.5 to 13
- Basic environment at the liner/concrete interface should prevent corrosion by passivating the steel
- Disruption of this basic environment at the concrete/liner interface (e.g., embedded foreign material, cracks allowing ingress of contaminants) can increase liner corrosion susceptibility

Containment Liner Corrosion Challenges

- NRC staff focusing on OD initiated through-wall liner corrosion
- Visual exams performed in accordance with ASME B&PV Code Section XI, Subsection IWE, are unable to identify liner corrosion initiating from the outside until it penetrates the liner wall
- Large scale screening to look for foreign objects at the interface between the concrete and the liner not possible with current NDE techniques
- UT sampling can identify corrosion initiated at the liner OD but a full liner UT inspection is not practical

Containment Liner Corrosion - NRR Activities

- Issued Information Notice 2010-012 “Containment Liner Corrosion” in June 2010
- Discussed at ASME Section XI, Subsection IWE/IWL meeting and being tracked under generic containment degradation issue
- Enhanced NRC Refueling and Outage Activities Baseline Inspection Procedure to provide additional guidance regarding liner items that may be indicative of a larger problem, such as blistered paint and/or rust
- Issued a user need to request support from the Office of Nuclear Regulatory Research
- Monitoring the results of the Beaver Valley 1 UT inspections

NRR User Need Request

- Task 1 - Evaluate historical information related to liner corrosion
- Task 2 – Determine the corrosion mechanism related to through-wall liner corrosion
  - Is a foreign object needed for through-wall OD corrosion?
  - How do key parameters (e.g., oxygen, moisture, plant operation) affect the corrosion mechanism?
- Task 3 – Using knowledge from Task 2, determine if certain plant designs or construction practices result in greater susceptibility to liner corrosion

Nuclear Regulatory Research Activities – Task 1

- Reviewed operating experience with containment liner corrosion
  - Licensee inservice inspection (ISI) reports
  - Licensee event reports (LER)
  - NRC inspector reports during PWR RPVH and/or SG replacement
  - NRC inspections during license renewal
- Obtained foreign plants liner corrosion experience from colleagues in France, Japan and Sweden
- Summary report produced in June 2010 in response to NRR UNR 2010-002 Task 1

Containment Construction

Reactor type	Total number	Free standing steel primary containment	Reinforced concrete with a steel liner	Post tensioned concrete with a steel liner
Boiling water Reactor	35	24	9	2
Pressurized water reactor	69	14	19	36

Liner Corrosion History

- 4 cases in U.S. plants where corrosion penetration of the containment liner associated with embedded foreign material in the reinforced concrete containments
  - Brunswick-2 (1999) wood and a worker's glove
  - North Anna-2 (1999) wood
  - D.C. Cook-2 (2000) wire brush with a wood handle
  - Beaver Valley-1 (2009) wood
- 1 case of liner corrosion associated with voids/poorly consolidated concrete
  - Barsebeck -2 (1999) Sweden
- 1 case where cause of external corrosion was not identified (concrete was removed for steam generator replacement)
  - Beaver Valley-1 (2006)

Liner Corrosion History (cont)

- 3 additional cases where embedded foreign material was found without liner corrosion
  - Arkansas Nuclear One – 1 (2000) wood near the exterior surface of the concrete
  - North Anna – 1 (2001) 6 pieces of wood visible from the exterior surface of the concrete; 1 piece contacted the steel liner
  - Point Beach – 1 (2001) wood near the exterior surface of the concrete

User Need Task 2 Activities

- During analysis of historical liner corrosion and discussions with RES-NRR task force, an expert panel was determined to be the best method to inform Task 2 of the user need
- RES contracted Sandia National Laboratories to assemble an expert panel and conduct a workshop on containment liner corrosion
- Areas of expertise:
  - Corrosion of steel in concrete
  - NPP Containment structure design, construction, and operation
  - Concrete aging and degradation
  - Concrete/steel NDE, characterization testing, and sampling
  - Concrete repair and corrosion mitigation

Expert Panel Members

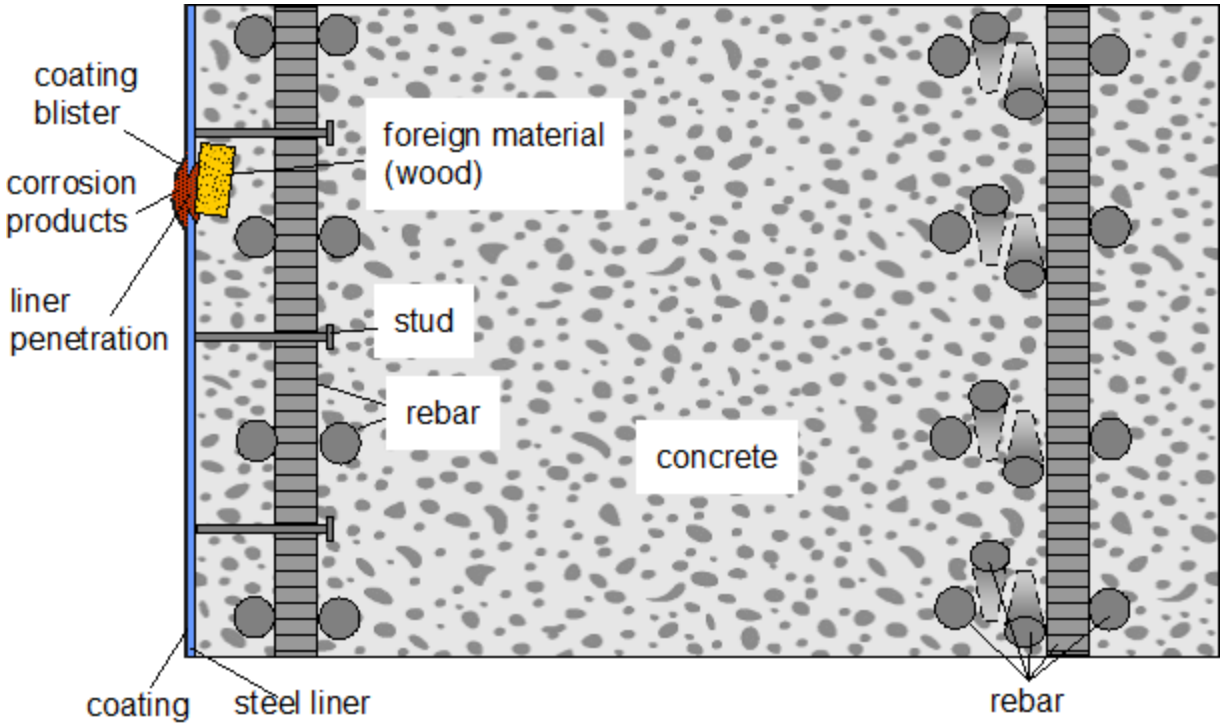
Member	Affiliation	Expertise
Dr. Jason Petti	Sandia National Laboratories	Containment structural integrity
Bryan Erler	ASME Board of Nuclear Codes and Standards	Containment design and construction
Professor Alberto Sagues	University of South Florida	Corrosion, concrete degradation
Dr. Dan Naus	Oak Ridge National Lab	Aging management, containment design and construction, NDE
Professor Richard Weyers	Virginia Tech	Corrosion, concrete degradation and repair
Dr. Neal Berke	W.R. Grace	Concrete aging and characterization
Henry Stephens *	EPRI	Containment design, NDE
Nathan Muthu *	EPRI	Containment liner NDE

* Non-panel member participant

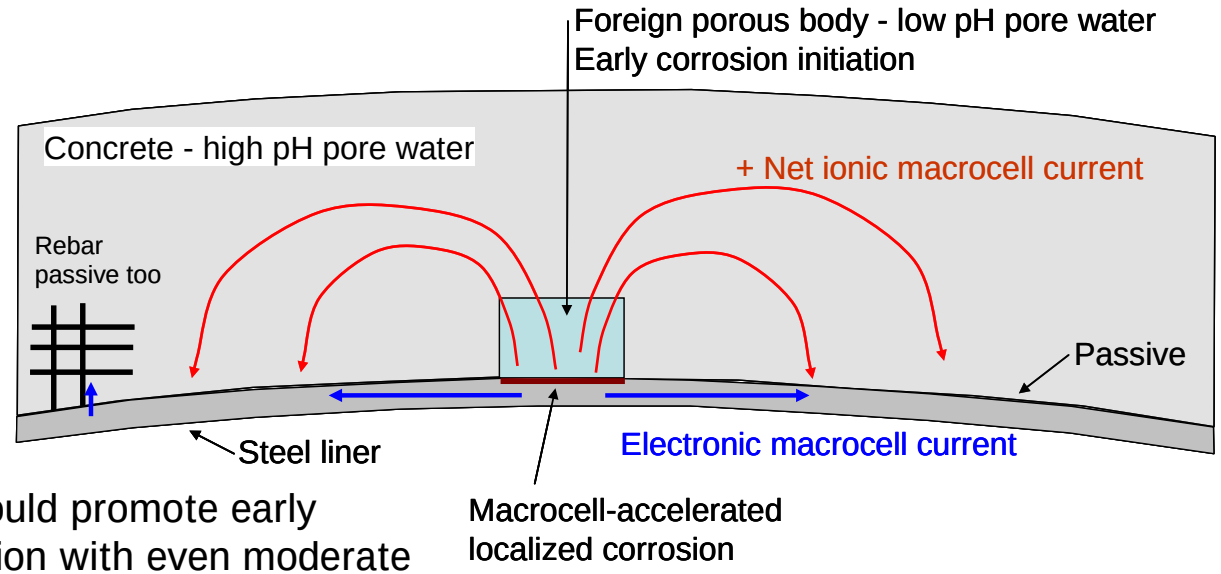
Expert Panel Tasking

- Expert panel provided with the Task 1 summary report and asked for input to the following:
  - Identification of the liner corrosion mechanisms
  - Aging and environmental factors that affect the degradation of concrete containment structures and corrosion of steel
  - Methods to evaluate aging effects and degradation of concrete structures
  - Non-destructive evaluation methods to detect construction defects, and corrosion of the steel containment liner
  - Evaluation of construction practices and concrete defects on concrete degradation and steel corrosion
  - Summary of industrial experience using methods to prevent or mitigate concrete degradation and corrosion of steel in concrete
  - If applicable, future research to evaluate containment liner corrosion mechanisms

Containment Wall Cross-Section Schematic



Expert Panel Discussions



- Foreign body could promote early corrosion initiation with even moderate pH decrease and minor chloride presence
- Concrete can provide moisture needed for macrocell
- Initial calculations are consistent with time frames for through-wall corrosion penetration
- Liner surface and rebar provides ample passive surface for cathodic reaction
- Even limited oxygen presence may provide enough cathodic action for corrosion

Expert Panel – Preliminary Insights

- Construction defects (i.e., foreign objects) create the localized conditions that result in corrosion of the liner
- Local environment at liner, not global conditions (e.g., plant operation, climate) determine corrosion susceptibility
- Reinforced concrete containment construction more prone to have foreign materials left in place due to rebar congestion
- Current NDE methods not capable of detecting foreign objects at the liner/concrete interface
- Aging and concrete degradation have not been important factors in liner corrosion events to date
- No condition found resulted in the containment failing to meet the 10CFR50 Appendix J integrated leak rate test

Path Forward

- Expert panel final report expected in late December 2010
- NRR-RES task force meetings to discuss expert panel report conclusions and recommendations
- Determine if additional research is necessary
- Continue to monitor plant operating experience
- Stay cognizant of potential EPRI program to evaluate NDE methods
- Re-evaluate and update NRC regulatory positions as appropriate

- Back-up Slides

OD Liner Corrosion History

reactor-unit	year of incident	age at time of incident	construction	liner/metal thickness	corrosion penetration	average corrosion rate	observations
Barsebeck-2 BWR Sweden	1993	16	reinforced concrete	7 mm 0.275”	7 mm 0.275”	0.44 mm/yr [17 mpy]	void in the concrete from initial construction and water accumulation
Brunswick 2 BWR Mark 1 GE 4	1999	24	reinforced concrete	8 mm 0.312”	8 mm 0.312”	0.33 mm/yr [13 mpy]	foreign materials in concrete
North Anna-2 PWR W-3LP	1999	19	reinforced concrete sub-atmospheric	10 mm 0.375”	10 mm 0.375”	0.5 mm/yr [20 mpy]	foreign material in concrete
D.C. Cook 2 PWR W-4LP	2000	22	reinforced concrete ice condenser	10 mm 0.375”	10 mm 0.375”	0.43 mm/yr [17 mpy]	foreign material in concrete. unclear if penetration was exclusively from corrosion
Beaver Valley-1 PWR W-3LP	2006	30	reinforced concrete sub-atmospheric	10 mm 0.375”	1.1 - 5.8 mm 0.045 - 0.227 in	0.04 - 0.2 mm/yr [1.5 – 7.5 mpy]	3 areas of corrosion concrete pH < 11
Beaver Valley-1 PWR W-3LP	2009	33	reinforced concrete sub-atmospheric	10 mm 0.375”	10 mm 0.375”	0.29 mm/yr [11 mpy]	foreign material in concrete

Reinforced Containment