Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
U.S. EPR Subcommittee

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Tuesday, February 21, 2012

Work Order No.: NRC-1468 Pages 1-276

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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U.S. EPR SUBCOMMITTEE

+ + + + +

TUESDAY

FEBRUARY 21, 2012

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Dana A. Powers, Chairman, presiding.

COMMITTEE MEMBERS:

DANA A. POWERS, Chairman

CHARLES H. BROWN, JR., Member

MICHAEL T. RYAN, Member

JOHN STETKAR, Member

GORDON R. SKILLMAN, Member

NRC STAFF PRESENT:

KATHY WEAVER, Designated Federal Official

STEPHEN HAMBRIC, NRO

RENEE LI, NRO

JULES LINDAU, NRO

MICHAEL MIERNICKI, NRO

ERIC REICHELT, NRO

DAVID TERAO, NRO

GETACHEW TESFAYE, NRO

JIM XU, NRO

ALSO PRESENT:

JOSEPH BRAVERMAN, BNL

JOHN BURGESS, AREVA NP

NISSEN BURSTEIN, AREVA NP

CARL CONSTANTINO, NUMARC

DAVID FOSTER, NUMARC

MARK FOSTER, AREVA NP

DARRELL GARDNER, AREVA NP

THOMAS HOUSTON, NUMARC

PRABHAT KRISHNASWAMY, Emc^2

CHRIS McGAUGHY, AREVA NP

MANUEL MIRANDA, BNL

ASHOK NANA, AREVA NP

DENNIS NEWTON, AREVA NP

TODD OSWALD, AREVA NP

DO-JUN SHIM, Emc^2

TIM STACK, AREVA NP

PAVAN THALLAPRAGADA, AREVA NP

RUSS WELLS, AREVA NP

KEITH WICHMAN, Emc^2

CALVIN WONG, AREVA NP

C-O-N-T-E-N-T-S

C-O-N-T-E-N-T-S (CONTINUED)

C-O-N-T-E-N-T-S (CONTINUED)

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

8:30 a.m.

CHAIR POWERS: The meeting will now come to order.

This is the first day of the Advisory Committee on Reactor Safeguards, U.S. EPR Subcommittee.

I'm Dana Powers, Chairman of the Subcommittee.

ACRS members in attendance are Dick Skillman, John Stetkar, Mike Ryan, and Charles H. Brown, Jr.

MEMBER BROWN: This is the first time anybody has ever used the whole words.

CHAIR POWERS: Signs of respect just pour in around you.

(Laughter.)

Kathy Weaver of the ACRS staff is the Designated Federal Official for this meeting.

The purpose of this three-day meeting is to continue our review of the SER with open items for the Design Certification Document submitted by AREVA NP for the U.S. EPR design. Over the next three days we will hear presentations and discuss Chapter 3, Design of Structures, Components, Equipment and

Systems, Section 9.1, Fuel Handling and Storage, of Chapter 9, Auxiliary Systems; and everyone's favorite, Chapter 14, Initial Test Program and ITAAC, a non-controversial issue, if ever there were one.

A portion of this meeting may need to be closed to the public to protect proprietary interests. I am asking this staff and the applicant to identify the need for closing the meeting before we enter such discussions, for the simple reason that I have no idea what parts are proprietary and which parts are not. And we will verify, then, that only people with higher clearance and need to know are present.

The Subcommittee will hear presentations by and hold discussions with representatives of AREVA NP and the NRC and other interested persons regarding these matters. The Subcommittee will gather relevant information and plans to take results of the reviews of these chapters, along with other chapters reviewed by the Subcommittee, to the full Committee at a future full Committee meeting to be determined.

Rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in The Federal Register.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting. Let that not be a deterrence. If you have something to say, please contact either me or Ms. Weaver, and we will get you on the agenda.

A transcript of this meeting is being kept and will be made available, as stated in The Federal Register notice. Therefore, we request that participants in the meeting use the microphones located throughout the meeting room when addressing the Subcommittee. Participants should first identify themselves and speak with sufficient clarity and volume, so they may be readily heard.

Copies of the meeting agenda and handouts are available in the back of the meeting room.

There is a telephone bridge line today, and I understand we will have participants from NRC consultants on the line periodically during the meeting. We request that the participants on the bridge line identify themselves when they speak and to keep their telephone on mute during time when they are just listening.

Do any members of the Subcommittee have opening statements?

(No response.)

Seeing none, I do have one. We will mess with the agenda on Thursday. I intend to recess after the 10:30 break and to resume at 1:30, so that members can be briefed on some of the initiatives that the Commission has in mind. I think we can accommodate that interruption in the agenda we have now.

If there are no other opening comments to be made, I will turn to Getachew Tesfaye, the NRO Project Manager for the EPR DCD review to make his opening statements.

MR. TESFAYE: Thank you, Mr. Chairman.

Good morning, everyone. My name is Getachew Tesfaye. I am the NRC Project Manager for the AREVA U.S. EPR design certification project.

Today we continue our phase 3 ACRS presentation of the staff's Safety Evaluation with open items.

For the record, I will briefly summarize our first three activities. To date, we have completed the phase 3 presentation of 15 of 19 chapters and portions of another chapter.

We presented Chapter 8, Electric Power, and Chapter 2, Site Characterization, on November 3rd, 2009, and Chapter 10, Steam Power Conversion System, and Chapter 12, Radiation Protection, on November 19th, 2009.

On February 18 and 19, 2010, we presented Chapter 17, Quality Assurance, and portions of Chapter 19, Probabilistic Risk Assessment and Severe Accident Evaluation.

On March 3rd, 2010, we presented Chapter 4, Reactor, and Chapter 5, Reactor Coolant System and Connective Systems.

On April 6th, 2010, we presented Chapter 11, Radioactive Waste Management, and Chapter 16, Technical Specifications.

On April 8th, 2010, we briefed the ACRS full Committee on the seven chapters that were completed through March 2010.

On April 21, 2010, we completed the Chapter 19 presentation.

Also on April 21, 2010, we received a letter from the ACRS full Committee Chairman on the seven chapters that were completed through March 2010. The letter stated ACRS has not identified any issues that merit further discussion.

On March 27th, 2010, the staff submitted its reply to ACRS.

On November 30, 2010, we presented Chapter 13, Conduct of Operation.

On February 7 and 8, 2011, we presented

Group 1 section of Chapter 15, Transient and Accident Analysis.

On March 23rd, 2011, we began the Chapter 15, Group 2 presentation with realistic large-break LOCA topical report presentation.

On April 5, 2011, we presented Chapter 6, Engineered Safety Features.

On August 18, 2011, we presented Chapter 18, Human Factors Engineering, and completed Chapter 15, Transients and Accidents, by presenting Group 2 sections.

On November 14 and 15, 2011, we presented Chapter 9, Auxiliary Systems, all sections except 9.1, and Chapter 7, Instrumentation and Controls.

This week we will complete our first representation by presenting Chapter 3, Design of Structures, Components, Equipment, and Systems; Chapter 9, Section 9.1, Fuel Storage and Handling, and Chapter 14, Verification Programs.

We have issued the Safety Evaluation for Chapter 1, Introduction, but have no plan to make a formal presentation, as it contains no new material that is not covered by the other 18 chapters.

Our next ACRS activity is a full Committee briefing on Chapters 6, 7, 11, 13, 15, 16, and 18, scheduled for March 8th, 2012. The full Committee briefing for the remaining five chapters tentatively scheduled for May 2012.

Mr. Chairman, on Thursday afternoon, for the time allotted for Chapter 1, we may bring back Chapter 7 discussions --

CHAIR POWERS: The watchdog timer stuff?

MR. TESFAYE: Yes.

CHAIR POWERS: Fantastic.

MR. TESFAYE: All right. Thank you.

CHAIR POWERS: Fantastic.

MR. TESFAYE: That completes my prepared remarks.

CHAIR POWERS: I mean, that would be terrific because, like you say, Chapter 1 is probably not going to have us on the edge of our chair.

(Laughter.)

I think we could probably cruise through Chapter 1 very quickly, like acknowledge its there and go on.

But the watchdog timer is an issue. If we can get that --

MR. TESFAYE: Well, they are working on it. I am hoping they will get an answer by then.

CHAIR POWERS: Fantastic. That would be

terrific, if we could.

MR. TESFAYE: Thank you.

CHAIR POWERS: Okay. Darrell, are you ready?

MR. GARDNER: I am.

CHAIR POWERS: Let's do it.

MR. GARDNER: Okay. Good morning. I am Darrell Gardner, Manager, Regulatory Affairs for the U.S. EPR for AREVA.

Obviously, we're glad to be back --

CHAIR POWERS: Oh, like to me some more.

(Laughter.)

MR. GARDNER: -- for what we hope is the home stretch here.

As Getachew mentioned, we are covering Chapter 3, Section 9.1, and Chapter 14. Today our presentation on Chapter 3 will provide an overview of this chapter of the EPR. This chapter includes a variety of topics, including civil structural design, pipe break analysis, equipment qualification, and other topics. We have not prepared a specific presentation on Section 3.1. We will describe conformance to the GDC as discussed within the various chapters of the FSAR.

AREVA's presentation for this session is non-proprietary. However, portions of the materials that AREVA has used to support some of the pipe hazards analysis in this chapter are contained within proprietary technical reports. I would ask the members and our presenters that, should a question border on proprietary, we would request the session be closed or save that question until a time we could close the session.

The AREVA team presenting this morning will be Dennis Newton, Todd Oswald, and Calvin Wong. That will get us through the civil structural session. We will do a little bit of personnel changeout to discuss the afternoon sessions related to pipe hazards, leak-before-breaks.

Dr. Powers, we would hope that we would be able to complete Chapter 3 today. So, that is our objective.

CHAIR POWERS: A good objective.

MR. GARDNER: Okay.

CHAIR POWERS: I do have one comment

MR. GARDNER: Okay.

CHAIR POWERS: A personal anecdote. When I got out of school, a young, bushy-tailed individual, I went to work for a relatively-stern director who told me, in no uncertain terms, that if you use visual aids in a talk, they should have no more than 15 words on them. And he enforced that by only reading the first 15 words on any visual aid. I just toss that out, having briefly gone through your visual aids here.

(Laughter.)

MR. GARDNER: Well, that is encouraging. Then, our presentation will go a lot faster. Okay.

CHAIR POWERS: It was incredible. He would read the first 15 words on your viewgraph, and if you had any more, he would simply deny they were there because he had dictated there would only be 15 words on a viewgraph, and he knew you would not violate his dictate.

(Laughter.)

MR. GARDNER: Right. Fifteen lines.

CHAIR POWERS: You violate that several times.

(Laughter.)

MR. GARDNER: Can we go to the next slide, please?

Okay. So, as I mentioned earlier, we are not preparing a specific presentation on 3.1. The U.S. EPR conforms to the GDC. The section of the FSAR does not provide a comparison to the GDC and identifies the specific FSAR sections where we demonstrate conformance. There is one COL information item in this section, and that is that the COL applicant will identify their site-specific QA program plan for compliance with GDC 1.

That is all we had on 3.1.

With that, I will turn it over to Dennis Newton.

MR. NEWTON: Okay. Good morning. My name is Dennis Newton. I am Supervisor in the Nuclear Island Systems Engineering Group at AREVA. I have over 35 years' experience in nuclear power plant design and operation and testing. I have been involved with ANS standards, working on SSC classifications.

Now that you know who I am, let's go to slide 6.

The U.S. EPR uses three types of classifications. They are the safety classification, seismic classification, and quality group classification. They are typically classifications that are used in the nuclear industry.

This slide, slide 6, addresses safety classification. There are three categories. There is safety-related, supplemented grade, and non-safety-related.

The safety-related is based on the definition of safety-related in the Code of Federal Regulations.

The supplemented grade applies to structures, systems, and components that have a license requirement or commitment. And it is based on NRC regulations or guidance.

There are three examples that I have on the slide there, such as the oil collection tanks. That is addressed in Reg Guide 1.189. The station blackout diesel generators are addressed in Reg Guide 1.155. And liquid waste storage tanks are addressed in Reg Guide 1.143.

And the third category is non-safety-related.

MEMBER STETKAR: Dennis?

MR. NEWTON: Yes?

MEMBER STETKAR: Where does equipment, within these three categories, where does equipment on your design reliability assurance program list fit within these three categories? I know it is not safety-related, but is it supplemented grade?

MR. NEWTON: It would fit on the supplemented grade.

MEMBER STETKAR: Okay. Thanks. Thank you.

MR. NEWTON: Okay. Slide 7.

CHAIR POWERS: We have on occasion seen analyses and that people create four categories. Among those categories, they have categories for equipment that proves to be risk-significant, but it is not in a category of safety standard.

Do you have items of that nature?

MR. GARDNER: You're speaking about RTNSS, regulatory treatment of non-safety systems?

CHAIR POWERS: No. No, when they look at their PRA, they come up with metrics, Fussell-Vesely, risk achievement with risk reduction work, that are significant for the equipment, but it is equipment that does not appear in the list of safety-related equipment.

MEMBER STETKAR: That is the D-RAP.

MR. GARDNER: That would be the D-RAP list that Mr. Stetkar spoke of.

MEMBER STETKAR: And you said that is in your non-safety whatever it is called?

MR. GARDNER: Those are --

MEMBER STETKAR: NS-AQ.

MR. GARDNER: -- Supplemental QA

requirements for those D-RAP components.

MR. NEWTON: Slide 7.

This slide addresses seismic classifications. The classification is based on Reg Guide 1.29, the seismic design classification; Reg Guide 1.143 on design guidance for radioactive waste management, and, of course, standard review plan; 3.2.1.

There are five categories: Seismic Category I. That applies to SSEs and remains functional during and following an SSE.

Seismic Category II, radwaste seismic, conventional seismic, and non-seismic.

CHAIR POWERS: We have recently had an interesting seismic event in Virginia not too far away from where your RCOLA licensee proposes to build a plant. Does that have any impact on your thinking about seismic?

MR. NEWTON: It wouldn't have any. It does not have any impact on the classification. The classification is based on the function that the system structure or component has to perform as opposed to the design criteria for assuring that that can occur.

MR. GARDNER: Maybe another way to answer that, Dr. Powers, is that as we get into the civil structural part, we could talk about how the design envelopes four specific seismic considerations. But, as Dennis said, it wouldn't change how you classify components in terms of --

CHAIR POWERS: My question really is, did it change any of your thinking about this plant?

MR. GARDNER: In what way?

CHAIR POWERS: Go through and say, gee, I didn't think this thing would be involved in a seismic event, and it was. I mean, not very much happened at North Anna. It is actually kind of boring, what happened at North Anna.

MR. GARDNER: Not for the operators.

CHAIR POWERS: Yes, not for the guys at the plant.

(Laughter.)

MR. OSWALD: Right. I think, Dr. Powers, between post-Fukushima and the Mineral, Virginia, earthquake, we certainly have given it a lot of thought.

The EPR is a pretty rugged seismic design. We have a very broad spectra that we are using for our certified design response spectra. We also have an EOC in the Section 3.7 discussion. The high frequency, we have included an additional high-frequency motion.

But, yes, we certainly have given it a lot of thought, and we feel pretty good about the Mineral, Virginia earthquake and our ability to withstand that.

CHAIR POWERS: Interesting. Yes, go ahead.

MR. NEWTON: Okay. Slide 8.

This slide addresses the quality group classifications. The quality group classifications are based on Reg Guide 1.26, which addresses quality group classification, and on Standard Review Plan 3.2.2.

The quality group classifications apply to pressure-retaining components. There are five categories. The first three quality groups, A, B, and C, apply to safety-related components. And the classification is based primarily on the functions that are given in Reg Guide 1.26.

And then, there is Quality Group D and Quality Group E, which has -- it is not Quality Group A, B, C, or D.

CHAIR POWERS: What you are telling me is that staff told you how to do this and you did it that way. Would you have done it any different? If the

Reg Guide didn't exist, would you have done it any different?

MR. NEWTON: Well, I think the Reg Guide gives a pretty good process, and we would have done it similar to that. And it is pretty typical throughout the nuclear industry. So, we wouldn't want to do something that is totally alien from what everybody else is doing.

CHAIR POWERS: At a different plant. I mean, Darrell pointed out, you have got a fairly robust plant, a little bit different design than most plants. I wonder, I mean, is there a better way, would there be a better way to do it for this particular plant? Or it doesn't matter? All you have to do is have a way of doing it.

MR. GARDNER: A, B, and C are Code-driven, right?

MR. NEWTON: Yes. Yes, as Darrell is mentioning, A, B, and C are based on 10 CFR 50.55(a). So, it parallels the Code.

CHAIR POWERS: So, what you are telling me is this is not a forced fit?

MEMBER SKILLMAN: Dennis, if I look at slide 7 and 8 --

MR. NEWTON: Yes.

MEMBER SKILLMAN: -- if I were to look at those side-by-side, could you describe where fire systems are categorized, please?

MR. NEWTON: Well, the fire systems would be, the components would be supplemented grade because they are addressed in Reg Guide 1.89.

MEMBER SKILLMAN: These would be CS, conventional seismic, CS, on your slide 7?

MR. NEWTON: It depends on what is called out in Reg Guide 1.89 on seismic. If it gives special seismic considerations for a particular component, then that is what would be applied.

MR. GARDNER: I think the short answer to your question, Mr. Skillman, is there is a table in the SER that would identify the specific classification for each of those components. We could have someone look up if there was a specific one, but there are many components listed related to fire protection/detection systems. Is there a particular one you had in mind?

MEMBER SKILLMAN: Well, I am thinking of the bulk of the plumbing. I think the industry has pretty much taken it onboard. We have got Seismic I and Category I for reactor coolant system pressure boundary, ECCS, and those SSCs that we depend upon for an accident.

It seems also to me that in many cases the hardware of the fire protection system has been simply related to commercial grade and possibly non-seismic, unless someone pushes pretty hard to get them there.

MR. GARDNER: We can have someone look that up. I believe ours is a higher classification.

MEMBER SKILLMAN: That is a curiosity question. I would like that. I would like to know.

And if I look at slide 8, I would ask, also, where it fits in your quality group classification.

MR. GARDNER: Sure. I think we have somebody who will answer back here.

MR. WELLS: Hi. I'm Russ Wells with AREVA, the licensing group.

To just go ahead and answer your question, part of our distribution system, as Mr. Newton mentioned, is NS-AQ, based on the various Reg Guides and NFPA standards. There are some portions of that system that are designed to Seismic Category II that are needed for the conventional area, for safe shutdown equipment protection. And then, those that are outside of the nuclear island are non-seismic. But those that are needed to ensure inside the conventional area and needed for safe shutdown, we make a Seismic Category II.

MEMBER SKILLMAN: Thank you.

MR. WELLS: You're welcome.

MEMBER STETKAR: Dennis?

MR. NEWTON: Yes?

MEMBER STETKAR: Before you flip over on this, I will go back to my D-RAP question. In terms of quality group, equipment on a D-RAP list, where does it fit into your quality group categories? It is not safety-related. So, it is probably not A, B, and C.

MR. NEWTON: It would fit under supplemented grade. The method, the process that we use is still being discussed between AREVA and the NRC.

MEMBER STETKAR: Oh, is that still open?

MR. GARDNER: I think maybe, Mr. Stetkar, where you are headed with that is it depends on the components. So, if we are talking about a pressure-retaining component that will be subject to quality group classifications, it would fit in one of these classifications.

MEMBER STETKAR: Thank you. Thank you.

MR. GARDNER: It really depends on the

component.

MEMBER STETKAR: Thank you.

MR. NEWTON: Okay. Slide 9.

The seismic safety and quality group classification is shown in the FSAR Tier 2, table 3.2.2-1. That was what Russ Wells was just looking at. So, if you want to get a classification for a specific component, you have to look at that table.

MEMBER STETKAR: It is only 188 pages long.

(Laughter.)

MR. NEWTON: Yes. That is why I really couldn't answer the question. I don't remember them all.

And the combined license applicant will identify the site-specific SSCs.

CHAIR POWERS: Thank you, Mr. Newton.

MR. GARDNER: That is all we had on that. Thank you, Dennis.

We will move along to Todd Oswald. We are going to do this a little bit out of sequence from what is in the FSAR, simply because --

CHAIR POWERS: Why should this be any different than anything else we have done in this plant?

(Laughter.)

MR. GARDNER: It will eliminate some of the shuffle of presenters, I'll say.

CHAIR POWERS: I think Todd gets extra gold stars. I mean, Dennis gets to do 3.2. You have got a whole list of things here to do.

MR. OSWALD: They're all tied together.

(Laughter.)

MR. GARDNER: He drew the short straw.

CHAIR POWERS: Serious seismic implications tying these all together here.

Go ahead.

MR. OSWALD: Okay. Good morning. I'm Todd Oswald. I am a technical consultant with AREVA in the civil structural area.

My background, I came out of the Navy and went into the nuclear Navy with a civil degree because Mr. Rickover didn't have enough people at the time. He was looking for folks. So, have a Navy nuclear background, and went to McGuire Nuclear Station for about eight years, and then came out, wanted to get civil structural design experience. So, I was involved in the System 80-Plus licensing, some work on North Korean plants, and then with AREVA on the U.S. EPR.

CHAIR POWERS: This must have been a cultural shock coming from the nuclear Navy to Duke.

(Laughter.)

MR. OSWALD: Yes. Good times, all good times in the past.

CHAIR POWERS: We would love to hear what you did with the North Korean plants, but on another day.

(Laughter.)

MR. OSWALD: Next slide.

Just to familiarize yourself, this is the structures involved in the U.S. EPR design. Everything you see here is in the scope with the exception of the turbine building and the switchgear, and then, that one building, the access building that is kind of stuck in the middle there, the lighter color. But these, the turbine building and the access building, are included in a conceptual manner because they are Category II structures. So, we have to put some criteria in there, but it is conceptual design in the U.S. EPR.

CHAIR POWERS: For the structures?

MR. OSWALD: For the structures, yes.

Okay. Section 3.3 describes the basis used in the U.S. EPR design for our wind and tornado loading and hurricane loading. The basic wind design is based on the ASCE Standard 7-05, and it represents the highest hurricane wind speed for the U.S. with the exception of there is an area around the tip of Florida or the eastern tip of Louisiana that is not enveloped by that 145-mile-an-hour basic wind speed.

CHAIR POWERS: Is there a physical law that limits it to 145 miles per hour?

MR. OSWALD: A physical law?

CHAIR POWERS: I mean, somebody has judged that 145 miles per hour is the open-terrain maximum speed that we are ever going to have in the United States. I have whole vast numbers of people telling me that the climate is changing and things are evolving, and the former Vice President is preaching the gospel how things are going to be very different in the coming 60 years. Is that 145 a golden number now?

MR. OSWALD: That is in the current standard.

CHAIR POWERS: Yes, I know. Current standard is --

MR. OSWALD: With our importance factor we apply, we end up with about a 100-year --

MEMBER STETKAR: Let me follow up on that just a little bit because I do want to understand this a little bit better.

As I understand it, that 145 miles per hour is based on a 50-year, five-zero-year, recurrence interval scaled by a nominal importance factor of 1.15. That is inferred that that is, then, a 100-year recurrence interval, is that correct?

MR. OSWALD: That is my understanding of the ASCE.

MEMBER STETKAR: So, there is a 60 percent probability that we will exceed this in the 60-year life of the plant, is that correct?

MR. OSWALD: That sounds --

MEMBER STETKAR: This is design basis. There is a 60 percent probability that we will exceed the design basis over the life of the plant at least once.

MR. OSWALD: Okay.

MEMBER STETKAR: I'm curious why we are setting the design basis on something that I would bet, not a lot but I would bet, that we would exceed.

MR. OSWALD: Well, also, the hurricane doesn't typically control our design, particularly in this design.

MEMBER STETKAR: Okay.

MR. OSWALD: We have the seismic is usually predominant.

CHAIR POWERS: Well, if we made 165 or 185, there is a good chance it might control your design.

MR. OSWALD: I would have to work through the load combinations and see. I know, currently, it is not a controlling load combination.

MEMBER STETKAR: It couldn't be at that. But if you flip back to slide 11, which of the buildings on this slide are designed to that 145-mile-per-hour wind loading?

MR. OSWALD: Okay. All of them would be evaluated. The 145-mile-an-hour -- let's see. Let me clarify that. The Seismic Category II buildings, the access building and the turbine building, they would be evaluated at that 145-miles-an-hour, along with the seismic design, for interaction, for their safety, to protect the safety-related features. The radwaste building would be designed, it is about three-fifths of that value, according to Reg Guide 1.143.

So, essentially, everything is evaluated to that with the exception of the radwaste building, which would is not a Category II structure. It is not a safety-related structure. It falls under our radwaste seismic category, and it would be evaluated about three-fifths of the value. So, everything there would be evaluated by that.

MEMBER STETKAR: I am still curious, because there is a Reg Guide that says you should evaluate your plant for hurricane loads at a 10 to the minus 7 recurrence -- I'm sorry -- exceedance frequency, which is about 1 in 10 million years rather than 1 in 100 years. I am curious why you are using 1-in-100-year wind loading that is actually derived from some scaling of 1-in-50-year wind loading. It just doesn't seem consistent.

I have no idea, you know, I don't know what the -- actually, I do, but it is beyond this discussion for this Subcommittee. I don't know what that 1-in-10-million-year, straightline, 3-second wind gust speed would be for a bounding site, if you want to exclude the coastal zones along the southeastern coast and Gulf Coast. I suspect it would be higher than 145.

MR. OSWALD: I suspect it would at that return period.

MEMBER STETKAR: Yes.

MR. OSWALD: I don't know what the number is.

MR. GARDNER: I think we can say, though, this is the design envelope. Of course, if you were to site it in areas where you saw that, then you would evaluate those higher loads and see whether or not those were controlling loads.

MEMBER STETKAR: Do you have any idea what fraction of the U.S. would exceed it, if I used a 1-in-10-million-year recurrence interval rather than a 1-in-100-year recurrence interval? You know, if the COL went out and looked at what is their site-specific 1-in-10-million-year recurrence interval, would that exceed 145 miles per hour? What fraction of the potential sites in the U.S. might exceed that?

MR. OSWALD: I don't know. I would guess any hurricane-prone region would --

MEMBER STETKAR: I don't know. I mean, I have no idea, even on straightline winds inland. I just don't know.

MR. OSWALD: Yes, I don't, either. I don't know what that --

MEMBER STETKAR: But that is the way it is derived, right? It is a nominal 50-year recurrence interval scaled by that magic 1.15 factor?

MR. OSWALD: 1.15.

MEMBER STETKAR: And that is inferred

that it is a 1-in-100-year event?

MR. OSWALD: That's correct, to meet the SRP.

MEMBER STETKAR: Which, if I operate the plant for 60 years, there is a 60 percent probability that that event would occur at least once during the life of the plant.

MR. GARDNER: It would depend on the site-specific location.

MEMBER STETKAR: For the certified design, there is a 60 percent probability that you will exceed the straightline wind-loading design basis over the life of the plant. For the certified design. Now I am not sure about site-specific. There may be a higher or lower probability.

MR. OSWALD: Right. It would depend on the site-specific value.

Okay? Moving on there, we talk about exposure Category C is used when determining the velocity pressure coefficients. And again, as you mentioned, Category C is applicable to flat, open country, grasslands and all water surfaces in hurricane-prone regions.

As far as round structures, we use ASCE Paper 3269 to derive those pressure velocity coefficients.

Tornado wind design, tornado winds are considered in the design of all the Category I structures and in the evaluation of the potential for non-seismic Category I structures to interact with Category I structures, as we talked about earlier.

Again, the tornado wind design is per the Reg Guide 1.76, Region 1, which is the most severe region identified in the Reg Guide. As I mentioned, Reg Guide 1.143 is used for the radwaste structures, which is about three-fifths of the Reg Guide 1.76 tornado wind design parameters.

The tornado wind design parameters are 230 miles an hour total, which consists of 184-mile-an-hour rotational wind speed and 46-mile-an-hour translational. The maximum radius considered is 150 feet for the tornado.

As discussed earlier, also, there are COL information actions for the COL to ensure that our design envelopes their site.

MEMBER STETKAR: Todd, I was reading in the SER. There is quite a long discussion about tornado wind-loading designs. Have you committed to design the nuclear auxiliary building, turbine building, and access building to that 230-mile-per-hour tornado wind-loading?

MR. OSWALD: For the interaction.

MEMBER STETKAR: Yes.

MR. OSWALD: For the interaction, Seismic Category II interaction, yes, we have.

MEMBER STETKAR: Okay. So, that is just interaction --

MR. OSWALD: Correct, not the missiles.

MEMBER STETKAR: -- but not necessarily structural integrity, if it is not an interaction?

MR. OSWALD: That's correct.

MEMBER STETKAR: Okay.

MR. OSWALD: And not the missile design, not the missile barrier design, because there is no safety-related equipment there.

MEMBER STETKAR: Okay. Thank you.

MR. OSWALD: Okay?

Section 3.4 describes the basis used for the design for flood for the U.S. EPR. The internal flood protection strategy is based on physical separation to limit the damage to one division. The safeguard buildings, the emergency power generation buildings, and the central service water buildings are separated by divisions. The fuel building is separated into two separate divisions.

There are no doors or unsealed penetrations in division walls below grade in the U.S. EPR design.

The reactor building interior and reactor building annulus have no physical divisional separation for flood barriers. The maximum water inventory of the reactor building all floors into the IRWST, the In-Containment Refueling Water Storage Tank. And the water inventory in the annulus is calculated that it wouldn't result in a flood level high enough to reach safety-related equipment.

For the external design, the U.S. EPR uses, what we refer to as, a dry site concept, where we have site grade level is above the maximum design flood level or the maximum flood level for a given site. The site grade is at least 1 foot above the maximum flood level. Groundwater is at least 1 meter below the grade elevation.

And the COL applicants are required to determine the probable maximum flood, the probable maximum precipitation, evaluate the seiche and other hydrologic conditions per Reg Guide 1.159 and Reg Guide 1.102.

MEMBER RYAN: Just a quick question on the groundwater, what groundwater level is that? Is that the maximum groundwater elevation or some average? Or how do you do it?

MR. OSWALD: No, that is maximum. We consider in our structural design that that ground water is the 1-meter below grade for all the stability considerations, sliding and overturning.

MEMBER RYAN: So, how do you know that 1-meter below grade is the maximum groundwater level for every site or for any site?

MR. OSWALD: Well, we don't. We have to evaluate it. If the site comes in and it is above that, we are into a site-specific evaluation. But the standard design is based on the 1-meter below grade.

MEMBER RYAN: All right. So, you've got a provision to deal with that, if you have to?

MR. OSWALD: Right.

MEMBER RYAN: Okay.

MR. OSWALD: The COL applicant has to demonstrate that.

MEMBER RYAN: Thanks. Yes.

MR. OSWALD: And if it is above, we look at site conditions and evaluate it.

MEMBER STETKAR: A couple of questions, Todd.

One is I was reading about the external flooding. In one place, I see that it says -- it is Section 3.4.2.4.1 of the SER, but I didn't bother going back and finding if in the FSAR. But the U.S. EPR design, the yard grade elevation is assumed to be .305 meters, 1 foot above the elevation of the probable maximum flood, which is what is on your slide there.

In another place, there were questions about access barriers from external flooding. In other words, door heights above grade and things like that. There was a statement -- and this, again, is from the SER, so I want to make sure that I am understanding it correctly.

It says, the applicant stated that elevation zero is the elevation of the threshold of the lowest personnel access penetration through which flood water might gain access. Plant grade is the finished top of the supporting soil. Elevation zero is approximately 1 foot above plant grade.

MR. OSWALD: Yes.

MEMBER STETKAR: Now I am just sort of a simple guy. If I walk up and I am standing on the ground, and I look at a door and that door has a gap under it, is that gap 1 foot above the maximum external flood level from the probable maximum flood or is it 2 feet above that level?

MR. OSWALD: In our evaluations, that actually is 1 foot in our calculations.

MEMBER STETKAR: So, all I am doing is trying to understand the margins that are available in the certified design. So, I basically have a 1-foot margin for water intrusion from the nominal probable maximum flood. Is that --

MR. OSWALD: Let me clarify. In our evaluations, we have calculated. That is what we use for our structural design. Actually, we are requiring it to be 1 foot below finished grade, the nominal finished grade. If you look at table 2.1.1 -- and we will check that. You should have table 2.1.1. It is described as 1 foot below finished grade is the maximum flood level.

MEMBER STETKAR: Well, my question is --

MR. OSWALD: That would put it 2 feet below the door threshold.

MEMBER STETKAR: Two feet below the door threshold?

MR. OSWALD: Yes.

MEMBER STETKAR: Okay. At times, the term finished grade sometimes gets a bit muddied. That is what I was trying to understand.

MR. OSWALD: Right. And we will look at table 2.1.1 here in a moment --

MEMBER STETKAR: Okay.

MR. OSWALD: -- and see how it is worded. But it is worded, it will be 1 foot below the finished grade, is the requirement.

MEMBER STETKAR: But the door threshold is --

MR. OSWALD: Is a foot above.

MEMBER STETKAR: Is a foot above finished grade?

MR. OSWALD: Right. Two feet above the --

MEMBER STETKAR: Is that true for all structures in the plant?

MR. OSWALD: All safety-related, yes.

MEMBER STETKAR: All safety-related.

MR. OSWALD: All safety-related structures.

MEMBER STETKAR: Thanks, Mr. Chair. Thank you.

MR. OSWALD: Yes. It gets very confusing.

MEMBER STETKAR: Make sure that is consistent.

MR. OSWALD: It gets very consistent.

MEMBER STETKAR: And again, was reading from the SER, and sometimes the nuances get a bit muddied in the translations. These are from RAIs. We don't have all of the RAIs and responses, as far as the Subcommittee, nor do we want them. We don't want them.

(Laughter.)

CHAIR POWERS: On the other hand, I think you deserve them.

MEMBER STETKAR: No, I don't.

(Laughter.)

I will just forward them to you, and they will disappear down the black hole that we were talking about.

(Laughter.)

MR. OSWALD: Okay. The next slide.

MEMBER STETKAR: Oh, I'm sorry.

MR. OSWALD: Okay.

MEMBER STETKAR: I was in these side conversations.

Also, again, reading from the SER, there was some discussion in the reactor building. I understand flood levels in the annulus. I understand where safety-related -- I guess cable penetrations are relative to the maximum flood level in the annulus.

In the reactor building, there was some discussion -- and again, it is filtered through SER summaries of RAI responses -- it seemed as though there may be safety-related, I'll call them, SSCs, because I don't know what they are, inside the reactor building that may be below the nominal flood level, below zero elevation. Is that true? And if so, what are they?

MR. OSWALD: Below the zero elevation are --

MEMBER STETKAR: Let me tell you what got me. There are a couple of sentences that said, submerged operation of safety-related -- I'm sorry -- no submerged SSCs perform a safety-related function for safe shutdown of the plant or to mitigate the consequences of an accident and no safety-related SSCs that perform safety-related functions while being partially or completely flooded.

There were a lot of qualifying phrases like it led me to believe that there might be safety-related things that could be flooded, but some determination was made that they were not necessary for some type of accident.

MR. OSWALD: I am not aware of -- I am going to ask Tim --

MEMBER STETKAR: Or are you aware that in the reactor building all safety-related equipment is above the flood level? I mean, if you can say that, that would solve my problem. But all is a big word.

MR. STACK: Yes, John, all is a big word.

MEMBER STETKAR: All is a big word.

MR. STACK: This is Tim Stack from AREVA.

What I would like to do is I would like to follow up with you today. I would like to retalk with our design engineers directly and determine if there is anything below the flood plain that we excluded because we don't need it.

MEMBER STETKAR: Yes, that's what I was --

MR. STACK: That is what you are trying to determine.

MEMBER STETKAR: That is what I was curious about because I was just curious because of the way the phrases were put. I couldn't find a phrase that said no safety-related equipment in the reactor building is below the flood level.

MR. STACK: Right. We will follow up and we will confirm that today.

MEMBER STETKAR: Okay. Thanks, Tim.

MR. OSWALD: That is the flood level being zero or 1 foot below --

MEMBER STETKAR: No, well, I think for internal flooding, I'm talking internal flood. I mean, it could come in from the outside or it could come in -- it is based on the fire water piping, I think.

MR. STACK: So, again, you are just asking for confirmation that there are no safety-related components below the flood plain or, if there are, that we have evaluated and determined they are not needed?

MEMBER STETKAR: That's correct. And what's the basis for why they are not needed then? And I think it was -- you know, I don't care whether the water comes in from the outside or whether it is a fire water pipe break inside. The source of the water is irrelevant. It is just the flood elevation and if there is anything below it.

Thanks. Thanks, Tim.

MR. OSWALD: Okay. We will follow up on that one.

Okay. Section 3.5 describes the approach used to protect the safety-related SSCs from externally- and internally-generated missiles. There is a screening criteria that we are using. Missiles are screened out if the probability is less than 1 times 10 to the minus 7.

The internal missile sources include the high-energy fluid systems, rotating equipment, and pipe ruptures. The external missile sources include turbine missiles or tornados missiles.

The strategy we are using in the U.S. EPR design for missile protection is to locate the safety-related SSC within a missile-resistant structure, such as a Seismic Category I structure; separating redundant systems from missile path or the range of the missile, or use local shields or barriers, or design the SSC to withstand the impact of the missile.

Design features to prevent the generation of missiles are also included, such as valve bonnet designs where we don't have the valve stem coming out, and then the orientation of the missiles to prevent a strike on safety-related equipment.

COL applicants are required to evaluate their site-specific conditions to see if there are any other missiles to be considered for a site.

CHAIR POWERS: When you are relying on orientation, that means you have either some physical rule that says a missile cannot come in certain directions or a probability distribution.

MR. OSWALD: Right.

CHAIR POWERS: Which is it? You can take the turbine as an example.

MR. OSWALD: It is a physical. Physical, yes, probability and physical. You said, which is it. It would be both.

CHAIR POWERS: Yes, I mean, if I look at my turbine and I say, okay, the turbine blade breaks --

MR. OSWALD: Right.

CHAIR POWERS: -- and the rotor breaks, and it is most likely to come out orthogonal to its axis, but it promptly encounters some structures. And so, there is some probability that it is actually going to come up in a direction of less than 90 degrees to the axis.

So, what do you do? Do you just say it is going to be 90 degrees to the axis, and there is a physical law that says that? Or is it some probability that it will be less than 90 degrees?

MR. OSWALD: Right. We are looking at 45 degrees, typically, is what we are looking at.

CHAIR POWERS: Forty-five degrees, and it will never come off less than that?

MR. GARDNER: Yes, there is a zone of influence in one of the Reg Guides, and I don't recall the Reg Guide number. It may be that one.

MEMBER STETKAR: 1.115.

MR. GARDNER: Thank you.

MEMBER STETKAR: You're welcome.

MR. GARDNER: And that is the zone of influence that we use for turbine missiles.

CHAIR POWERS: Okay. So, you just use what that tells you to use? Okay.

MR. GARDNER: Right.

CHAIR POWERS: They would never lead you astray.

(Laughter.)

MEMBER STETKAR: Let me follow up on turbine missiles. It is my understanding, and if you go back to slide 11, it is graphically a little bit more clear, the central service water buildings 3 and 4 are well within whatever that footprint is. They are directly orthogonal to the turbine. And whatever direction plant north is, the closer to our viewpoint ends both emergency power generating building 3 and 4 and 1 and 2, the near ends of those are, as I understand it, just within that possible footprint.

So, for this plant, there are safety-related SSCs that are within that nominal footprint. And yet, you claim that this turbine is favorably-oriented. I don't understand that.

And I will read a quote out of the Reg Guide. Plants designed with no -- no is a very small word or very big, depending on how you interpret it -- plants designed with no essential SSCs within the low-trajectory hazard zone are considered to have a favorable turbine orientation.

As I understand it, you have got four safety-related SSCs within this footprint. So, I don't understand why you characterize your plant as having favorable turbine orientation.

The difference being that, if you have a favorable turbine orientation, you only have to show that missile ejection frequency is less-than-10-to-the-minus-4 event per year for a favorably-oriented turbine. If you have an unfavorably-oriented turbine, that criterion drops to 10 to the minus 5 per year, a decade lower.

So, I was going to ask the staff about this because they have, apparently, agreed that you are favorably-oriented, which is troubling to me. But I am curious what basis you used for making that determination.

MR. GARDNER: I will attempt to give that a shot. I don't have that Reg Guide in front of me, Mr. Stetkar. But one part of the language, as I recall, was that that definition is with respect to the containment, and there's probably some other words that you have read. But it is the favorable orientation was with respect to the containment.

MEMBER STETKAR: I don't believe it's --

MR. GARDNER: Now we have also evaluated other SSCs that are in that zone of influence, and we have done that evaluation. So, in that context, that is why we say it is favorably-oriented with respect to the containment.

MEMBER STETKAR: I would be curious to find that qualification because I searched the Reg Guide, and they do talk about impacts on containment, but to try to find a definition of what a favorably- or unfavorably-oriented turbine is, I mean, it is not a crisp, one-line definition.

MR. GARDNER: We can look for that language that I am referring to during one of the breaks.

MEMBER STETKAR: Because I find, this is a direct quote: plants designed with no essential SSCs within the low-trajectory hazard zone are considered to have a favorable turbine orientation. And by exclusion, anything else would be an unfavorably-oriented --

MR. GARDNER: Are you reading from the SER or the Reg Guide?

MEMBER STETKAR: I am reading directly from the Reg Guide, Revision 2.

MR. GARDNER: We will look for the language I am referring to.

CHAIR POWERS: The language is less of concern than the design here.

MEMBER STETKAR: The language is less of a concern than the design, that's right.

CHAIR POWERS: And it would appear that the essential service water building is subject to missiles.

MEMBER STETKAR: It would appear that.

MR. OSWALD: Some portion. One of them is blocked.

CHAIR POWERS: Yes, one of them is blocked by the other one.

(Laughter.)

MR. OSWALD: Well, we also have the requirement of the frequency, the 1 times 10 to the minus 7. And I will look at that. Is that on the turbine --

MEMBER STETKAR: I don't want to get into a long discussion, because of time, on Reg Guide 1.115. But what they say is that you have three probabilities. P1 is the missile ejection. P2 is the likelihood of a missile, given it is ejected, striking a target. And P3 is the likelihood that the target damaged, given that it is struck.

The Reg Guide essentially provides a very, very coarse screening process, and it says, unless you are going to do a detailed evaluation of P2 and P3, they will take some nominal values. And they focus on the missile ejection probability.

So, they basically presume 10 to the minus 3 conditional strike and damage probability for a favorably-oriented turbine, the product of P2/P3; a 10 to the minus 2 for an unfavorably-oriented turbine. They back out from 10 to the minus 7, then, the frequencies of 10-to-the-minus-4 missile ejection or 10 to the minus 5, depending on the turbine orientation.

And most people focus on the missile ejection frequency as the basis, and you do the turbine missile, you know, the turbine overspeed analysis and turbine missile ejection probabilities to meet those 10-to-the-minus-4 or 10-to-the-minus-5 numerical criteria, without doing the full quantification of P2 and P3, which is a more involved process.

That option is always open to somebody. If you have an unfavorably-oriented turbine with a higher missile ejection frequency, you can, then, go out and do the rest of the math. But you would have to do that.

MR. GARDNER: Right. I think our SAR demonstrates that, considering the orientation with respect to containment, we have also looked at those things within the zone of influence and demonstrated in the FSAR that you can still safely shut down the plant, that there is not a --

MEMBER STETKAR: That isn't what this coarse screening process does. If you want to talk about doing a more detailed analysis, you can always do that. The coarse screening process essentially gives you a free pass to not have to do that analysis.

MR. GARDNER: But we did the additional discussion of the impact.

MEMBER STETKAR: The qualitative discussion?

MR. GARDNER: The qualitative discussion?

MEMBER STETKAR: That is a qualitative discussion. It is not a quantitative discussion where you look at actual probabilities of turbine overspeed, missile ejection. You look at what is P2, what is P3, and then a conditional probability of core damage, given whatever damage that, then, instills.

If you say you comply with the Reg Guide, you are essentially taking the free pass. But if you say you comply with the Reg Guide, you had better comply with the Reg Guide, is my whole point.

I think that is enough for here. I kind of got it out on the table. I really want to quiz the staff about this because they essentially accepted your arguments, and I don't understand the basis for that.

MR. GARDNER: Okay. I will look into it a little closer, too. We just need to look at it closer.

MEMBER STETKAR: By the way, Darrell, if you do look in the Reg Guide and if you do find that it is restricted to only the containment, I would be interested in that.

MR. GARDNER: We will hunt that language down, right.

MR. OSWALD: Okay. On to the next slide. The next section is Section 3.7, and Section 3.7 describes the seismic analysis methods for designing of structures, systems, and components to withstand the effects of the Certified Design Respond Spectra, which is really, essentially, our SSE for our certified design.

You see the four subsections of 3.7, which should be familiar to everyone.

Next slide.

Section 3.7.1 discusses the seismic design input parameters used for the U.S. EPR design. The Certified Seismic Design Response Spectra for the U.S. EPR is based on three individual control motions which are developed for soft, medium, and a hard soil, all anchored to a .3 g P ground acceleration. In addition, we have a high-frequency motion which is included, and it is based on one of our U.S. EPR target sites.

The response factor for these motions will be shown in the next couple of slides, and I will show you a comparison where our three control motions meet the Appendix S requirements of an appropriate shape and anchored at least a .1 g.

For the structures that aren't on the nuclear island common basemat, we consider the effects of the structure-to-soil-to-structure interaction in our evaluations. So, there is some amplification that is considered for the design input of the other structures.

Our time histories are developed which meet the Reg Guide CR-6728 criteria.

There is prescription for the COL applicant to do the reconciliation to make sure that his seismic design parameters are within the envelope of the U.S. EPR design.

The next slide.

This is a slide showing all of our control motions, our input control motions or our Certified Design Response Spectra. You notice the three shapes that we are using for hard, medium, and soft soil. Those are anchored at .3 g.

And then, also, we have the high-frequency motion, which is the red and the blue lines there that are shown. One is the horizontal, the higher one, and then the blue line is the vertical high-frequency motion that we are using.

On the next slide, there is a comparison with the Reg Guide 1.60 and the minimum requirements of Appendix S. Again, the three flat curves are U.S. EPR spectra, soft, medium, and hard. Then, the curve with the peak, the dark brownish-looking curve is our Reg Guide 1.60 spectra, anchored at .3 g.

And then, we have the light blue line at the bottom is an envelope of our three control motions, anchored at .1 g, which is the minimum Appendix S requirement. And the red line is just our horizontal high-frequency design spectrum.

The next, there is a two-part --

CHAIR POWERS: The axis on this particular plot is mysterious to me.

MR. OSWALD: Oh, you don't have it. That is the g-level or the acceleration, and it is, the first bottom, there you go, .1, .2, .3, .4. I didn't realize that acceleration wasn't labeled. Sorry about that.

CHAIR POWERS: And your ability to distinguish colors greatly exceeds mine. Which is the Reg Guide? This one there?

MR. OSWALD: The Reg Guide 1.60 has that peak at about 2.5 Hertz.

CHAIR POWERS: Thank you.

MR. OSWALD: Okay. The next slide, there's two parts to your seismic design inputs, one being your control motion, which we discussed, and then the soil profiles is the next key parameter in your design input.

We used eight different soil profiles in our design. Each one has a control motion associated with those soil profiles. I will show you that on the next slide that follows.

Our damping we use is per Reg Guide 1.61.

This slide is probably one of the busy slides you mentioned when we opened up. This is just so you would have the numbers to see how it all fits together, which control motion is associated with which soil case or which soil profile. And the next two slides I will show you the soil profiles, and it will explain this.

Okay. What you see here is our five standard soil profiles, not our high-frequency site on this slide. And as I mentioned, the slide before shows which one of these is associated with the hard, medium, or soft control motion. Again, these different soil profiles will give us a broad range of excitation along with the different input control motions.

You will notice our basemat, what you have here on the left side is the depth down below grade, starting at the top right, and you work your way down. The top right, that zero would be essentially finished grade elevation. So, our basemat, where you see that horizontal line there, that is actually a blue horizontal line at about minus 42 feet; that is the bottom of our basemat.

So, as you move from left to right across this slide, you have your softer soils, as indicated by the shear wave velocities in the horizontal profile. Then, you have the stiffer soils on the right. So, the soft soils on the left, the stiffer soils on the right. Again, depth versus shear wave velocity is the chart.

Okay. The first soil profile on the left, which is pink, is the 1n2ue case, and that is a linear gradient soil profile where the soil gets stiffer down below the basemat.

Okay. The next soil profile, blue, is our soil case, what we call 1n5ae, and it represents with a soft backfill and a hard soil below the foundation. So, it is, essentially, sitting on a pretty stiff component, uniform down below.

The next soil profile that you see, orange, is one of our layered soil cases. It is a soft backfill along the side walls and a soft soil layer below the foundation on top of sort of a medium stiff layer.

And again, what we are trying to do is set up different impedances, capture different motion to get it into our structure.

The next soil profile, you see green is a condition which is kind of a uniform, medium stiffness of the surface all the way down below the foundation.

And then, the soil case on the far right is a very stiff soil. It is a hard soil all the way down below the basemat.

MEMBER STETKAR: Todd?

MR. OSWALD: Yes?

MEMBER STETKAR: If I recall, some of these adopted from the European standard, is that right, the soil profiles?

MR. OSWALD: The control motions.

MEMBER STETKAR: The control motions?

MR. OSWALD: The control motions on the previous slide were adopted --

MEMBER STETKAR: Okay. I'm sorry. Thanks.

MR. OSWALD: -- from the European standard. That is why they have an EUR, European Utility Requirement, document.

MEMBER STETKAR: Thanks.

MEMBER SKILLMAN: As you explained the layered consistencies of the soil there, are you communicating that those are engineered layers or those are natural layers? Do these characteristics exist because of excavation and compacting or because that is the true underlying characteristic of the foundation?

MR. OSWALD: It could actually be either, but we are assuming this -- I mean, we are idealizing soil columns here. Anything we actually have is going to be multiple layers, typically, unless it is on rock. So, that is where we end up in the site-specific evaluation, looking at the real site condition.

And what we were trying to do here is get enough input into our building where, when we make our comparisons, that we are enveloped with any given site.

MEMBER SKILLMAN: Okay. Thank you.

MR. OSWALD: That's the objective.

CHAIR POWERS: The COL applicant has to show that one or more of these bounds whatever he has got, right?

MR. OSWALD: Right. And most likely, he is not going to match these exactly. Now the next slide is our high-frequency site. So, that is our actual site. You can see what a real site would look like, as an example. We have a reconciliation process in Chapter 2 that it uses.

Slide 15, this is our high-frequency soil profiles. These are actual lower bound, upper bound, and best estimate of soil profile prediction. You can see it is a relatively-soft backfill alongside a relatively-stiff material below the basemat. Again, the horizontal line is the bottom of our basemat elevation.

CHAIR POWERS: Physically, what happens when a shear wave comes in and it has a high natural velocity, and it starts encountering regions of low velocity? You get a shock?

MR. OSWALD: You are talking about lateral variability within --

CHAIR POWERS: I mean, I know what happens in a gas. I am trying to understand what happens in a solid. In a gas, I know what happens. You create a shock wave --

MR. OSWALD: Uh-hum, uh-hum.

CHAIR POWERS: -- when you have got impedance mismatches in the velocities. What happens in the solid physically?

MR. OSWALD: So, what you are asking is --

CHAIR POWERS: The physical phenomena?

MR. OSWALD: The physical phenomena of the wave passing through stiffer and softer soils?

CHAIR POWERS: Yes, if I am riding on the wave front, and I am coming from below, what happens? What do I see?

MR. OSWALD: Not being a geologist and seismologist, I am sitting here trying to imagine. I am not sure I am qualified to explain exactly what is happening other than the wave passed through the soil and it slows down and speeds up, just excites the soil in a different frequency.

CHAIR POWERS: Yes, but, see, the other wave fronts are coming right behind. They are coming fast, and so they catch up with me. And I start seeing my neighboring wave front. I am just not physically sure what happens.

MR. OSWALD: Well, that is what we refer to as coherent sea or incoherent sea, you know, what those wave fronts are doing as they come up and catch up with each other. And these large basemat, it typically helps us a little bit in the higher frequencies as they aren't hitting us at the same time.

Do you want to take a shot at that?

MR. WONG: Yes, my name is Calvin Wong with AREVA.

Maybe looking at this slide here as an example, you have a wave coming through here. One of the challenges that we do have is you do have a soft layer right here. So, the waves coming up here do get trapped, for example, in this layer and you get a lot of excitation. So, that is an example.

What you said about the waves combining, and whatnot, it is the same theory. The waves will start adding/subtracting from each other.

CHAIR POWERS: So, I get bigger peaks and deeper troughs is what you are telling me?

MR. WONG: Yes. This right in here, you can get a lot of energy trapped in that layer because you have a reflective boundary here.

CHAIR POWERS: I would think that that's exactly what happens, is suddenly you start focusing the energy in on the basemat.

MR. WONG: Right. And in this case, it would be at the frequency of this soil layer.

CHAIR POWERS: Okay. Thank you. It's really interesting.

MR. OSWALD: Okay. The next slide.

Section 3.7.2 discusses the seismic analysis methodologies we use. We have three major seismic categories, as you saw earlier this morning in

Section 3.2.2, discussed by Dennis there.

U.S. EPR structures, the major seismic categories are Seismic Category I, which has the safety-related structure; Seismic Category II is any non-safety-related structure which has the potential to interact with the safety-related structure, and then, we have our Radwaste Seismic. Again, that is anything that has a potential for offsite release. We use the seismic criteria in Reg Guide 1.143.

What you see here at the buildings that are included in each of these seismic categories, our nuclear island and the EPGB or essential service water building, emergency power generation buildings. Those are Seismic Category I.

The buildings with the potential to interact with Seismic Category I are the nuclear auxiliary building, the access building, and the turbine building, and switchgear building. Again, these are site-specific structures, and they have to be evaluated on a site-specific basis.

And then, the radwaste seismic structures include the radwaste building and the nuclear auxiliary building because of their content.

MEMBER RYAN: The nuclear auxiliary building is in Seismic Category II and Radwaste

Seismic?

MR. OSWALD: Yes, it is. The structural interaction evaluation is based on Seismic Category II criteria. So, we use the full SSC, the full tornado wind loads, and everything, and then the design of the components inside the building would be just as required for Reg Guide 1.143.

MEMBER RYAN: Got it. Thank you.

MR. OSWALD: Okay. The next slide, as we went through the evolution of the EPR, we started off with our distinct model designs which have been used for a while. They seemed to give us pretty good results. We evolved to an embedded stick model because we were asked questions by the staff in the effects if embedment; whereas, before we had considered the embedment effects would only help lower our response. But the staff continued to ask questions. So, we went and modeled the embedment.

And then, as our software capabilities and our hardware capabilities increased, we moved to an embedded finite element model, and our soil structure and our action analyses, and one of the major reasons for doing that was to capture the high-frequency motion that is now known to be evident in the central and eastern U.S. sites. So, in order to propagate that up into the structure, we have evolved to a fairly-complicated 3D finite element model included our soil structure action analyses.

Okay. The analysis of the Category I structures involves, as you saw on the previous slide, a rigorous analysis approach using 3D finite element models and seismic analysis computer codes to determine the response and generate in-structure response spectra to feed into the design of the structure systems and components within the building.

CHAIR POWERS: How do you know that the models are right?

MR. OSWALD: How do we know that the models are right? We have done sensitivity studies to ensure our --

CHAIR POWERS: You can run the model until your eyes fall out --

MR. OSWALD: Right.

CHAIR POWERS: -- but that doesn't tell you it's correct.

MR. OSWALD: Okay. How do we know? The model is considered a pretty good approximation of giving us a response.

CHAIR POWERS: Somebody must make that consideration and there must be some basis. What is the basis for thinking that the 3D finite element model is an adequate description?

MR. GARDNER: Are you asking in the context of modeling the behavior or how well do we just translate physical structures into models?

CHAIR POWERS: I am really interested in, I have got a real structure. I calculate how it is going to respond to a loading. How do I know that the model is right, gives me a good answer?

What model is it, by the way? Yours or somebody else's?

MR. OSWALD: This is our model. We have our model for our seismic or our dynamic analysis or seismic analysis.

CHAIR POWERS: It is one you wrote?

MR. OSWALD: It is one that we developed based on the general arrangements of the structure, and we did an ANSYS finite element model and converted it to a dynamic model to use in SASSI.

CHAIR POWERS: So, how do we know it is correct, that it gives us an answer that is useful?

MR. GARDNER: Well, what we do on our dynamic model, we benchmark against an ANSYS 3D finite element model, the static model. Do the modal analysis, a comparison to tune it up, so to speak, with our 3D.

But I guess your question is more along the lines of, how do we know that what we are tuning to is correct?

MR. OSWALD: It is about the best tool we have available to us right now.

CHAIR POWERS: What does your model predict? Stress? Strain?

MR. OSWALD: The static model does predict the stresses in the building. The dynamic model is used to capture the dynamic properties and feed it into our soil structure action analyses model to capture the response of the structure. We are trying to predict in-structure response spectra.

CHAIR POWERS: So, how do you know it is right? I mean, it gives you a number. It probably gives you a number to a great number of significant digits, too, if I'm guessing. How do you know it's right? Or close?

MR. WONG: This is Calvin Wong again.

I guess, if you ask, how do we know it's right, there are some physical laws that we can relate to. There is also past experience, benchmarks against real structures. I would venture to say concrete structures, while complicated in some sense, are not really all that complicated. We get the stiffness of the structure. We have properties of the structure, and we know how stiff it is, the material properties.

As I referred to earlier, the physical laws are, if you have a rigid structure, it is going to behave a certain way, and we know how it behaves with respect to the input motion. So, there are bounds that we can rely on to understand if our model is behaving properly.

So, that is the structural model. The soil model that we include in there is another factor. But in terms of the structure itself, as Todd alluded to earlier, we have gone from simple stick models to more complicated finite element models. We show that we see certain trends. As you get more sophisticated, the response, global responses remain essentially the same, but you get additional detail.

CHAIR POWERS: And you have never calculated a real structure subjected to a real load to see if you get the observed result?

MR. WONG: There have been past studies where you have built real structures that you benchmarked against, in academia, in industry.

So, really, the models that we have, for example, are just extensions of beam models, if you will. And those are all classical theory.

CHAIR POWERS: The trouble is that a beam I can understand. A structure this complicated I cannot understand. And so, you are telling me that the computer code does. And I am saying, why do you think that? What leads to your confidence?

MR. WONG: My confidence would be, going back to this slide, when we go from a simple stick model to the finite element model, there will be similarities between the two. The overall global response of the structure should be evidence in both models. And we do see that in terms of the specific details when you go to the finer model. When you go from the very specific details, the only check that you could rely on would be breaking it down to more simpler models to see if --

CHAIR POWERS: I mean, I understand you are saying that my model will, when taken to the limit, go to your stick, and I understand the stick.

MR. WONG: Uh-hum.

CHAIR POWERS: The part of the model output that I am interested in, however, is not built into the stick. It is something peculiar to the global structure. That is the output I am interested in. How do I know I get that right?

MR. WONG: Well, I guess one of the things that we want to get out of this, even for our large model, is basically accelerations. That is one of the products that we want out of it.

And as I stated earlier, you do get certain bounds that the more complicated model will still have to comply with. So, really, the difference between going from the stick to the finite element model is we are trying to capture a little bit more detail to capture the high-frequency response. But the overall global responses remain the same. So, that gives us confidence in our larger, more complicated model, that we have captured the essence of the destructive behavior.

CHAIR POWERS: Thank you.

MEMBER SKILLMAN: Let me build on Dr. Powers' question, please. Is the model that you are using peer-reviewed? Are other people who are in this business using, if you will, the same or similar model, the same or similar technology? So that, if peers were to get together, one would say, using this complicated model versus this other complicated model, for all intents and purposes, they are predicting the frequencies, the accelerations that are similar, without those parties revealing, if you will, their intellectual property?

I hear you, you know, just in a word, you have gone from a simple model to a very complex model. Those are the words you used. So, my colleague says, how do you know it is predicting accurate results, so that we can take it to the bank?

And I hear your words. I understand the technical logic that you are using. But I wonder, have you done a peer review? Do you have other people who are from the civil structural area, from different portions of the industry, or a different industry, that would say, yes, that's representative. That will do it for you? Have you done something like that?

MR. OSWALD: This one has not been peer-reviewed, but it tends to respond, as to what we have seen in the past on other models, but we haven't done -- we have had review sessions with other experts, but there has not been an independent model built.

We did have, we call it, a design review board, where we brought in four or five -- I could get the names; I remember the names; I don't remember the number of experts -- to take a look at our results and look at our in-structure spectra results and our global results.

MEMBER SKILLMAN: My comment is not to suggest an inadequacy. It is to dig into what Dr. Powers is asking. How do you know the results are ones that appropriately and accurately predict motions and accelerations?

MR. WONG: If I may interject, I would just say that in terms of the procedures that we use in building the models, they are really conventional methods. The models that we use are standard structure-analysis-type models. So, in that sense, we are not breaking in any new ground.

If the other vendors and structural analysis, any type of structure analysis would use similar methods that we used. So, in that sense, our building model is nothing that is out of the ordinary. We have concrete shear walls, and we model them with shell elements. Standard practice, if you will.

MR. GARDNER: I was going to say, maybe some of the challenge I am listening to here is that we are using the term model. The model, the physical model of the structure was just our physical model because it is our structure. It is not a model anyone else would use because they have their own structure, their own model for their structures.

But the tools and techniques you use to

analyze that model are consistent with the same tools --

MR. WONG: Yes, it is general practice.

MR. GARDNER: -- that everyone else is using.

MEMBER SKILLMAN: Thank you. Thanks.

I think we will follow up with the staff later. This gets into how they evaluated your model with your structures.

CHAIR POWERS: Most guaranteed, we will have more discussion of this with the staff.

MEMBER SKILLMAN: Darrell, thank you. Todd, thank you. Calvin, thank you.

MR. OSWALD: Okay. Let's go to the seismic model, yes, okay. A little more description on these seismic models and the analysis approach.

Also, in these models we looked at the effects of embedment, as described before, and we looked at the effects of concrete cracking. We considered both cracked and uncracked properties because the real answer probably lies somewhere in between. So, we look at the two bounds of cracked and uncracked conditions.

The mass of components within these models is included in two manners. One is just lump mass that we have included to capture the weight effects. Some large components, such as the reactor coolant system, is explicitly modeled in a beam simplified compared to what the reactor coolant guys use. We use a simplified beam and lump mass model to capture that stiffness in the mass and its effect on our building.

And then, again, we also include our nuclear auxiliary building as a separate stick model because of its mass and its potential to influence the response of our nuclear island.

We use what we refer to as the MTR version of the SASSI computer code. If you are not familiar with SASSI, SASSI stands for a System for Analysis of Soil Structure Interaction.

Again, each of the eight control motions and soil combinations that I showed you on the previous slide, we run each of those cases up through the structure and generate in-structure response spectra for the design of our structure systems and components.

That is all I want to say on this slide. Next.

The way we look at Seismic Category II structures, we look at Seismic Category II structures in the same manner as we look at Seismic Category I.

It is a rigorous analysis, and we evaluate that.

CHAIR POWERS: When you say rigorous, what does that mean?

MR. OSWALD: Well, we do a response -- it is not a static simple application of accelerations. It is a response spectra analysis that we input.

CHAIR POWERS: I mean, I am trying to understand what the word rigor means in this context.

MR. OSWALD: Well, essentially, we do a full dynamic analyses, instead of just application of static accelerations into the models, to look at, say, a pushover effect or a simple static evaluation.

We run through all of the required evaluations that we would have on a Seismic Category I structure from a structural perspective. And these buildings will be designed to the Seismic Category I codes, which is ACI-349 and N690, which are the nuclear design codes. Okay?

CHAIR POWERS: So, rigorous just means you comply with the codes?

MR. OSWALD: Comply with --

CHAIR POWERS: With the requirements of the codes?

MR. OSWALD: Yes, that's correct.

MR. GARDNER: Dr. Powers, I just want to

come back to that -- sorry -- just to make sure we communicate correctly.

For these structures, if they were just looked at as Cat II, you wouldn't have done this level of analysis for these normally. So, we have imposed a higher level of analytical tools onto these structures because of the interaction.

MR. OSWALD: Right. Yes, you said Cat II, you mean non-Seismic --

MR. GARDNER: Right.

MR. OSWALD: If they were non-seismic. Cat II, by definition, we are applying all the Category I criteria to the evaluation.

Let's see where we are at here. The seismic input for the NAB, the nuclear auxiliary building, is obtained from the analysis of the NI common basemat, as we talked about, to capture those interaction effects.

The Seismic Category II criteria for the access building, turbine building, switchgear buildings, are conceptual in the U.S. EPR design, since they are not in the scope of this certified design. The COL applicant will make the determination if they will continue to use that Seismic Category I criteria, which we are fairly confident they will, or present another criteria, showing full details of how they demonstrate an equivalent margin of safety as a Category I structure.

The access building and the turbine building are evaluated to the site-specific SSC by the COL applicant, in lieu of the certified design response spectra.

Again, there is a requirement to check the gap between all the structures to ensure there is no interaction from the seismic loads or any settlement contribution to those, you know, the ability to close the gap between structures.

But, again, the COL applicant has to look at their site-specific conditions to verify that gap is adequate.

MEMBER STETKAR: Todd, for those gaps, since there are gaps, and I guess the values of the gaps may be proprietary -- I don't know -- but they vary. According to my reading, they are about a foot to a foot and a half, depending on the building and things like that.

MR. OSWALD: Correct.

MEMBER STETKAR: Who does the evaluation of relative motions of those buildings with respect to potential failures of piping, cables, and so forth, that go through those gaps? Is that the COL?

MR. OSWALD: The scope of the COL is the buried piping and buried conduits. But for between the buildings --

MEMBER STETKAR: For example, turbine building versus the NI or the nuclear auxiliary building, if there is relative vertical motion or horizontal motion between those buildings, I am assuming there is a fairly large number of piping and cable penetrations that span those gaps. Who does the analysis to assure that those things don't break? Or are none of those required for safe shutdown?

MR. OSWALD: We do, the civil structural group, we provide the seismic anchor motions, as we refer to it, between the buildings, and they are considered all out of phase.

MEMBER STETKAR: Well, but that is for structural interactions. I am talking about penetrations.

MR. OSWALD: Correct, but the seismic anchor motions are the structural displacements, and they are applied to the piping analysis or to --

MEMBER STETKAR: Okay.

MR. OSWALD: -- whatever component.

MEMBER STETKAR: Okay.

MR. OSWALD: But we provide them that. We have a book of instruction responses.

MEMBER STETKAR: Okay. Okay. So, they just have to show that they meet those?

MR. OSWALD: Correct. They have put those seismic anchor motions into their analyses.

MEMBER STETKAR: Okay. Thank you.

MR. OSWALD: Yes.

Okay. Next slide, 3.7.3 is about seismic subsystem analyses. The ones you see here listed are what is included in the scope of 3.7.3, everything from HVAC ductwork, cable tray. We call them distributed systems and platforms. Everything, all the remainder of the items are in 3.7.3.

Seismic Category I systems are designed to withstand the certified seismic design response spectra and still perform their safety function. The methods for the subsystem analyses include response spectra methods, time history methods, or equivalent static load methods.

We do consider -- well, the operating basis earthquake is not explicitly considered for the SECY 93-087, but we do look at the exemptions for elimination of the OBE, as addressed in the SECY, to address the fatigue loading.

Any site-specific subsystems or anything, the COL applicant is required to address.

Section 3.7.4 describes the seismic instrumentation requirements to ensure plant features important to safety can be evaluated promptly following an earthquake. The instrumentation is required to conform to the Reg Guide 1.112; in other words, qualified the IEEE standards 344.

Pre-earthquake planning and post-earthquake actions are required to conform to the Reg Guide 1.166, and the exceedance criteria is established per the EPRI reports NP-6695 and NP-5930. And the CAV, the cumulative absolute velocity, is calculated in accordance with the EPRI Technical Report 100082.

Then, we require the restart requirements to conform to the Reg Guide 1.167.

There is a requirement for the COL applicant to ensure he has his free-field sensors located where he can adequately assess the earthquake that has come on his site and he can assess it as a free-field, compare it back to his design basis earthquake appropriately.

CHAIR POWERS: I have -- excuse me.

MEMBER STETKAR: No, go on. You're

probably on this slide. I'm slow.

(Laughter.)

CHAIR POWERS: No, I am just as disconnected as the submission of this material is.

(Laughter.)

If I have an earthquake that exceeds my OBE, but it is less than my SSE, I have to inspect this plant?

MR. OSWALD: That's correct.

CHAIR POWERS: Do you provide any guidance on what I ought to look at, based on your analyses?

MR. OSWALD: Other than what is in the Reg Guide 1.166, we have not provided --

CHAIR POWERS: You don't provide anything special?

MR. OSWALD: We haven't provided anything special here at this stage.

MEMBER STETKAR: I was going to ask you a curiosity question. You don't have to flip back to the previous slide. But I was thinking about, you know, you have added the high-frequency spectrum to the plant design.

MR. OSWALD: Uh-hum.

MEMBER STETKAR: When you added that, did you find anything that required a rework, let's say?

In other words, did you find very stiff equipment? I am thinking mostly electrical/electronic stuff --

MR. OSWALD: Right.

MEMBER STETKAR: -- in a fairly stiff building that could be susceptible to high natural frequencies. Did you find any of that?

MR. OSWALD: I am not aware of any -- obviously, it didn't affect any of the structures that we deal with. I am not aware of any of the other disciplines having issues. It will show up in the required response spectra for testing --

MEMBER STETKAR: Yes.

MR. OSWALD: -- in the IPEEE or the 344 testing.

But I am not aware -- I will look at my colleagues around the room to see if anyone else is aware of anything that changed as a result of the high frequency.

MEMBER STETKAR: I was just curious. The question has come up before.

MEMBER SKILLMAN: If they haven't done the piping, detailed piping design or anchorage --

MEMBER STETKAR: Yes. Yes, piping I am not so concerned about. I was thinking more of support for electrical things. And I don't know. I am not a structural engineer, so I am not really familiar kind of in an intuitive sense with what the natural frequencies of those sorts of things tend to be, anyway. I was just curious.

MEMBER SKILLMAN: Yes, I would have thought you would have answered cabinets, racks, smaller structures that are fairly compact that may have a relatively high natural frequency.

MR. OSWALD: Yes, that is what we refer to as chatter-sensitive equipment. That will be impacted when -- I mean, right now, what we have done is generate that motion, so they have their required testing structure.

MEMBER STETKAR: Okay.

MR. OSWALD: They will have that motion.

MEMBER STETKAR: I understand.

MEMBER SKILLMAN: The answer is there is some stuff that is swept in --

MEMBER STETKAR: Yes, yes.

MEMBER SKILLMAN: -- with the higher frequency.

MR. GARDNER: It has the potential for being impacted. We just haven't done those analyses. Practically speaking, I think we are going to find --

MEMBER STETKAR: You don't have the

anchorages and everything. You are just specifying the anchorages right now?

MR. OSWALD: Correct. Up to this point, we just haven't seen it. It will be in the test requirements.

MEMBER SKILLMAN: Thank you.

MR. OSWALD: Uh-hum.

MEMBER STETKAR: Sometimes I get ahead myself, thinking you actually have a real design.

(Laughter.)

MR. OSWALD: It would allow us to answer some questions sometimes.

CHAIR POWERS: Some places they do have a real design.

MEMBER STETKAR: No, I'm being facetious a bit.

MR. GARDNER: Dr. Powers, this may be a good spot for a break.

CHAIR POWERS: I was thinking that we would probably take a brief recess, if you guys are done with 3.7.

There was one question. You went through it, and I'm slow. Analyzing the building, and you have a big, heavy reactor inside of it. And what you do is you approximate that as a hanging mass, if I understood you correctly.

MR. OSWALD: The reactor itself and the component steam generator is a beam and lump mass model lumped in the power finite element.

CHAIR POWERS: Yes. So, that stuff has the potential of getting out of phase with the building itself responding to things. Does it? And how big is the relative motion?

MR. OSWALD: So, the question is, does the reactor coolant system get out of phase with the building?

CHAIR POWERS: Yes.

MR. OSWALD: I am looking at my reactor coolant system colleagues in the back.

(Laughter.)

We get a lot of complaining from them, but I am not sure how he wants to categorize it.

MS. WEAVER: The microphone, yes, sir.

MEMBER STETKAR: You have to identify.

MR. McGAUGHY: I'm sorry.

MEMBER STETKAR: Just give your name for the record.

MR. McGAUGHY: This is Chris McGaughy. I do reactor coolant system analysis for AREVA.

Of course, we do have a lot of components that are supported in different ways. I am sure that some of them do get somewhat out of phase with the reactor building. But we have a very detailed model of the reactor coolant system, along with a simplified stick model of the interior concrete structure. So, we try to incorporate any of those phase differences in our model.

And alternatively, they have a more detailed model of the reactor building and a less detailed model of the reactor coolant system. And so, we compare those two to make sure that we are getting similar results, especially loads in the supports and response factors.

CHAIR POWERS: What I am trying to do is get a physical feel of how big the relative motions can be.

MR. McGAUGHY: Like, for example, in the reactor vessel?

CHAIR POWERS: Yes, take the vessel. That is an easy one.

MR. McGAUGHY: Okay. Yes, and, as a matter of fact, we have compared relative motions between the reactor vessel and the building, and it is actually quite small.

CHAIR POWERS: Small like in a four-door

model or small in like a nanometer?

MR. McGAUGHY: It's like an eighth of an inch. It is a small number, yes.

CHAIR POWERS: Okay. So, it rattles a little bit.

Your steam generators are on, I mean, the big, large ones, what kind of motions do I get on the steam generators?

(Laughter.)

Hey, you've got numbers.

MR. McGAUGHY: I'm sorry, what was that question?

CHAIR POWERS: Well, I mean, the steam generator is a big thing hanging up in the air.

MR. McGAUGHY: Sure.

CHAIR POWERS: And so, when it gets to moving, you have got a big lever arm on that.

MR. McGAUGHY: Sure, sure.

CHAIR POWERS: And I am trying to get a feel for the relative motions, you know, the magnitude of the swing there.

MR. McGAUGHY: Okay. I am not sure exactly what the values are --

CHAIR POWERS: Yes, sure.

MR. McGAUGHY: -- where the steam line

connects to it, for example.

CHAIR POWERS: Yes.

MR. McGAUGHY: But it is in the neighborhood of an inch or so.

CHAIR POWERS: Okay. So, it swings around, but --

MR. McGAUGHY: Yes, it does swing around a bit. Yes, it is not a foot.

CHAIR POWERS: It would be fun riding on the top of it. You're telling me that.

MR. McGAUGHY: It might be interesting.

CHAIR POWERS: Yes. Wear your brown pants that day.

(Laughter.)

Okay. With that poignant comment, we will take a recess for 15 minutes.

(Whereupon, the above-entitled matter went off the record at 10:15 a.m. and resumed at 10:32 a.m.)

CHAIR POWERS: Let's come back into session and hear about Section 3, which I believe is on design of Category I structures.

MR. OSWALD: That's correct.

Section 3.8, there's five sections, subsections of Section 3.8 we will address here today.

Section 3.8.1 is containment, concrete containment. 3.8.2 is the steel containments, which there is some scope in the U.S. EPR, although we have post-tension concrete containment. Section 3.8.3 is the concrete and steel internal structures that make up the inside of the containment. 3.8.4 is the other Seismic Category I structures, and 3.8.5 is the foundations.

Next slide.

CHAIR POWERS: Can I ask -- and maybe you don't even know the answer to this -- but I will ask, anyway. Why a post-tension concrete structure?

MR. OSWALD: Why do we have the post-tension concrete structure for the U.S. EPR?

CHAIR POWERS: Yes.

MR. OSWALD: It is the standard design that has been used over in Europe for quite some time. Part of it is, if you have a tendon failure, I mean why post-tension is to --

CHAIR POWERS: I understand those things. Of all the designs you could have picked, you picked a post-tension design. And maybe it was, then, just because historically that is what you did. It happens to be one we have tested a lot. I just wondered if there was any particular reason.

MR. OSWALD: No, other than that was the standard design that had been developed by AREVA over in Europe.

CHAIR POWERS: Well, fortunately, it is one we kind of understand.

MR. OSWALD: Yes.

CHAIR POWERS: Okay. I was just curious.

MR. OSWALD: Okay. 3.8.1 is our post-tension reinforced concrete containment. Just one comment. We have a concrete shield building on the exterior, in addition to our post-tension concrete containment. So, what I am talking about here is the pressure vessel itself, the ASME concrete containment pressure vessel. It is the interior concrete building.

It is reinforced concrete, post-tension reinforced concrete, designed for protection against the missiles. It is designed per ASME Section III, Division 2, since it is a pressure vessel. It does include a quarter-inch steel liner plate, which is pretty common here in the U.S.

One thing that is a little bit unique --

CHAIR POWERS: Hopefully, there are no 2x4's.

(Laughter.)

MR. OSWALD: Well, it hasn't been built yet. There's certainly none in our finite element models that we included, I can tell you that.

We use a grouted tendon design in the U.. EPR, which is very common in France, and they have had very good performance of the grouted tendon design. It meets the requirements of the Reg Guide 1.90 for the use of grouted tendons.

CHAIR POWERS: These tendons are just cable, seven-cable kind of tendons, or something like that?

MR. OSWALD: Yes. Seven is not the right number, but I am sitting here drawing a blank. I have got a presentation. I can pull that information out. But that is the pretty standard cables that will be pulled through and anchored as post-tension.

MEMBER SKILLMAN: Let me ask, please, about the ASME Section III, Class 2. Should we interpret that to mean the liner on the concrete, the penetrations, the ground mat --

MR. OSWALD: That should be interpreted --

MEMBER SKILLMAN: -- the extensions, if you will, of the membrane that would be that pressure vessel to all pertinences that are classified as containment?

MR. OSWALD: Yes, the scope of the ASME Section III, Division 2, will be all the concrete-backed containment where concrete is used for the structural component. It would be the concrete-backed steel components. Once you get to a steel component that is not concrete-backed, that is Class 2, Subsection NE, component.

I need to give you an example, such as the sleeves that penetrate through containment where we have components attached to it. Well, where it is backed by concrete, that is governed by ASME Section III, Division 2. Where it is not backed by concrete, that is Subsection NE in the ASME.

And so, that would include --

MEMBER SKILLMAN: Hatches?

MR. OSWALD: Well, the hatches would be in III.8.2, which would be Subsection NE.

MEMBER SKILLMAN: Got you. Thank you.

MR. OSWALD: Uh-huh. And it does include the basemat, also.

MEMBER SKILLMAN: Thank you.

MR. OSWALD: All right.

See, the containment designed for normal loads, such as dead load, live load, and severe environmental loads, such as wind. Well, wind is not applicable because we have the 60-year shield building. And then, the extreme environmental loads would be something such as the SSE, and abnormal loads are such as line breaks or combustible gas loading.

The containment design pressure is 62 psig.

Again, the COL applicant has to make sure that there aren't any site-specific loads that need to be considered for containment design that we haven't considered in the design certification.

The next slide is just a representation of our detailed finite element model, which is what we use to get our loads distributed out through the building and get them to the structural elements. So, the results from this model are used to design the structural elements.

MEMBER SKILLMAN: Do the discolorations or the variances in color at the crown, where the crown meets the cylinder, have any mean -- yes, right there, those -- or is that just part of the --

MR. OSWALD: It is just the graphics.

MEMBER SKILLMAN: -- way the graphics --

MR. OSWALD: It is just the way it is shown there.

MEMBER SKILLMAN: It is meshing.

MR. OSWALD: Yes, the meshing is just the view we have cut out.

MEMBER SKILLMAN: Thank you.

MR. OSWALD: Okay. Section 3.8.2 describes the steel components of the concrete containment. Again, these are still components that form the pressure boundary that fall into Section 3.8.2.

It includes the penetration, such as equipment hatch. There is a dedicated spare penetration, personnel airlocks. There is a construction opening. It is sealed up after construction. Pipe penetration sleeves, electrical penetration sleeves, and fuel transfer tube sleeve design. Again, these components are ASME Section III, Subsection NE.

And again, these steel components or containment are designed for the service loads, factored loads, and other loads required by the ASME code.

MEMBER SKILLMAN: So, does it suggest that the pertinences or these penetrations are actually an ASME division higher than the concrete-backed steel?

MR. OSWALD: No, there's not -- well, I am not sure when we talk about hierarchy.

MEMBER SKILLMAN: You are showing on slide 31, Division 2, the design meets the requirements of ASME III, Division 2. But on 33, you are showing that the penetrations are Division 1, NE.

MR. OSWALD: Yes, there is no hierarchy there. It is just the way the code is organized.

MEMBER SKILLMAN: Okay. Thank you.

MR. OSWALD: All right.

Okay. The next slide.

Section 3.8.3 describes the reinforced concrete walls and the floors, the steel framing members, and other concrete and steel structural elements that are located within the containment structure, including the structural elements listed there.

Okay. The next slide.

CHAIR POWERS: The IRWST, your analysis is just of the structure? You don't take into account the sloshing load?

MR. OSWALD: Yes, we do.

CHAIR POWERS: How do you do that?

MR. OSWALD: The sloshing loads are accounted for by looking at the response spectra input. I would have to go back and look at the details on the impulse of the convective and the loadings. But we consider, by looking at the response spectra that is calculated and its effect on that fluid mass, and calculating the --

CHAIR POWERS: Is it a big effect or a little effect? Is the sloshing load a big effect or a little effect? And my intuition in this particular design is it is no effect at all, but I don't --

MR. OSWALD: I would have to go back and look at the details. I don't think it governed the design, but it certainly depends on the load combination that we are looking at. Off the top of my head, I can't tell you the magnitude.

MEMBER SKILLMAN: For the core melt retention area, your last bullet, what are the requirements for the concrete in that area?

MR. OSWALD: The requirement, there is some ceramic bricks that are on top of the concrete.

Tim, do you happen to recall much of the detail on that core melt retention area with the ceramic bricks and the water cycling?

MR. STACK: Yes, I do. I am not sure, do you have a specific question in mind?

MEMBER SKILLMAN: Yes. I'm wondering if the core melt retention area has a requirement for basaltic-type concrete as opposed to a carbonatic or calcium carbonate limestone that is a carbon dioxide generator on core melt. The basaltic material is resistant to that; whereas, the limestone-type is a source of carbon dioxide.

CHAIR POWERS: I will comment. There is a wide misconception that the two categories, siliceous and calcareous concretes, have wildly-different responses to core melt because the calcareous has a lot of carbon dioxide generation. That is a misconception people have.

And the misconception arises because they look at the inventory of gas-producing material. They don't consider that you get gas only because of thermal decomposition, and siliceous concretes have a much lower enthalpy of decomposition than do calcareous materials.

As a result, when you analyze them or when you experiment with them, you get about the same amount of gas from both of them. The enthalpy of decomposition of a calcareous concrete is so high that, yes, per-unit volume of concrete decomposed, you get a lot of gas, but you don't decompose nearly as much volume.

Here in your design you have got a bunch of, I think they are either magnesia or zirconia bricks on top of them, and whatnot. And so, you are not really affecting the concrete per se, until you go through the bricks, and that is an inspirational event when you do it, should you happen to do it. You are trying to drain it off before you do it, but if you do -- we have done that experiment, and you don't want to do that.

(Laughter.)

MR. STACK: We agree.

MEMBER SKILLMAN: Thank you, Dana, for your explanation.

CHAIR POWERS: Yes. I mean, it's floating around. Everybody says, oh, my god, don't use calcareous. Actually, calcareous concrete is a really good thing to use because it will suck the heat right out of your metal, and whatnot. Basaltic concretes are really nice because they provide lots of material to dilute and things like that. I think it doesn't matter. You know, use whatever concrete you want, and whatnot. The basic answer is don't melt down the core. That is a really bad idea, as it turns out.

(Laughter.)

MEMBER SKILLMAN: Thank you. I'm good. Thanks.

MR. OSWALD: Okay. Let's go down to the

next slide.

The internal structure of the concrete meets the requirements of, we use ACI-349 and ANSI N690 for the steel design. These are safety-related components.

We design for normal loads, severe environmental loads, extreme environmental loads, and abnormal loads, such as high-energy line break.

Again, there is a requirement for the COL applicant to determine if there are any site-specific loads that we haven't considered in design certification.

What you see there is just the representation of our finite element model that we are using for the interior structure, the concrete.

Okay. Moving on to 3.8.4, this section talks about the other Seismic Category I structures that are not on the nuclear island -- well, that are on the nuclear island common basemat and those that are not on the nuclear island common basemat, such as our central service water building and emergency power generation building.

I have the structures listed and indicated their location. They are either on the common basemat or separate.

You will also notice that we do talk about buried conduit and duct banks and the buried pipe and pipe ducts. But, essentially, it is a COL scope. It is not part of certified design.

CHAIR POWERS: If you were to change this containment to a filtered vent containment, where would you put the filter vent?

MR. OSWALD: Well, we have a dedicated spare penetration. I don't know if the size is right. I haven't reviewed that. So, there is a dedicated spare penetration that we have here.

MR. STACK: Tim Stack again from AREVA.

Yes, we are required to have a spare penetration, and we do. My recollection, it is about 3 feet. It is per the Code of Federal Regulations.

I will also add that some of the other EPRs worldwide actually have filtered, vented containments.

CHAIR POWERS: And that, too, is another really, really bad idea in this world.

Please go ahead.

MR. OSWALD: Okay. Section 3.8.4, right. Again, as mentioned, it is designed to meet ACI-349 and ANSI N690. We do not use any masonry walls in the design of Seismic Category I structures.

CHAIR POWERS: Yay, yes.

(Laughter.)

MR. OSWALD: It's a nice architectural feature, but that's about it.

(Laughter.)

We design for normal loads, severe environmental loads, extreme environmental loads, and abnormal loads.

And again, the COL applicant always has the requirement to make sure that he is not going to do something that we haven't considered in our design certification for our structures.

CHAIR POWERS: Do you take account of high whip, I mean pipe whip, in these breaks?

MR. OSWALD: Yes.

CHAIR POWERS: You do?

MR. OSWALD: Yes, it is a requirement for pipe whip, absolutely.

Section 3.8.5, foundations. The Seismic Category I foundations in the U.S. EPR design include the nuclear island common basemat -- and that is the foundation that is under everything, as you see in the picture there -- the emergency power generation building basemat, and the central service water foundation basemat.

Again, these components are designed to meet ACI-349, the nuclear concrete code, and then, ASME Section III, Division 2, where the basemat forms the pressure boundary of containment, essentially, the round portions of the basemat there you see in that figure.

CHAIR POWERS: Do they have an embedded liner in them?

MR. OSWALD: Yes.

CHAIR POWERS: How thick is that? Is that still a quarter inch?

MR. OSWALD: Still a quarter inch.

CHAIR POWERS: And how thick is the basemat all together?

MR. OSWALD: About 9 feet, 13 feet. It depends.

CHAIR POWERS: Yes, but, I mean, there is nothing special about it? It is kind of like everybody else?

MR. OSWALD: Right. Correct. It is just a big, thick basemat.

Okay. For foundations, we look at stability, the sliding and overturning evaluations. Those are always challenging to show.

CHAIR POWERS: Yes.

MR. OSWALD: Analytically, it has cost us quite a lot of angst to try to come to those conclusions, a lot of analysis.

CHAIR POWERS: So, what kind of torque on the basemat do you get?

MR. OSWALD: We are seeing some uplift on the basemat. I am trying to remember our latest results. I don't recall exactly. In the 10 to 15 percent range, something maybe. I would have to go back and look at our latest results.

CHAIR POWERS: So, I mean, it is non-zero by law?

MR. OSWALD: It is non-zero.

CHAIR POWERS: It has got a big torque.

MR. OSWALD: Yes.

CHAIR POWERS: And I guess it makes some sense.

MR. OSWALD: I would have to look at the final numbers, where we were. I recall some earlier numbers.

CHAIR POWERS: Interesting. Interesting.

MR. OSWALD: Again, the COL applicant has to make sure that he is not doing anything to our basemat that we haven't considered in our certified design.

CHAIR POWERS: If you get a 10 to 15 percent torque, again, you have this problem of all the penetrations coming in from the adjacent structures that are separated here. That's a lot.

MR. OSWALD: Well, when I say 10, what I am saying is you see some of the basemat uplift.

CHAIR POWERS: Yes.

MR. OSWALD: Now when you say torque, there is some basemat uplift experienced, and that is calculated in our seismic anchor motions that we consider for all of these umbilicals attached. We do have to consider that.

CHAIR POWERS: What do you bend it on?

(Laughter.)

MR. OSWALD: Yes. I mean, the key is get enough distance where you can get flexibility.

CHAIR POWERS: Yes, yes.

MR. OSWALD: And that is our challenge.

CHAIR POWERS: Yes, you want some give n these things.

MR. OSWALD: Uh-hum.

Okay. I think this is actually the last slide I have to give you on Section 3.8.

MEMBER STETKAR: I was reading the SER. Have you finished the analyses of the ESWB, the essential service water building?

MR. OSWALD: No, we haven't.

MEMBER STETKAR: You are still in progress?

MR. OSWALD: Right, we are, and stability is one of the key --

MEMBER STETKAR: That is the sense that I got, but sometimes, you know --

MR. OSWALD: Yes.

MEMBER STETKAR: -- we are not operating, necessarily, in real-time, but those are still being worked on?

MR. OSWALD: That is correct.

MEMBER STETKAR: Okay.

MR. OSWALD: Stability analysis is where we are at now. We are into time history analyses.

The last slide I have for you this morning is there is a requirement in 10 CFR 52.47 which says, for design certification, you have to have an essentially complete design. So, we refer to our critical sections design. We are not doing everything on the U.S. EPR structure. So, we select certain areas to demonstrate that the design is good.

And we have a selection methodology that we created to do this. There are three sections to it: a qualitative criteria, a quantitative criteria, and then a supplemental criteria, where it just says, well, we want to look at this, too, essentially; it is important.

Again, our qualitative criteria is something that is critical to perform a safety function. Now you can argue the whole building is, but we kind of looked at containment. I mean, by definition, we are going to look at containment. That is the one that fell out into our first criteria there.

Our quantitative criteria, we have our finite element results, where we have thrown all the load combinations, multiple thousands of load combinations, worked through that, sorted it down, and looked at certain high-stressed areas, which we say we had better look at that a little closer.

And then, we have supplemental criteria. It didn't show up in the first two criteria. We said, well, we need to make sure that we can do the steel designs, the steel component. It is really more on judgment, kind of looking at things that we want to make sure that it is going to work.

So, that is what we have used. We ended up with about 35-36 areas. Now when I say area, I am not talking about just a wall panel. I am talking about a wall. You know, it is an area. It is a large area, not just a little element that we are trying to design.

So, we ended up with about a total, between the nuclear island and the other buildings, of about 36 sections to do detailed concrete design or steel design on, and that is work-in-progress, an open item right now.

CHAIR POWERS: When we have tested concrete structures -- and usually these tests are not seismic tests; they are structural tests, overpressurization tests -- we have always found the failures occur at details below the level of resolution of any computer code. And the argument has always been that: oh, well, yes, it failed at something that we actually don't want, but had it not failed, it would have failed at slightly higher pressures at a membrane section. And so, it's okay.

Do you have the same problem here, that you model these things, but there is a limit to the detail that you are going to try to model? And sometimes those things that you don't model are, in fact, the high-stress or weak regions?

MR. OSWALD: Well, the detail in

requirements and the code requirements sort of address the majority of that in concrete. I am trying to think of what examples you may have been talking about. I mean, absolutely, we are not finite element modeling every little detail, but there's requirements built into the codes to have the margins in your connections. I mean, in structural design, we really focus a lot on connection design.

I know I am not answering your question, but I am not really sure --

CHAIR POWERS: Well, I think you are. I think you are saying that you are fairly confident that you modeled those things that are likely to be the points of failure. I mean, you are not going to model it rock-by-rock.

(Laughter.)

MR. OSWALD: We are going to get our loads out of our big model results as finite element models. Those are used to get the loads distributed throughout the structure. And then, we go from there. Then, it is really the detail design is a lot of code application and a lot of design details that have to be thought out.

We don't get the answer out of the finite element model, absolutely not. Well, we get the load, but we don't get design for this exactly.

That should be the last slide that I have there, yes, for Section 3.8.

MR. GARDNER: If you will be patient with us, we are going to do Curly shuffle with presenters.

CHAIR POWERS: Are we going to let them shuffle or should we just make Darrell do the rest of it?

MEMBER SKILLMAN: I want to see the Curly shuffle.

(Laughter.)

CHAIR POWERS: Yes, please go ahead.

MR. McGAUGHY: All right. Good morning, everyone. I am Chris McGaughy. I am a professional engineer in Virginia, an advisory engineer with AREVA. I have been working for the company for 22 years, mostly in structural and thermal hydraulic analysis of reactor coolant system and Class 1 piping components and supporters.

I have got a few subject matter experts here with me to help me through this complicated section.

This is Ashok Nana. He has been with the company for 31 years. He is our expert in leak-before-break and fracture mechanics analysis.

I have John Burgess over on the wall, who is also an advisory engineer with AREVA. He works with flow-induced vibration.

And Pavan Thallapragada works in Class 1 component analysis.

And also, Mark Foster is in our civil and layout group.

So, let's move to the next slide here.

Okay. This is on Section 3.6, which discusses design of the EPR relative to dynamic effects associated with pipe rupture, termination of rupture locations, and also leak-before-break evaluation procedures.

Section 3.6.1 covers the design for protection of essential systems, and it follows the guidance of BTP 3-3 and the SRP.

The EPR design employs redundancy, distance, intervening structures, and separation of the four safeguards building when exiting containment. Physical protection includes the use of barriers, enclosures for essential equipment, and guard pipes also.

Section 3.6.2 discusses ruptures in the high- and moderate-energy piping inside and outside containment. The ruptures and leakage cracks are located using the guidance of BTP 3-4 and the SRP. This includes circumferential and longitudinal breaks and leakage cracks in high-energy lines, and only leakage cracks in moderate-energy lines.

Pipe whip analysis, the dynamic effects are evaluated if it is determined that an essential SSC can be affected by the break. And the whipping of a broken pipe is evaluated based on SRP criteria.

Continuing on with Section 3.6.2, we have a tech report, ANP-10318P, that describes the methodology used for jet impingement loads on essential SSC. The methodology addresses jet unsteadiness, resonance, and deflection of jets.

The methodology was developed based on concerns of the ACRS with ANSI standard 58.2 methodology. And briefly, the method uses the following basic principles:

Source conditions are evaluated throughout the blowdown to determine the worst-case loading after the rupture. The jet plume effective link for two-phase jets is based on NUREG/CR-2913, and for steam jets it is based on NEA Report NEA/CSNI/R (95)11, which was based on some testing in real situations.

Jet properties are based on basic thermodynamic principles. Resonance minimum frequencies are based on a paper by Dr. Chris Tam, who is a Florida State University noted member of the applied math, acoustics, and fluid dynamics community. As a side note, Dr. Tam provided us a great amount of help in developing our approach to resonance.

Higher frequencies are assumed to line up with the structure natural frequencies. So, basically, we have a method to develop what the minimum natural frequency or resonance frequency is within the jet, but that doesn't tell us what all the possible frequencies are for the jet. So, we assumed that any higher frequencies would just line up with the structure that is being impinged upon. And so, we will just apply loads at that frequency to that component, and we will calculate stresses that way.

CHAIR POWERS: So, how do you calculate amplitudes?

MR. McGAUGHY: Okay. We have done it about as conservatively as we possibly could. We took the --

CHAIR POWERS: Well, you certainly were conservative in your choice of frequencies.

(Laughter.)

MR. McGAUGHY: Exactly.

CHAIR POWERS: I don't see how you could

be more conservative than that.

MR. McGAUGHY: That is what we are hoping for, yes.

Basically, we take the force on the jet, which is basically the exit-plane forces, and we take that as the amplitude of the --

CHAIR POWERS: So, your high-frequency components have the same --

MR. McGAUGHY: That's right, and what we found is, after you get past a certain frequency, usually in the neighborhood of 75 Hertz or something, the response to that really drops off a lot and the stresses are pretty small. But we still, for like a plate-and-shell-type structure, like a pressure vessel, our criteria is we go up to a minimum of 500 Hertz. And then, hopefully, the stresses will start coming down in the component, but we make sure that we have dropped at least 75 percent before we stop looking at frequencies.

CHAIR POWERS: That is pretty interesting. Resonances are all equal amplitude.

MR. McGAUGHY: And especially in a pressure-vessel-type structure, the shell, it starts a lot of localized modes where you get multiple peaks in it. And really, with a jet, you are only loading at one spot. So, it doesn't really respond very well to that type of a load, which is helpful for us.

MEMBER SKILLMAN: Chris, how did you choose your target population?

MR. McGAUGHY: Well, basically, anywhere that the jet can strike. You know, we have terminal end-breaks and, also, intermediate breaks based on stresses. And so, anywhere that that jet can strike, that would be a target.

MEMBER SKILLMAN: Thank you.

MR. McGAUGHY: And we have a flowchart of our methodology included in our tech report and, also, in the response to RAI-354, Question 36233.

And also, blast effects, we have found that blast effects only occur in lines containing steam, and the steam lines outside --

CHAIR POWERS: I am not sure what you mean by blast effect.

MR. McGAUGHY: Okay. Okay. Well, a blast, basically, if you have a disturbance in the atmosphere that is high-speed, and it would be a compression or heating or both, like in the event of TNT, then --

CHAIR POWERS: So, you are just saying you have shock waves?

MR. McGAUGHY: Exactly. It is a shock wave traveling at the speed of sound --

CHAIR POWERS: All right. Now I understand.

MR. McGAUGHY: -- and that is a blast.

CHAIR POWERS: Absolutely. So, you can have them with steam, yes.

MR. McGAUGHY: Yes, definitely with steam, and with cold water or saturated water, you typically would not see that until you get up into a higher quality. Because, really, the speed of sound of the fluid at the higher qualities, it is really low when it is coming out of the break. So, it is difficult to develop a blast wave if you have such low speeds.

CHAIR POWERS: Right.

MR. McGAUGHY: Now the steam lines inside containment are not evaluated for pipe rupture effects because we have qualified those to LBB. But we know right outside containment we have the main steam isolation valves, and they are in rooms right next to each other. And so, we have to evaluate a break there which could affect the opposing main steam isolation valve.

MEMBER SKILLMAN: What actions have you taken for the certified design to ensure that there are not target locations out in the plant where there is vulnerability to important equipment? I am thinking of the trauma that the industry has gone through over the years where there have been theorized breaks at some arcane steam location out in the turbine building.

MR. McGAUGHY: Sure.

MEMBER SKILLMAN: But there is a panel that has an important-to-safety instrument, and the work the industry has had to go through to protect that panel or that instrument. What effort has been invested in this certified design to ensure that there is not a population of orphans out there where, when we look at the robust part of the building, we are saying everything is protected, but there are these other vulnerabilities that may not have been considered?

MR. McGAUGHY: Okay. So, you are speaking of like a panel outside the containment building, for example?

MEMBER SKILLMAN: It could be in the turbine building.

MR. McGAUGHY: It could be anywhere.

MEMBER SKILLMAN: It could be over in the --

MR. McGAUGHY: And if it has a safety-related function --

MEMBER SKILLMAN: And gee whiz, there is an energy supply in a contained pipe or compressed air, and, all of a sudden, I now have vulnerability that I must factor back into my risk assessment.

MR. McGAUGHY: Well, if that were a safety-related piece of equipment, then it would have to be in an enclosure or protected by some sort of a barrier.

MEMBER SKILLMAN: Would the barrier have been evaluated for blast effect?

MR. McGAUGHY: Yes. If that barrier is intended to protect safety-related equipment, then it would be safety -- well, it is not really safety-related, but it has to be evaluated for the blast or the jet impingement just as well.

MEMBER SKILLMAN: Thank you.

MR. McGAUGHY: Okay. Leak-before-break. Section 3.6.3 discusses leak-before-break and methodologies used to apply to U.S. EPR piping systems. The methods used are consistent with NUREG-1061 and SRP 3.6.3.

LBB has been applied to the RCS leak piping, the pressurizer surge line, and, also, the main steam line inside containment, as I mentioned a moment ago.

CHAIR POWERS: Go over those again?

MR. McGAUGHY: I'm sorry, what's that?

CHAIR POWERS: Which ones are you --

MR. McGAUGHY: The main steam line inside containment, the pressurizer surge line, and the main coolant loop piping, hot legs and cold legs.

CHAIR POWERS: Surge line, and what was the third one?

MR. McGAUGHY: Main coolant loop piping, hot leg, cold leg, crossover leg.

The LBB results are illustrated in the form of an Allowable Load Limit diagram which provides minimum moment along the X-axis and maximum moment along the Y-axis. And then, you have to show that your point fits within the boundaries of the curves.

MEMBER SKILLMAN: Let's look at that population again. Main coolant pipe, I understand. Surge line, I understand. Main steam lines inside containment, I understand.

How about LBB values in CS lines?

MR. McGAUGHY: No, we have not applied LBB to any other lines.

MEMBER SKILLMAN: Thank you.

MR. McGAUGHY: The critical location is the surge line dissimilar metal weld at the pressurizer surge nozzle.

Leakage detection. Continuing on with 3.6.3, leakage rates for the reactor coolant system and the surge line piping are 5 gallons per minute, and for the steam line it is 1 gallon per minute. This provides a factor of 10 over the leakage detection capabilities of the EPR systems, per the guidance of SRP 3.6.3.

Leakage detection methods include local humidity detection and containment sump level. The local humidity detection systems are discussed in Section 7.1.1, and leakage detection systems are discussed in Section 5.2.5.

CHAIR POWERS: What size of crack would I need in the main --

MR. McGAUGHY: The main steam line?

CHAIR POWERS: -- the main steam line to get 5 gallons per minute?

MR. McGAUGHY: It is 1 gallon per minute for the steam line.

CHAIR POWERS: I'm sorry.

MR. McGAUGHY: Yes.

CHAIR POWERS: One gallon.

MR. McGAUGHY: I will turn that to Mr. Nana.

MR. NANA: Pardon me. Can you phrase your question again?

CHAIR POWERS: How big of a crack do I have to have in the main steam line to get 1 gallon per minute?

MR. NANA: I am not sure I have the answers about --

CHAIR POWERS: I mean you don't have to give me a number to three significant digits. This big or this big?

MS. WEAVER: Could you please say your name for the court reporter?

MR. NANA: Oh, this is Ashok Nana.

MS. WEAVER: Okay.

MR. NANA: From AREVA.

I think it is -- and this is my recollection -- 8-inch size.

CHAIR POWERS: Eighth inch?

MR. NANA: Eight inch. Eight inch.

CHAIR POWERS: Eight inch? An 8-inch size, and what the unstable size?

MR. NANA: About 22.

CHAIR POWERS: Twenty-two? So, a factor

of three on the critical crack size. That's not a lot, is it? Well, it depends on the crack growth rate, I agree with that.

MR. NANA: You know, the requirement is a factor of two for leak-before-break demonstration.

CHAIR POWERS: I mean, this is a guy that puts all of his frequencies right at the resonance frequency. I mean, he is a very conservative guy.

(Laughter.)

For crack lengths, he is not so conservative.

(Laughter.)

MEMBER STETKAR: Does the LBB analysis on the main steam lines extend out through the annulus? Or do you just take credit for the guard pipes out there?

MR. NANA: It does not extend past the annulus area.

MEMBER STETKAR: I am talking about the space in the annulus.

MR. NANA: I think it is before the annulus itself, just prior to the annulus.

MR. McGAUGHY: We have the sleeve or the guard pipe that goes into the inner containment, and we have that anchorage that is in the middle of the guard pipe, right? I think we go up to that anchorage, right, but it is inside the guard pipe at that point?

MR. NANA: Yes, up to the anchorage point potentially.

MEMBER STETKAR: Thanks.

MR. McGAUGHY: Okay. This is Section 3.9, which covers mechanical systems and components.

Section 3.9.1 covers a few topics, including design transients, computer programs and stress analysis methods. A listing of the design transients can be found in table 3.9.1-1 of the FSAR, and U.S. EPR considers a standard set of transients. There is nothing special about the transients for the U.S. EPR.

MEMBER STETKAR: Well, I mean, there is how you have subdivided some of them, because you have taken credit, apparently, for the plant runback capability for loss of offsite power in terms of numbers of events and severity of events, as best as I can tell.

(Laughter.)

Is that correct? Because the way that you have subdivided loss of offsite power is in short duration with a return to power from a thermal perspective versus a longer duration with a natural cooldown. It seems to account for the plant design capability to rapidly reduce power --

MR. McGAUGHY: Right.

MEMBER STETKAR: -- and remain non-tripped, for example. Is that a right interpretation? I mean, I have read the short paragraphs.

MR. STACK: The answer is, yes, that is a correct interpretation.

MEMBER STETKAR: Okay.

MR. STACK: We will also be covering that when we do Chapter 14 as the testing. We will discuss that, if you have further questions, and we will have our experts then.

MEMBER STETKAR: Thanks.

MR. McGAUGHY: Software used in the mechanical design of the EPR is listed in Appendix 3(c) of the FSAR and the Piping Topical Report. All software used in safety-related applications are verified, validated, and maintained, per internal procedures. And we do not use any experimental stress analysis techniques in the design of the EPR.

CHAIR POWERS: When you do a leak-before-break analysis, you are taking into account all of these conditions, normal and upset. How far up the spectrum do you go?

MR. McGAUGHY: It is all the normal and upset transients, plus SSE, right? Or is it just normal?

MR. NANA: Essentially, it is leak-before-break analysis is done with the steady-state normal operating conditions. And then, in addition to that, for the followup conditions, the SSE loads.

CHAIR POWERS: Okay.

MR. NANA: It doesn't go through per se an upset condition.

MR. McGAUGHY: The SSE load, I believe, is just for the crack stability analysis, right?

CHAIR POWERS: Yes. I mean, that is kind of what you are worried about right now.

MR. NANA: Well, for example, for the surge line, I can just say, the stratification loads are actually lower, significantly lower, than the SSE loads. We ensure that we have got the bounding load set.

MR. McGAUGHY: Okay. Section 3.9.2 describes the startup testing and dynamic vibration analysis performed for the EPR, the flow-induced vibration analyses described in the Technical Report ANP-10306. The Tech Report also describes how the design of EPR conforms to Reg Guide 1.20, Rev. 3.

There are two areas where we departed from the Reg Guide, as you can see on this slide. Basically, looking at vibration analysis of the steam generator upper internals and vibration of the condensate system; we are using hand-held devices instead of mounted vibration protection systems.

CHAIR POWERS: Do you attempt to predict the vibrations in these upper internal structures?

MR. McGAUGHY: I'm sorry, what's that?

CHAIR POWERS: Do you predict the acoustic vibrations of these upper internal structures?

MR. McGAUGHY: John?

MR. BURGESS: Yes, sir, my name is John Burgess.

MEMBER STETKAR: You have to come to the microphone.

MR. BURGESS: Yes, my name is John Burgess with AREVA.

In regards to evaluating the steam generator upper internals for acoustic resonance, a screening criteria was applied to the steam line and, also, the main feeder water lines to ensure that the design was free of that source of flow excitation. So, in effect, the upper internals of the steam generator are susceptible to those types of loadings.

CHAIR POWERS: Uh-hum, but you don't actually predict them? You just screen them out or --

MR. BURGESS: That is correct, sir. We ensure that those two piping systems are free of that source of flow excitation.

MEMBER SKILLMAN: How is vane-passing frequency factored into your screening criteria, reactor coolant pump vane-passing frequency?

MR. BURGESS: Okay. That type of flow excitation is unique to the primary system. And since the secondary system is separated from the effects of that, that is not specifically vib wave, although we do consider feedwater pump vane-passing frequency. But, for the most part, we disposition those as being ineffective in creating significant excitation to the tube model.

MEMBER SKILLMAN: Do you have data to show that that assumption is accurate?

MR. BURGESS: No, sir, we do not. It is primarily established on the basis of the impedance that is created by the void fractions, the secondary side fluids, and its inability to transmit those particular waves through two-phase matrix.

MEMBER SKILLMAN: Thank you.

MR. McGAUGHY: Okay. Section 3.9.3 describes the structural stress and fatigue analysis methodologies, including environmental fatigue used for ASME components. It is environmental fatigue for ASME components. The component supports do not consider environmental fatigue.

Structural design of piping and pipe supports is discussed in the Piping Topical Report ANP-10264NP-A. The topics covered include applied loads and load combinations, allowable limits, operability criteria for components, functionality requirements for piping, and jurisdictional boundaries for the supports.

The boiler pressure vessel code requirements are called for the stress of fatigue analysis, and QME-1 governs the functional design and qualification of components.

Section 3.9.4 considers the control rod drive system, and 3.9.4 addresses control rod drive mechanism, rod cluster control assembly, as well as the operation and prototype-testing of the control rod drive mechanism.

CRDMs are based on a proven design which has more than 30 years of performance history, and it uses the Mag-Jack design principle.

The prototype testing was conducted at AREVA facilities in Germany for the U.S. EPR control rod drive system, and it was conducted to establish functionality at operating conditions, endurance, and also drop times.

Details for the CRDMs are discussed more in Chapter 4.

CHAIR POWERS: So, you don't look at functionality outside of the operating condition envelope?

MR. McGAUGHY: Functionality of the CRDMs?

CHAIR POWERS: Uh-hum.

MR. McGAUGHY: You mean for like during an earthquake or --

CHAIR POWERS: Yes.

MR. McGAUGHY: Yes, I mean, we look at drop times during a safe shutdown earthquake, yes.

Okay. Section 3.9.5 is the reactor pressure vessel upper and lower internals.

CHAIR POWERS: Yes. I mean, do you have a topical report or something on this testing?

MR. McGAUGHY: Oh, on the testing?

CHAIR POWERS: Yes.

MR. McGAUGHY: I don't believe there is a topical report on the control rod drive testing, was there?

CHAIR POWERS: I was just anxious to read all the gory details on this.

MR. WELLS: This is Russ Wells of AREVA.

No, there is no specific topical reports, but the results of the testing were shared with the staff. It was during an audit that was conducted here in Rockville. So, we brought some of our experts over from France who brought the results with them, and they were shared with the staff.

CHAIR POWERS: Okay.

MR. WELLS: I believe that also was documented in the staff's SER, too.

CHAIR POWERS: Oh, okay.

MR. McGAUGHY: Okay. Section 3.9.5, as I said a minute ago, is reactor pressure vessel internals. It provides a description of the important parts of the core support structures and reactor internals. It describes the coolant flow through the vessel and, also, loading conditions we consider in the design.

Table 3.9.5-1 provides a classification of the major internal components with regards to whether core support structures or internal structures are classified by Subsection NG.

Section 3.9.6 describes the functional design, qualification, in-service testing programs for pumps, valves, and dynamic restraints used in the safety-related systems.

In-service testing is performed in accordance with the ASME OM Code as well as Reg Guide 1.192 and NUREG-1482, Rev. 1.

Description of the functional design and qualification and IST programs in Section 3.9.6 allows the COL applicants to incorporate the description of these programs in their COL applications by reference with only plant-specific information needed to supplement the program descriptions.

Functional design and qualification in accordance with QME-1-2007.

The U.S. EPR design provides access to system structure and the components to allow testing using currently-available equipment and techniques.

The system allows full-flow testing of pumps and valves and permits check valves to be tested for performance in both flow directions.

MEMBER SKILLMAN: Let me ask you to reinforce that communication.

MR. McGAUGHY: Okay.

MEMBER SKILLMAN: If I would let my

imagination wonder, what you are communicating here is where the industry has been stymied in the past by inability to confirm ECCS in all accident modes because of alignment issues or because of outage contest issues between DK8 and ECCS, this certified design purposefully prevents that complication, such that these systems can fully flow test it?

MR. McGAUGHY: I will ask Tim Stack to help me with that answer.

MR. STACK: Tim Stack again from AREVA.

The answer is yes. One qualifier is that the mode that the testing is performed in may be a shutdown mode, but, in fact, we can do full-flow testing on all of the safety-related pumps.

MEMBER SKILLMAN: And the check valves?

MR. STACK: Yes, sir.

MEMBER SKILLMAN: Thank you.

MR. McGAUGHY: Let's see, Section 3.9.6 continuing, this slide provides some additional details concerning the IST programs for motor-operated valves and pilot-operated valves. A list of the pumps and valves included in the IST programs are found in FSAR tables 3.9.6-1 and 3.9.6-2.

Visual examination of the snubbers will be performed in accordance with the Code Case OMN-13m as accepted by the NRC in Reg Guide 1.192.

CHAIR POWERS: What is that visual examination?

MR. McGAUGHY: I'm sorry, what's that?

CHAIR POWERS: What is required?

MR. McGAUGHY: For a visual examination of like snubbers?

CHAIR POWERS: Yes.

MR. McGAUGHY: Well, basically, one would make sure that no oil is leaking out of it or --

CHAIR POWERS: It just looks like it is what it should be.

MR. McGAUGHY: Yes.

CHAIR POWERS: It looked like what was installed.

MR. McGAUGHY: Right.

CHAIR POWERS: Okay. It is not much of an examination, but --

MR. McGAUGHY: Yes.

MEMBER STETKAR: Chris, let me sandbag you a little bit here. Reading in the SER, apparently, the staff had a question about leak tightness testing of the main steam isolation valves in the reverse-flow direction, not the forward-flow direction, but the reverse-flow direction.

And apparently, there was a statement made that the MSIVs don't need to close, don't need to isolate in the reverse-flow direction for any credible event, I think is the term. And again, I am extracting things from the SER, which is in answer to an RAI. And I don't have the exact words. So, forgive me that.

Thinking about that, does the EPR safety analysis of a main steam line break upstream from the MSIVs, so inside containment or anything upstream from the MSIVs, include credit for closure of the main steam isolation valve in the faulted steam line to isolate reverse-flow from the other steam generators? And if it does, then it seems like the design does, indeed, include credit for isolation in the reverse-flow direction.

So, the question is, does the safety analysis include credit for closure of that valve? And I looked at Tim because I know Tim has the answer. I'm sure he does.

(Laughter.)

MR. STACK: The answer is yes.

MEMBER STETKAR: Yes. Okay. So, okay, we will follow up with the staff on why they accepted that. Thanks.

MR. McGAUGHY: Section 3.12 describes the design analysis methods used for piping and piping supports in the U.S. EPR systems. The detail of these methods is included in the Piping Topical Report. The topical report addresses all aspects of piping and pipe support design, including loading methodologies, load combinations, acceptance criteria, and special topics such as thermal stratification. Environmentally, system fatigue is evaluated in accordance with Reg Guide 1.207, which references NUREG/CR-6909.

Section 3.13 covers the design of threaded fasteners using pressure-retaining components. Design of these fasteners follows ASME Boiler and Pressure Vessel Code guidance with consideration from regulatory guidance such as Reg Guide 1.65, which addresses specifically requirements for RV closure head studs. Inspection of the fasteners is per Section 11 of the ASME Code.

CHAIR POWERS: And, of course, we have had some difficulties late in the precise area. Does that prompt you to do anything in your design? Bolt enclosures?

MR. McGAUGHY: Right.

CHAIR POWERS: I mean, we have had some

people -- not molting, bolting (laughter).

MR. McGAUGHY: You mean ensuring that the bolted closure is, indeed, tight?

CHAIR POWERS: Yes. Yes, tight.

MR. McGAUGHY: Well, I am sure that would follow basic procedures for installing the closure, which we would always have bolting --

CHAIR POWERS: I mean, you have requirements and things like that, but you haven't done -- I mean, it is basically an operator's problem. Did you do anything in the design to help him?

(Laughter.)

It is kind of an appalling thing.

MR. McGAUGHY: Right.

CHAIR POWERS: And it seems obvious that you ought to bolt things that are supposed to be bolted, but sometimes we don't.

(Laughter.)

MR. McGAUGHY: Right, things do happen. But, yes, we do ask them to follow the procedures.

CHAIR POWERS: The procedure?

MR. McGAUGHY: Right.

CHAIR POWERS: Just as a change on the routine, let's follow the procedure.

(Laughter.)

MR. McGAUGHY: Okay, and I believe that is about all we have. I believe Nissen is up next.

MEMBER STETKAR: In that, does AREVA supply the tensioning stuff for the head bolts?

CHAIR POWERS: I would assume they would. I would assume they would have to.

MR. McGAUGHY: I would assume so, too.

CHAIR POWERS: Yes. It doesn't matter if we don't pay any attention to them. Who are these guys? What do they know?

(Laughter.)

MR. GARDNER: Some more topics here. For 3.10 and 3.11, Nissen Burstein will be our presenter.

MR. BURSTEIN: Good morning. My name is Nissen Burstein. I am a technical consultant, and I have been associated with B&W, Framatome, and AREVA since 1978. I am a lead EQ engineer and a principal author of Sections 3.10 and 3.11 of the FSAR for EPR.

I belong to the Electrical Engineering Design Analysis and New Builds Group of AREVA. I earned bachelor's and master's degrees in aerospace engineering from Penn State and a master's in business from Lynchburg College.

I have been involved in EQ for over 40 years, starting at the Franklin Institute in the late sixties. I was the Vice Chair for five years and the Chairman for two years of the IEEE Nuclear Power Engineering Committee on Equipment Qualification. I am currently a member of numerous committees and working groups on nuclear power and EQ within IEEE, ASME, and IEC.

I am here to discuss the Sections 3.10 and 3.11 with you on seismic and dynamic qualification of mechanical and electrical equipment.

Section 3.10 provides the requirements for seismic and dynamic qualification, as seismic qualification is performed by test analysis or a combination of test and analysis. It is all done in accordance with IEEE 344-2004 and ASME QME-1-2007, as endorsed by Reg Guide 1.100, Revision 3. It should be noted that the seismic qualification by experience that is allowed by IEEE 344 is not utilized on the U.S. EPR.

Electrical and mechanical equipment is qualified for the SSE, as defined in Section 3.7.1, with low-level effects considered through five OBE testing, also in accordance with IEEE 344.

We have a section within 3.10 that lists all of the electrical and the I&C equipment that is being seismically-qualified in accordance with 344.

MEMBER BROWN: Can I ask a question?

MR. BURSTEIN: Yes, sir.

MEMBER BROWN: Relative to the testing regime, I have taken it, after you have gone through the litany, that that means you are going to actually do a seismic test on the reactor instrumentation control systems, protection systems, and various other electrical systems associated with monitoring and controlling?

MR. BURSTEIN: Yes, sir, that's true.

MEMBER BROWN: Okay. So, it will not be analyzed or based on experience. It will be tested? You are only dictating that or is that required by the DCD or your other design --

MR. BURSTEIN: No, we are allowing the methods by 344 that --

MEMBER BROWN: I understand that. It allows people to do that.

MR. BURSTEIN: If we can provide suitable, to us, suitable justification for doing analysis or previous operating experience, then we will.

MEMBER BROWN: To whom? Who do you provide that to? You said if you can provide a basis for doing the analysis --

MR. BURSTEIN: Well, that would be

essentially provided by the vendor to us. We would agree that they have met the requirements.

MEMBER BROWN: Okay. So, this spills down to when you actually place a contract for manufacturing in accordance with your design documents? And at that point, you will, then, wait for the vendor to request whether they either actually test it or whether they do it by analysis?

MR. BURSTEIN: Yes.

MEMBER BROWN: Is that what you are telling me?

MR. BURSTEIN: Yes. We allow that by our specifications.

MEMBER BROWN: Okay.

MR. BURSTEIN: Yes.

MEMBER BROWN: And your specifications are just by the IEEE standard?

MR. BURSTEIN: Well, both.

MEMBER BROWN: Okay. So, it is not locked in by any means? You are providing variability, in other words?

MR. BURSTEIN: Yes. There are some cases you just can't test something, diesel generators, for example.

MEMBER BROWN: Yes, I understand that.

MR. BURSTEIN: The equipment can come in on -- well, the control equipment for a diesel can come in on a pallet. We could require that to be tested.

MEMBER BROWN: I understand diesel generators, turbine generators, things like that, which are relatively huge, have a more difficult time if you don't do them by pieces. But, normally, the I&C equipment, cabinets, and other racks, and things of that nature, aren't necessarily huge components. Or the main control panels, they come in groups. They are not brought in in a 27-foot-wide trailer. They are brought in in assemblies and, then, assembled together.

So, I was wondering which way, if I can separate out the stuff that is huge from the stuff that is small --

MR. BURSTEIN: If the vendor cannot provide the evidence to us that those components are qualified to our requirements, then they have to be tested, if they can't provide the justification. I mean, we have pressure transmitters that have been qualified forever, and they are used on operating plants. In most cases, we would not expect them to have to be requalified.

MEMBER BROWN: Okay, separate, I understand the little transmitters, but the cabinets and the racks, and all that type of stuff is not necessarily in its assembly, and whatever it is for this plant has not necessarily been tested before.

MR. BURSTEIN: Correct. And if not --

MEMBER BROWN: I would expect those to be tested, but I am trying to figure out whether there is going to be some -- I don't want to call it sleight of hand, but some -- (laughter) I call it sleight of hand. I mean, the vendors love to come in and say, I don't want to test this stuff because, No. 1, it is difficult and it might show it breaks. Whereas, if they do it by analysis, you can --

MR. BURSTEIN: If they don't have something to back up the analysis, we won't accept it.

MEMBER BROWN: Well, after listening to the discussion of models earlier on other substructures and other things like that, you can always question whether the models are really suitable models for analyzing whether the cabinet will come apart or whether the welds will break, or whether the controls will come apart, et cetera. It is very difficult, particularly in electrical cabinets where you have connectors and other types of devices that have to be fastened together and have far more little pieces that you have got to deal with than when you have a large structure like a concrete wall.

So, I have stayed quiet during the other part because I was more interested in this, since I read back in the slides and saw it was coming. I am just interested in trying to figure out if you all were going to just wait. So, nobody will know for another five or six years whether they are going to get tested or whether you will accept it by analysis is effectively what I am walking away from.

MR. BURSTEIN: That's correct.

MEMBER BROWN: It is a nice, mushy answer. Okay.

Excuse me, Dana, but that is --

MEMBER SKILLMAN: I would like to ask for clarification, please, Nissen. Your fourth bullet, would you explain that bullet to us, please?

MR. BURSTEIN: About not being based on experience?

MEMBER SKILLMAN: Yes. What does that mean?

MR. BURSTEIN: There is a section in 344 that allows you to qualify by experience if you meet certain criteria. In our discussions with the staff, they have basically explicitly told us that is not acceptable. So, we have revised the FSAR to take that portion out, that we will not allow that.

MEMBER SKILLMAN: Okay. Does that now require that you either actually do a test or have some analytical qualification --

MR. BURSTEIN: Yes.

MEMBER SKILLMAN: -- that provides the qualification for that device?

MR. BURSTEIN: Yes. That's correct.

CHAIR POWERS: But in your oral response to Mr. Brown, you said, gee, we have this pressure transmitter that has been used forever in the plants. I can't remember the exact words. You wouldn't expect to have to requalify that. How does that jibe with bullet four?

MR. BURSTEIN: That's a good question because the experience is used in two different fashions.

In regard to the experience factor that is in 344, it is not the same experience factor that we are talking about with respect to that transmitter. It is an experience factor related to earthquakes, real earthquakes, going and taking a real earthquake and saying, okay, I don't have to do this because I meet that earthquake and that's what the staff say, no, you can't do that. That is the experience factor that is in the 344 comment.

MR. GARDNER: We would not requalify something already qualified, I think really was the point he was trying to make. If there was already an existing test for a component --

MEMBER BROWN: Yes, but when you go to a detector -- let me just go back to your point on the detector. The pressure detector, differential pressure detector, normally, those are tested; you have got to have a foundation inside of your structure that mounts those. And the testing of that detector itself is very dependent on the characteristics of the foundation and the springiness or non-springiness of the materials and how it is oriented.

So, I mean, if you are going to put something in and says, well, gee, it's qualified already, to me, that means you have to go look at the exact method of mounting under which it was qualified. That is the mounting methodology you have to do, and you have to analyze that mounting foundation structure to see that it passes through your seismic and other stress-type conditions that it has to endure.

Now I don't know if the vendor can do that or whether you have to do that in the context of accepting that qualification, the way you phrased it, for your particular plant design. So, it just seems a little fuzzy to me as to how you are going to get to the endpoint on this with some of these.

I understand the point of qualifications. I have done that. That was part of my past. We had qualify detectors, but, yet, we always got wrapped around the axle in terms of actual application within the structure of the reactor compartments or other parts of the ship we were putting it in, and why did it still meet -- why could you accept that qualification or those circumstances?

And I am not quite sure of the process because it seems that it stops with AREVA and it doesn't stop with -- there is no other higher-level authority in terms of finally accepting that.

It is just a question; that's all. I am trying to figure out what we, as a Committee, maybe ought to do.

So, that is all I have on that, Dana, unless you all have something else. I am not trying to cut it off, but I presume you wanted to get moving. So, I have got my answer right now.

CHAIR POWERS: You're satisfied?

MEMBER BROWN: Well, I'm not overwhelmingly satisfied. For big, big things, I can understand it. For the smaller cabinets, if you look at all the stuff we have looked at in the other designs so far, the structure is for the cabinets and the main control room racks and everything. They are not the same. Everybody's is a little bit different.

Qualifying, say, a circuit card for one thing is interesting, but it doesn't qualify if you put it in a cabinet and that cabinet does not support it the same way it was qualified.

MR. BURSTEIN: That's correct, and if it doesn't, then it has to be done over again.

MEMBER BROWN: Yes, I am trying to hope that you all test it, but it's very difficult for each and every cabinet --

MR. BURSTEIN: We allow for analysis as well.

MEMBER BROWN: I understand that. I didn't say I liked it, though, did I?

MR. BURSTEIN: And previous experience. And previous experience.

MR. GARDNER: I think maybe the challenge would be to say we're only going to test something without knowing everything until you get the components. There may be things you couldn't commit to that 100 percent. There may have to be a combination of analysis to go along with that.

I understand your point, but I am not sure how to give you an absolute --

MEMBER BROWN: Yes, I'm just not comfortable on some of the stuff unless they are identical applications, totally identical in terms of the applications and number of circuit cards, structure inside of them, and the backplanes, the whole rest of the smear.

I am just trying to grapple with that, the difference between the way I did the business in the naval nuclear program and the way it appears to be being done in the commercial world, which is considerably different in terms of qualification by extension, which is roughly what you are talking about, based on a past installation and it is supposed to look the same. So, I have just got to think about that now in the context of your answer. Okay?

Thank you for bearing with me, Dana.

MR. BURSTEIN: Continuing on with what we have in 3.10, we developed what we call an SQDP, which is a seismic qualification data package, for each equipment that documents the qualification results that established the capability of the equipment to meet its requirements. I know it is kind of going around what you were saying, but this is the paper trail that we developed or that is developed.

We have a sample SQDP format that is included in Appendix 3D. The Appendix also includes a procedure for qualification procedures that are more in detail for mechanical and electrical equipment also in 3D.

Lastly, if the COL applicant identifies any site-specific components, then they need to be added to the equipment list that is in table 3.10, which is our overall list of the seismic components that are being qualified.

MEMBER SKILLMAN: Let's go back to a comment that you made a few minutes ago that I think is indicative of the type of thing that Charlie is pointing to. Let's talk for a minute about 5-megawatt emergency diesel generator, a big diesel engine.

So, I have got a large mechanical machine. I have got a governor. But I also have the rack control. I have got the instrumentation tubing associated with that engine. Then, I have basically my ECCS power supply on the other end of the drive shaft. That is my ECCS power.

How do you envision qualification of that device under 3.10?

MR. BURSTEIN: Well, part of that is functionally we look at that with respect to 497 for diesel generators. The big pieces, if you will, are generally qualified on the basis of analysis and operating experience from before. Similar machines in the same family have been tested and qualified one way or another.

As far as the smaller components, if you will, and I wouldn't say piping so much as tubing, they would typically be qualified by themselves on racks that would be used on the engine, and they would generally be put on the table.

MEMBER SKILLMAN: The shaker table?

MR. BURSTEIN: The shaker table, yes. Excuse me. They would be put on the shaker table and subjected to the ROS that we have for their location. And they would be put through functionally. There would be air in the lines. There would be electrical wires connected. They would be operating, to show that this does, in fact, meet the seismic requirements.

MEMBER SKILLMAN: Thank you.

MR. BURSTEIN: Section 3.11 discusses the environmental qualification of mechanical and electrical equipment. This provides our approach to how we are qualifying to meet 10 CFR 50.49, including instead of just the I&C and certain post-accident, there are basically three classes: the class safety-related equipment, the post-accident monitoring equipment, and then the class of non-safety equipment whose failure cannot affect the performance of a safety function. Those are the three classes of equipment that are qualified.

CHAIR POWERS: When you qualify equipment, safety-related equipment for the post-LOCA environment, what do you do? What do you consider?

MR. BURSTEIN: Well, without going into a whole long thing, we will age it, dump it, thermally age it, subject it to radiation, non-seismic vibration, then the seismic vibration, and then we put it into a pressure vessel to hit it with steam and chemical spray.

CHAIR POWERS: In the post-LOCA environment what kind of doses do you consider?

MR. BURSTEIN: Excuse me. What kind of what?

CHAIR POWERS: Dose, radiation dose.

MR. BURSTEIN: The post-accident doses

that we are provided. We have a normal aging dose and then we have a post-accident dose that are provided by the folks who give us the environmental conditions from the accident analysis. Typically, we will test to 200 megarads of radiation.

CHAIR POWERS: And roughly what, a megarad per hour?

MR. BURSTEIN: Typically, yes.

CHAIR POWERS: If I subject cabling to a megarad per hour and it is polyvinyl chloride, won't I get a substantial hydrochloric acid?

MR. BURSTEIN: No. What do you mean substantial? No, I would say no, not hydrochloric acid.

CHAIR POWERS: Why would you say that?

MR. BURSTEIN: Well, first off, we don't typically use polyvinyl chloride inside the containment.

CHAIR POWERS: What kind of cabling do you have?

MR. BURSTEIN: EPR, ethylene propylene silicone cable.

CHAIR POWERS: You don't need to have any Hypalon?

MR. BURSTEIN: They are not making Hypalon anymore.

CHAIR POWERS: The equivalent thereof?

MR. BURSTEIN: Yes. But, no, PVC, no, it is almost like Teflon. We don't use that inside the containment.

CHAIR POWERS: Okay. All right. A megarad per hour, you have a substantial nitric acid dose?

MR. BURSTEIN: Not that I'm aware of.

CHAIR POWERS: If I irradiate air, and you have an air containment, I am going to get nitric acid.

MR. BURSTEIN: I'm not aware of that.

CHAIR POWERS: I hate to say trust me, but you can trust me on this one.

(Laughter.)

So, do you take into account acids?

MR. BURSTEIN: We will look into that. Not specifically. We do irradiation in air, but not in acidic environments, no, nor do I know of anyone that does that.

CHAIR POWERS: The question is, why not?

MR. BURSTEIN: To my knowledge, it has never been a concern, that it needs to be. There was no degradation as a result of it.

CHAIR POWERS: You have got 30 days that you have to survive and your electrical equipment in an irradiated environment at roughly a megarad per hour. I don't see how you would avoid forming nitric acid, and I can't imagine nitric acid is good for electrical equipment.

MR. BURSTEIN: Well, you are not irradiating it for 30 days. The post-LOCA environment is typically your steam environment. The radiation is done before the LOCA testing.

CHAIR POWERS: If I have a LOCA, I am going to have a radiation environment in my containment.

MR. BURSTEIN: Yes.

CHAIR POWERS: Now what you do in the testing, I don't care. But in the environment, in the post-LOCA environment, I am definitely going to have irradiation events.

MR. BURSTEIN: I have to agree. What I am describing has been acceptable to the industry, the staff, et cetera, on all operating plants.

CHAIR POWERS: And I am trying to find out why.

MR. GARDNER: Why don't we take an action and get back?

MR. BURSTEIN: We can look at it. I can't tell you any more than what I have.

CHAIR POWERS: Okay.

MR. BURSTEIN: Equipment in the scope of our 50.49 program is qualified on the basis of IEEE 323-1974, endorsed by Reg Guide 1.89 and related standards that we have in table 3.11-4 of our Section 3.11.

The environmental conditions that we qualify to include anticipated operational occurrences, normal, accident, and post-accident environments due to a DBE.

The FSAR includes a detailed listing by part number, or tag number -- excuse me -- of all of the equipment that is being qualified. The listing is approximately 200 pages long, including 15,000-odd pieces of equipment.

In addition, we are also considering a new environment, if you will, electromagnetic compatibility, from the standpoint of equipment susceptibility and emissions, particularly because of the real operational involvement, if you will, of digital equipment and equipment that emits EMC. So, we have required that as one of our qualification environments.

MEMBER SKILLMAN: A question, please.

MR. BURSTEIN: Yes, sir.

MEMBER SKILLMAN: The choice of the exterior or interior pressure, temperature, humidity, radiation environment and other environmental factors for each device depends on where it is located in the plant.

MR. BURSTEIN: Yes.

MEMBER SKILLMAN: And I believe what that means is that for this program to have foundational importance for the EPR, the device's location must be associated with a compartment-by-compartment analysis of the mass and energy and radiation as it reaches those compartments.

So, my question is, what effort is AREVA investing to ensure that a compartment location for a certain device -- and therefore, the EQ requirements for that certain device -- match?

MR. BURSTEIN: I am not sure I follow the last part of your question, but let me try to answer what I think --

MEMBER SKILLMAN: Let me suggest that there is a high-energy line break.

MR. BURSTEIN: Okay.

MEMBER SKILLMAN: And the rarefaction wave has worked its way through the various compartments. The steam and the humidity are chasing into those compartments, and I have important devices in those compartments.

MR. BURSTEIN: Okay.

MEMBER SKILLMAN: And so, for the EQ evaluation to be meaningful, then the device's qualification must represent what is the maximum pressure, temperature, radiation --

MR. BURSTEIN: Yes.

MEMBER SKILLMAN: -- for that compartment. So, what is the matching between the required environmental qualification for the device and the compartment where that device resides?

MR. BURSTEIN: Essentially, what we do is require qualification to the most severe environment, which is inside the containment.

MEMBER SKILLMAN: For everything?

MR. BURSTEIN: For everything inside, not counting outside, not with the steam line breaks in a second here, but everything that is inside the containment has to be qualified to the most severe conditions that are inside the containment --

MEMBER SKILLMAN: Okay.

MR. BURSTEIN: -- which is the most severe for any of these compartments and rooms that you are talking about.

When we go outside, the only concerns that we have outside are for feedwater and main steam vault, valve vaults, and those are not as severe as the condition inside the containment. And so, we do qualify separately for those.

But if we qualify, and we could qualify a piece of equipment for the containment condition, so it could be used anywhere in the plant. Is that what you're asking?

MEMBER SKILLMAN: Yes, what I am really wondering is, if in your EQ program which is really good, old, classic 50.49, one could say in this compartment for this accident, these are the pressure, temperature, humidity, radiation environment conditions, and, by golly, here is the qualification paperwork for those devices --

MR. BURSTEIN: Yes.

MEMBER SKILLMAN: -- that shows that these devices are --

MR. BURSTEIN: And that environment will be less than what is in the containment, which is what it was qualified for.

MEMBER SKILLMAN: As long as you have

qualified it.

MR. BURSTEIN: So, we can use this device anywhere. That is the purpose of it. So, we don't have a big inventory problem of keeping track of where that device can only go.

MEMBER SKILLMAN: So, how does the EPR, if you will, configuration control program assure that the device is parked where it is qualified for? This is a configuration management issue.

Now I have got a device off in yonder compartment.

MR. BURSTEIN: That compartment environment is no worse than what it was qualified for; i.e., what is in the containment.

MEMBER SKILLMAN: So, is there a list that shows which device and which compartment and what it is qualified for?

MR. BURSTEIN: Yes.

MEMBER SKILLMAN: Okay.

MR. BURSTEIN: Yes.

MEMBER SKILLMAN: I think that is the answer to my question.

MR. BURSTEIN: Okay. Yes, it does show where it is located and what conditions it has been qualified for.

MEMBER SKILLMAN: Okay. Thank you.

MEMBER STETKAR: The concern, obviously, Nissen, is there are a fairly-large inventory of equipment that are only qualified for a mild environment in a plant.

MR. BURSTEIN: Yes.

MEMBER STETKAR: How do we have assurance that none of that equipment creeps into a location that is classified as a harsh environment location?

MR. BURSTEIN: That basically --

MEMBER STETKAR: You attack the problem --

MR. BURSTEIN: Yes.

MEMBER STETKAR: -- from the good-to-bad correction.

MR. BURSTEIN: We would hope that --

MEMBER STETKAR: We are concerned --

MR. BURSTEIN: We have the program for configuration control.

MEMBER STETKAR: We hope.

MR. BURSTEIN: It is not something, unless I am -- Russ? -- unless I am speaking incorrectly --

MEMBER SKILLMAN: Well, unless you have a COL item that puts the burden on the applicant, then this is very much an EPR design issue.

MR. BURSTEIN: Could you help me out here?

MR. GARDNER: I think we are answering that we are identifying within that list component-by-component what the qualification requirement is. At that point, the ITAAC that are in place will confirm that the components go into the location for which they were qualified for. There is an ITAAC for EQ.

MR. WELLS: Yes, this is Russ Wells.

Yes, there is an ITAAC for both the environmental qualification and seismic qualification. Furthermore, we have information items that are the applicant's responsibility for the maintenance and control program. So, a lot of those components you are talking about would be part of the maintenance program, which is the COL applicant's responsibility. So, that would be as part of both the configuration and maintenance control program.

MR. BURSTEIN: But they are all for ITAAC 4 installation? I think that is what you are asking.

MR. WELLS: Well, the ITAAC is to ensure that the as-built conforms to the as-designed. And again, as far as the configuration control and maintenance to ensure that those components are properly maintained and put in their proper location, that would be under the COL's maintenance program.

MEMBER SKILLMAN: Thank you.

MR. WELLS: Uh-hum.

MR. BURSTEIN: Okay. On this slide, we are discussing that we are also qualifying PAM, post-accident monitoring, equipment in accordance with Reg Guide 1.97, that it gets environmentally-qualified.

Our Section 3.11.2.2 demonstrates that our approach to qualification of mechanical equipment agrees with the SRP 3.11 and GDC 4. Specifically, mechanical pressure boundary components are qualified by virtue of an end stamp.

Components that contain mechanical non-metallic or consumable parts -- we call those C/NM -- are qualified in accordance with Appendix QR-B to ASME QME-1. And the qualification is maintained via preventive and surveillance maintenance and periodic testing.

The summaries of the qualification activities are documented in what we call an EQDP, which is an Environmental Qualification Data Package, similar to the seismic data package.

And again, if a COL applicant has site-specific equipment, that has to be added to the qualification list of Section 3.11-1.

CHAIR POWERS: Any other questions to pose to the speakers on generally Section 3?

(No response.)

MR. GARDNER: That completes our presentation.

CHAIR POWERS: Seeing none, I think I will recess for a lunch break, and we will resume at one o'clock.

(Whereupon, the above-entitled matter went off the record for lunch at 12:02 p.m. and resumed at 1:00 p.m.)

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

1:00 p.m.

CHAIR POWERS: It is time to come back into session.

It's your show.

MR. MIERNICKI: Okay. This afternoon we have the staff's presentation on Chapter 3, Design of Structures, Components, Equipment and Systems.

My name is Mike Miernicki. I am the Chapter PM for Chapter 3. I am going to provide a brief overview for the side packages that you have of the Chapter, some metrics and stuff like that about the review. And then, we are going to move on to several of the topical areas that the staff selected that might be of interest to the ACRS.

So, on slide 2 there, you can see the staff review team.

MEMBER STETKAR: By the way, upfront, be real careful with your paper, that you don't hit those things. We don't care, but she will kill you.

(Laughter.)

CHAIR POWERS: She's got tae kwon do skills.

MEMBER STETKAR: It just explodes in her ears.

MR. MIERNICKI: Okay, we don't want to do that.

Okay. On slide 2, we have got the staff review team. Chapter 3 is a large chapter.

CHAIR POWERS: No kidding.

(Laughter.)

MR. MIERNICKI: Lots of pages, a long SER was written by the staff. So, we had quite a big review team that represents a number of branches, Engineering Mechanics, Structural Engineering, Balance of Plant, Component Integrity, Rad Protection, Accident Consequences, Geoscience and Geotech Engineering, and Instrument Controls and Electrical Engineering. So, you can see on the next several slides here the names of all key reviewers.

And then, moving along, the overview slide there, slide 6, you can see a table of the various sections in the FSAR and SRP and the number of questions asked in each section. So, there is a grand total of 828 questions asked. The last column there, you see the number of open items that were listed in the SER. So, we have 68 open items at this point.

Chapter 3, being a large chapter, we issued it in a couple of groups, going back to 2010. So, we have been able to resolve a number of questions since then, and since the SER, actually, for the last two groups, staff has been able to resolve a number of questions with the applicant.

So, starting on page 7, you see brief descriptions of the open items. The next several slides list all those. As I said, there is a grand total of 68, and 26 of which have been resolved to the satisfaction of the staff reviewers.

MEMBER STETKAR: Mike?

MR. MIERNICKI: Yes?

MEMBER STETKAR: This is an awful lot of material to digest in real-time. So, you are going to have to help me at least understand where and when I should ask questions. I see that you are planning to have more detailed presentations on parts of 3.6, 3.7, 3.8 I guess.

I had a couple of questions. And the first open item on page 7 --

MR. TESFAYE: Mr. Stetkar, may I interrupt there?

MEMBER STETKAR: Yes.

MR. TESFAYE: You know, that list that we gave you is just for documentation purpose. Any open items that you would like to discuss, you can defer it. When the technical staff gets here to address that section, that would be appropriate.

MEMBER STETKAR: Okay.

CHAIR POWERS: The trouble is we have no idea when the technical staff will be here. I think what we will do is ask the question. You may defer the answer until later. Otherwise, we don't know how to do our timing, unless you put up a card that says, you may ask questions about 3.5 at this time. Otherwise, we have no idea when to ask questions.

MR. MIERNICKI: I invited several of the key staff members, then, Dr. Powers, as part of the discussion to be here right after I went through this list of open items. That is the first opportunity we would. Some of the reviewers will be here and, if not, we will have to defer the question, try to pick it up at the end of the day.

MEMBER STETKAR: Okay. That's fine.

MR. MIERNICKI: That will be a game plan.

MEMBER STETKAR: I get the message. I will wait.

CHAIR POWERS: I won't.

(Laughter.)

On this first item, one of the questions I posed to the applicant when he presented this, because we have some experience, particularly at South Texas where they showed us safety-significant and risk-significant. And there were some items that fell in the not safety-significant, but they were risk-significant.

Are there such items in connection with the EPR and, if so, shouldn't we do something about that?

MR. MIERNICKI: Well, okay, I don't know if we have anyone who wants to step up from the Tech Branch on it.

I guess for STP that was --

MR. TESFAYE: What is the question, Dr. Powers? Let me try to understand this. Are you saying, is there a distinction between safety-significant and risk-significant, and how is it addressed in the EPR?

CHAIR POWERS: What my concern is, when South Texas did their analyses, they came back and said, gee, there are items that do not get classified as safety-significant items, but they turn out to be risk-significant. And that's interesting because they ordinarily are not subjected to the enhanced QA requirements, and they probably don't even get the kind of surveillance that you might.

I am asking, are there such items in the

EPR that are risk-significant, but not classified as safety-significant? And if there are, should we do something about them?

MR. TESFAYE: I understand the question, and I don't have the answer, and I will get back to you.

CHAIR POWERS: Okay. Yes, I mean, that is a fair answer.

MEMBER SKILLMAN: I would like to pile onto Dr. Powers' question. It seems to me that at this early stage -- and it is, before one of these plants has been built -- resolving the terminology will prevent future years of heartburn as the licensees attempt to describe what is safety-related and is important to safe, what is risk-significant, what is not.

Our experience over the past 40 years has been that these terms begin to become knotted together or become shades of gray with each other. Words matter in this business. And it seems like there ought to be a lexicon early on that defines these terms, so that the future licensees know precisely what the terms mean.

We would have benefitted immensely years ago if we had resolved this terminology. And it is not just the licensee. It is the NRC. It is everybody who is involved. There seem to be probably a half a dozen or nine or ten of these terms that, if codified, may make life simpler for everybody who is involved in the design, licensing, and operation of these systems.

So, I would like to offer, that ought to be something that is seriously considered, a lexicon that really clarifies what these terms mean and what they don't mean.

MEMBER STETKAR: Getachew, let me try a little --

CHAIR POWERS: Well, important to safety is very well-defined. The items on risk-significant, I mean, I don't think that appears anywhere in Reg Guides or anything else. But important to safety and safety-significant are well-defined terms.

So, it is the risk terms that you are asking about.

MEMBER SKILLMAN: I still think there are shades of gray in there, Dana.

CHAIR POWERS: Undoubtedly.

MEMBER STETKAR: As a card-carrying PRA guy, let me shed my insights on this. Every design certification is required to identify a list of SSCs, on safety-related SSCs, that are, quote/unquote, important to safety as a result of the risk assessment. You use a PRA. You develop measures, numeric measures, of the equipment that, if it is above the line, it is important to safety. If it is below the line, it isn't.

Now you can argue about where should that line, but there is a line. In particular, for the EPR, that line is drawn on any component whose Fussell-Vesely importance is greater 0.005 or risk achievement worth is greater than 2.0. So, that is a very, very -- as I said, you can argue about how those things are defined, but anything that is above those lines are on this D-RAP list. That is why I keep coming back to D-RAP list as opposed to some combination of words in quotes, because that is at least something that I can point to, and I understand how it is populated.

So, it has actually been defined. I don't rely on those words. So, in effect, what we are asking is, if you go back to slide 7, the first open item there is requests clarification on how systems safety-related and important to safety -- I don't care about stuff in quotes. Is your question about how equipment on the D-RAP list is going to be treated?

For the life of me, reading through the pages of stuff in the SER regarding this particular topic, I couldn't understand what you were asking for. So, first, I am not sure what that open item means.

MR. MIERNICKI: My recollection is that this asked about coming to terms with the terms that you said, correct, and finalizing a list. That is my recollection on this question, but we will have to get back to you on that.

MEMBER STETKAR: Let me add my additional spin on that. Everything that I read about this open item focuses on seismic, seismic, seismic. If I read other parts of the SER, and I start to think about winds and floods and pipe breaks, and everything else that can occur that can affect stuff in the plant -- and I will use the generic term stuff to avoid any of these --

CHAIR POWERS: Yes, the highly-precise technical term, stuff.

MEMBER STETKAR: It invariably focuses only on safety-related. I can't find any questions from the staff similar to seismic regarding the apparent confusion between safety-related, important to safety, risk-significant, or any of those other ill-defined terms.

So, I am curious about why you are concerned about this nebulous distinction only regarding seismic classification and not for other types of hazards that exist in the plant.

MR. TESFAYE: That is a fair question. I am sure we will get back to you. And it is a relatively-new --

MEMBER STETKAR: But, first, I would like to understand what the whole notion of that open item is.

MR. TESFAYE: A fair question. We will get back to you.

MR. MIERNICKI: Any other questions about any of the items at this point on the open items list? Of course, we can come back and ask them at the end, if you have any questions.

CHAIR POWERS: We will.

MR. MIERNICKI: Okay. What we are going to do next is we are going to go a little bit out of order, based upon tech reviewer availabilities and their consultant availabilities. So, we are going to jump to one of the technical topics of interest is LBB in 3.6.3, and that starts on page --

MR. TESFAYE: Thirty-two.

MR. MIERNICKI: -- 32. We will move to

that slide.

I am going to turn the presentation over to Eric Reichelt, who is going to give an overview and introduce his contractor skill through this section of the presentation.

MR. REICHELT: Good afternoon. My name is Eric Reichelt, and I'm a Senior Materials Engineer in the Office of New Reactors, Division of Engineering, the Component Integrity Branch. I am the technical reviewer for Sections 3.6, leak-before-break design for the EPR DCD.

At this time, I would like to give you a brief overview and introduction on work that was performed for this section, since it has been quite some time since we last addressed the ASCR on LBB.

The use of LBB applications has been utilized in previous design certification applications, including the System 80 Plus, AP600, and the AP1000.

It should be pointed out that LBB is part of a piping design acceptance criteria, or DAC, and is based on preliminary piping design and the use of bounding LBB parameters.

The leak-before-break approach for new reactors to use bounding limits established during the design certification phase and to verify the final as-built design during the construction used in ITAAC was approved by the Commission in its SRM for SECY-93-087, and which will be discussed by our contractor in more detail.

The technical review was performed by Engineering Mechanics Corporation of Columbus, otherwise known to us as Emc^2.

At this time, I would like to turn the presentation over to Dr. Prabhat Krishnaswamy and Dr. Do-Jun Shim to discuss the technical review and conclusions for Section 3.6.3. In addition, in the bullpen, we have Mr. Keith Wichman of Emc^2 and Mr. David Terao, a Branch Chief of the Component Integrity Branch, for additional technical support.

DR. KRISHNASWAMY: Good afternoon, everybody. My name is Prabhat Krishnaswamy. I am with Engineering Mechanics Corporation of Columbus. We are a contractor to the NRC. And I am here along with my colleagues, Dr. Do-Jun Shim and Mr. Keith Wichman.

The outline of my presentation in the next few slides is to review the leak-before-break or the LBB methodology, the regulatory approach, followed by the two main things that we did, which is the confirmatory analysis of the leak prediction procedure and the confirmatory analysis of the flaw stability procedure in the ALL diagram. Those are the two parts of the LBB methodology, and we did a confirmatory analysis of each one of those. That is the core of our work. And then, of course, we will end with some conclusions on where we are in the LBB analysis.

The regulatory requirements and acceptance criteria for LBB essentially states that the basis for excluding dynamic effects associated with postulated pipe ruptures in nuclear power plants, that is in 10 CFR Part 50, Appendix A, GDC 4.

As part of that, the SRP 363 calls for specific safety margins in performing the LBB analysis, and it involves a factor of 10 on the leak rate and a factor of two safety margins on the crack size.

Go ahead.

The EPR LBB methodology essentially involved developing the ALL diagrams that are used as a bounding criteria. The confirmatory work involved, there are three parts to this. One is the degradation, the mechanisms involving water hammer, corrosion, creep, fatigue, et cetera. We have confirmed that they are extremely low causes of pipe rupture.

The core of the analysis involves deterministic fracture mechanics evaluation, and I will show those in a couple of slides.

CHAIR POWERS: When you say extremely low, you are speaking of the probability?

DR. KRISHNASWAMY: The deterministic analysis, yes, extremely low probability of rupture, but the analysis is deterministic in nature.

CHAIR POWERS: Uh-hum. Yes, I understand.

DR. KRISHNASWAMY: And then, the last bullet there talks about the leak detection system that feeds into the LBB analysis that has to be reliable and redundant. So, you can estimate the flaw size and, then, the flaw stability.

CHAIR POWERS: When you do your deterministic fracture mechanic evaluations, you use something like APPRAISE or some computer code?

DR. KRISHNASWAMY: Yes, there are two codes involved, and I will go through that in a couple of slides.

CHAIR POWERS: Do they presume square flaw sizes, you know, rectangular flaw sizes, or things like that?

DR. KRISHNASWAMY: Yes, we can define the flaw sizes.

CHAIR POWERS: So, nothing special? I mean, rectangular flaw sizes are thought to be fairly conservative.

DR. KRISHNASWAMY: This is the first of the confirmatory analyses for the leak rate prediction procedure. What you see is a graph of the moment versus crack length for each specific case of the surge line nozzle width at a 5-gallons-per-minute leakage rate. And for a given leakage rate, you can have a combination of crack length and moment that results in that.

What we did was to confirm what AREVA's calculation was using bare code, proprietary code, KRAKFLO, with the NRC-developed code SQUIRT. As you can tell, we confirmed the moment with this crack length curve very correctly and duplicated it.

CHAIR POWERS: This is pretty much contained, completely independent --

DR. KRISHNASWAMY: Yes.

CHAIR POWERS: -- confirmatory analysis?

DR. KRISHNASWAMY: Yes, independent confirmatory.

CHAIR POWERS: Very good.

DR. KRISHNASWAMY: And this is also for

the critical location that was identified in AREVA's presentation.

CHAIR POWERS: The critical location you just took, right?

DR. KRISHNASWAMY: Yes.

CHAIR POWERS: I mean, you are just doing the analysis?

DR. KRISHNASWAMY: Yes.

CHAIR POWERS: But that is very nice.

DR. KRISHNASWAMY: Now this is the second part of the confirmatory analysis involving the ALL, what we call the Allowable Load Limit diagram. And it shows the curve, the maximum moment versus minimum moment for the same location that we showed the leak rate curve.

What is shown are the applied moment, the maximum for the X-axis is the operating moment. For those values, the upper curve shows the maximum load-carrying moment for various values of the actual load. As you can tell, our calculations match those of AREVA and presented by AREVA very well. And that is the bounding curve that is shown, the top curve. So, the design point of the requirements has to be under that. And we have confirmed this analysis for the surge line case at the pressurizer surge nozzle.

The overall conclusion is that the LBB procedure -- and we have done that for a number of cases -- and the overall conclusion is that the acceptance criteria are satisfied, and that dynamic effects of pipe rupture may be eliminated from design.

There is one open item here involving a confirmatory analysis for one specific case where we are just going through the data that is required to complete it. And apart from that, we are done with this analysis.

CHAIR POWERS: Very nice. I mean, leak-before-break is a critical item. I am glad to see the staff is doing completely independent confirmatory analysis, at least on some aspects of it, where you can. I think that is an advertising point, that we need to make sure that the Commission knows you are doing that, because, I mean, this is a critical issue that gets a lot of the public attention. To have that kind of a technical understanding speaks well for what you are doing.

DR. KRISHNASWAMY: Thank you.

MR. MIERNICKI: Okay. Any other questions on this area, then?

(No response.)

Well, then, thank you very much, everyone.

We will have the next group of people come up. And we are going to move back to 3.6.2 and back to slide 21.

CHAIR POWERS: It seems to be a characteristic of Chapter 3 that one cannot go linearly through this chapter.

(Laughter.)

MR. MIERNICKI: Okay. I am going to introduce Renee Li, who is from the Engineering Mechanics Branch.

And, Renee, you can introduce your supporting cast here.

DR. LI: Okay. As Mike mentioned, I am Renee Li from the Engineering Mechanics Branch. I am the Senior Technical Reviewer responsible for Section 3.6.2 review.

Next to me are Dr. Steve Hambric and, also, Dr. Jules Lindau from Applied Research Lab, Penn State.

With technical assistance from ARL, the staff reviews EPR FSAR Section 3.6.2. The topic is determination of rupture locations and their associated dynamic effects.

Today, Dr. Hambric and I, we will jointly today this topic.

During this presentation, we will discuss the principal regulations and items of interest, including IEI summary for Section 3.6.2 review.

This slide shows our applicable regulations and the review guidance for Section 3.6.2 review. The application regulation is 10 CFR Part 50, Appendix A, General Design Criteria 4,which requires structures, systems, and the components important to safety to be designed to accommodate the environmental and dynamic effects resulting from postulating pipe failures.

To meet the GDC 4 requirements, SRP Section 3.6.2, including Branch Technical Position 3-4 and SRP Section 3.6.1, including Branch Technical Position 3-3, provides staff's guidelines for postulating pipe failures and the evaluation of their associated dynamic and environmental effects.

As you may know, ANSI 58.2 standard entitled, Design Basis for Protection of Lightwater Nuclear Power Plants Against the Effects of Postulated Pipe Rupture is commonly used by the nuclear industry for evaluating the dynamic effects of postulated pipe rupture.

However, it has some deficiencies and omissions which we will discuss later. Because of this deficiency, other technical journal articles and reports were used during the resolution of some of the staff's RAIs. A list of these articles and the reports are included in the backup slide 68 of this staff presentation package.

The other related regulation is 10 CFR 50.47(b)(1), which related to ITAAC. That is the inspections, tests, analyses, and the acceptance criteria.

Next slide, please.

There are two major areas of review in Section 3.6.2. First, it relates to criteria used to define pipe break and crack locations and the configurations. The staff's review of the criteria described in EPR FSAR determined that they are consistent with the staff guideline as described in SRPs and their associated Branch Technical Positions and are, therefore, acceptable. This area of review will not be discussed today.

The second review area relates to the evaluation of jet impingement and pipe whip effects. I would like to note that the original EPR FSAR makes a reference to the use of ANS 58.2 standard for the evaluation of jet impingement load on the nearby safety-related SSC.

As I mentioned earlier, the ANS 58.2 standard is commonly used by the nuclear industry for the jet evaluation and, to date, has been accepted by staff. However, during the review of GSI-191, which addresses the containment sump blockage by insulation in an event of nearby pipe ruptures, Drs. Wallis and Ransom from ACRS identified some potential non-conservatism in this standard, although the focus of the ACRS was on debris generation and some blockage. However, their comments directly impact the assessment of jet impingement loading from postulated pipe breaks on neighboring SSCs.

Next slide.

MEMBER STETKAR: Renee?

DR. LI: Yes?

MEMBER STETKAR: Before you leave this, this is an area that is far, far, far beyond my area of expertise. So, excuse the stupidity of my question. And the reason I ask it is you said you are not going to discuss the first bullet on this slide.

The applicant has evaluated leak-before-break for main steam line reactor coolant system and surge line.

DR. LI: Right.

MEMBER STETKAR: Why not the main

feedwater lines?

DR. LI: Okay. Because the SRP 363, they have a threshold of what type of systems can use the leak-before-break criteria.

MEMBER STETKAR: Yes, you know, I am not familiar with the SRP. I am more interested in terms of an energy release and the possibility of getting jet impingements from breaks or leaks in the main feedwater line.

DR. LI: The main feedwater line, since the leak-before-break is not applicable; therefore, they have to postulate break based on --

MEMBER STETKAR: And they do that?

DR. LI: Yes.

MEMBER STETKAR: Okay.

DR. LI: They do, yes.

MEMBER STETKAR: Okay. Thanks. Thanks.

DR. LI: Okay. And where am I?

MEMBER STETKAR: I'm sorry. It's the way we are.

(Laughter.)

DR. LI: Okay. This slide shows a brief summary of the inaccuracies and omissions of the standard. Later in the presentation, Dr. Hambric will discuss them in more detail and just go through it on a high level.

First, the standard ignores the effects of blast wave effects. Also, the standard has deficiencies in jet expansion modeling and jet pressure distribution within the jet plume.

The standard treats all jets as having uniform plume expansion and assumes a simplified special pressure distribution within the jet plume. In addition, the standard, it ignored the jet dynamic loading and structural dynamic response, including potential feedback amplification of blowdown force and jet resonance effects.

Because of these deficiencies and omissions of the ANSI 58.2 standard, during the EPR review the staff issued RAIs 03.06.02-6 through 03.06.02-13 and their associated supplement to RAIs, requesting the applicant to address this potential non-conservatism.

Next slide.

Before Dr. Hambric presents and discusses the details of our review of these issues, I would like to briefly summarize the current status of the RAIs.

For the jet dynamic effects, the staff found the applicant's jet impingement assessments are conservative. However, their final documentation is pending, and this issue remains a confirmatory item.

For the blast wave, the applicant is examining their current plant design to determine regions where blast wave may be important, along with the potential blast wave assessment. Therefore, this issue remains an open item.

With that, Dr. Hambric will present and discuss the details of our review on these issues.

Thank you.

DR. HAMBRIC: Good afternoon.

As Renee said, Dr. Lindau and I are both from the Applied Research Lab at Penn State. We do a lot of hydrodynamic, hydroacoustic work. Jay's background is in computational flow dynamics as well as flow mechanics. I am more what happens when the fluid hits the structure and how the structure responds to that, and whether it can withstand those sorts of loads.

Now, as Renee pointed out, past procedures that the industry has used to assess high-energy line breaks, HELBs, has been lacking in a couple of key areas. One key area is just completely ignoring the fact that you get an explosion and a blast wave that propagates into an enclosed space and strikes structures, potentially causing them to fail.

CHAIR POWERS: I find the nomenclature very remarkable. It is not in the nuclear trial reviews. You always get a shock wave. You really don't get an explosion. It is just a shock wave, right? Is my physical understanding correct?

DR. HAMBRIC: It is a shock wave, but I am dramaticizing the shock wave to make people understand it. But it is a shock wave that propagates through the internal region and strikes structures in a nonlinear way and causes them to vibrate substantially.

DR. LINDAU: It is similar to an explosive wave in almost every physical aspect other than --

CHAIR POWERS: Well, a shock wave is a shock wave, but --

DR. LINDAU: But a moving shock wave is referred to as a blast wave commonly.

CHAIR POWERS: I mean, I don't know. I can certainly understand how a shock wave would form in this circumstance. I mean, it makes sense, if you are blowing down steam, just because the velocity of sound is a function of temperature. But it seems like it would be a fairly broad shock wave. I mean, I don't think it would be a high-brisance kind of shock wave, would it?

DR. LINDAU: A high what?

CHAIR POWERS: Brisance.

DR. LINDAU: High-risk?

CHAIR POWERS: Brisance. When we shoot off explosives, we get really sharp shocks, and then we get sometimes long, broad shocks. But shocks are shocks, but the time it has on the structure changes. In my experience, I have, quite frankly, never broken a steam pipe line myself. You are about to convince me to go do it, just to find out what it looks like.

(Laughter.)

But I would think it would be kind of a broad shock wave. Now that can be very misleading because broad ones are ones that can do a lot of damage because they stay a long time on the structural surface. So, the things that are loose, they are going to get blown off really badly; whereas, high-brisance might not.

But it just seems like strange nomenclature. I would just call it a shock wave. But go ahead.

DR. HAMBRIC: Sure. Okay. Along with that initial shock wave, which can load structures, we also get jets. And two of the issues that the ACRS had concerns about was how the ANS 58.2 assumed the jets' shapes and pressure distributions behaved. And the applicants addressed that.

But another area that we were mostly concerned about was the fact that jets, up to this point, had been considered by the industry as just sudden impulse loads on structures with a static load applied over some small instant in time.

And the oscillatory loads in a turbulent, high-amplitude jet were completely ignored. So, we have asked the industry to address those issues, and they do now. You will find at the end of the slide package some more backup material on this issue, if you would like to get into that.

What I will now do is talk about how AREVA has been addressing these two topics, starting with the blast wave effects. This is still an open item. We are working with them to ensure that they have a design procedure that is conservative that addresses some of the topics you just mentioned, Mr. Powers.

Before they do, are examining their current plant layout to bound the problem. They are going to determine key regions that they really have to assess for blast wave effects. Based on their design, it looks like they only have to worry about steam line ruptures. After they come through the kinds of analyses they will be required to do for an EPR, they are going to present to us software which will look at the time-varying loads induced by the blast waves and the target SSCs. We have asked them to make sure that their procedures are validated using existing literature and are converged, that they have got sufficient mesh resolution and time discretization, and, most importantly, that they are handling reflections from indoor walls and ceilings and floors in their analysis.

CHAIR POWERS: I mean, that can be a real difficult analysis.

DR. HAMBRIC: I think it would be extremely difficult to get it exactly correct. It may not be extremely difficult to get conservatively bounding. So, that is the approach they have been taking in the jet problem, which I will address in a moment. But I think they are going to try to come up with a conservative loading methodology as opposed to an accurate loading methodology, which is fine with us. As long as they are conservative, we are happy.

MEMBER BROWN: How do you know it is conservative, not accurate? Is that a dumb question?

DR. HAMBRIC: I think that in the case of analysis of these blasts, it will be conservative in that they will provide a conservative estimate of the initial energy behind the blast.

CHAIR POWERS: Yes, you just don't put any dispersion in the calculation and just do a perfect reflection.

DR. HAMBRIC: That's right. Well, it will be an oiler calculation --

CHAIR POWERS: Yes, yes.

DR. HAMBRIC: -- using ideal gas assumptions. And that will be a pretty conservative, that will be a conservative estimate of the strengths of reflective waves.

CHAIR POWERS: I would just suspect that these kinds of shock waves have a high dispersive content, and when you do these things, it is really a geometry calculation and you take perfect reflection and things like that. And you are just looking for where you get reinforcement on the structure. I mean, you don't care about reinforcement in the middle of space, but you are looking for reinforcement on a structure.

We did it once for containment for hydrogen shock waves, and it drives you nuts, to be honest with you. But I would think these waves would be very dispersive.

DR. HAMBRIC: Well, that is part of why they are looking at their layout. If they get a certain distance away, they can argue it is not the problem.

CHAIR POWERS: Yes, and a shock coming on a cylindrical body is going to be disperse like crazy.

DR. HAMBRIC: Right, but if it strikes a corner --

CHAIR POWERS: Yes, straight-on, it is going to come right back at you. The worst ones are the ones that make the two corner shots, you know, off of corner, up off another one, and then come back into the main one, and you get a reinforcement there. Those are the ones that drive you nuts.

DR. HAMBRIC: So, we are still waiting for the response. I suspect it will be a combination of design to avoid the kinds of problems that you just mentioned as well as a conservative software route approach.

Now AREVA is further along in resolving the jet impingement portion. In fact, they have given us a Draft Technical Report that we are satisfied with, but they have not issued a final version yet. They have also included a summary of their procedures in the FSAR. But, again, we just have a draft. So, pending finalization of the report and the FSAR, the jet impingement resolution remains a confirmatory item. But barring some sudden change in the approach at AREVA, what I am about to tell you about next is, in our opinion, conservative and acceptable.

CHAIR POWERS: I have one question that has nothing to do with on the EPR, but just philosophically here. When you think about these jets, you think about them in terms of fluid. Do you ever think about them in terms of entrained solid particles?

DR. HAMBRIC: Like for two-phase flow?

CHAIR POWERS: Well, it would be definitely a two-phase flow at that point, but you don't ordinarily think --

DR. HAMBRIC: Like projectiles?

CHAIR POWERS: Yes, yes,

DR. HAMBRIC: For instance, the blast itself.

CHAIR POWERS: Yes, I was thinking -- I have not dreamed up where the particles are coming from yet, but, presumably, with a little imagination, I could. I am just wondering if anybody has ever thought about that sort of thing.

And in advance, now that is fine, and please do not write that down as an action item to think about. I am just speculating here out of curiosity.

The other question is, we know that these jets tear up fibrous insulation like crazy, and we have forced current plans to take out a lot of fibrous insulation and they have replaced it with reflective metal insulation. Do we know what the jets do to reflective metal insulation?

DR. HAMBRIC: We are not reviewing that here.

CHAIR POWERS: Okay.

DR. HAMBRIC: But the GSI-191 folks I think did that.

CHAIR POWERS: I guess what I am asking is where the state-of-the-art stands on that. Because the last time I left, they had done an experiment that said they tore up some RMI, and then I never heard back. Are we predictive on that, tearing up the RMI from these things?

DR. HAMBRIC: We are not part of the group doing that.

CHAIR POWERS: Oh, okay. So, you can't --

DR. HAMBRIC: We can't comment.

CHAIR POWERS: That's fine. That's fine. Just curiosity on my part.

DR. HAMBRIC: Like you, I knew they were doing that kind of study.

CHAIR POWERS: Yes.

MEMBER SKILLMAN: I would like to ask how in your jet dynamic loading, how the timing, particularly to the end of the transient, is addressed and, also, how the reaction on the broken component is being addressed. So, it is a dynamic question. How long does it last based on what? And how is the reaction on the component that is actually the origin of the jet being handled?

DR. HAMBRIC: Right. A reaction force is applied to the pipe. And I believe Mano will be reviewing that.

DR. LI: As far as the pipe that postulates rupture, they would be, could be restrained to stop the motion within the pipe.

CHAIR POWERS: Okay.

DR. LI: Okay. And, of course, when a pipe fails, they don't take credit of that pipe. So, is that your question, how they --

MEMBER SKILLMAN: Well, my question is two pieces. How is the reaction load accommodated? You have just communicated it is through restraints or pipe restraints or supports.

DR. LI: Right.

MEMBER SKILLMAN: What is the physical phenomenon that you use to calculate the timing of the jet force? Obviously, it is going to continue as long as there is a driving head to drive the two-phase or one-phase fluid to the point where the delta P no longer drives the jet. So, what do you use to calculate the dynamic time, the time length?

DR. HAMBRIC: Right. That is actually coming up on the next slide. We will walk through their procedure.

MEMBER SKILLMAN: Oh, okay.

DR. HAMBRIC: Okay. So, next.

Over the next couple of slides, we will summarize for you what AREVA is doing. We believe it is in the report. They provided a detailed assessment procedure. It is conservative. They look at the dynamic nature of the forcing functions, their impact on SSCs, as well as barriers and shields.

So, for a given break -- and I think this is the first part of your question -- they need to compute the source flow parameters, temperature, and pressure, size of the break. And they do that throughout the blowdown process, using thermohydraulic codes. They haven't committed to one in particular yet, but they have cited RELAP and CRAFT2. It is our understanding those are acceptable codes for assessing the source-terms.

Now, for the initial impulse, we did not put that in the slides here. But if AREVA can chime in -- I forget how long they assume it takes for the pressure to go from zero to source pressure, like a millisecond perhaps.

DR. LI: Yes, one millisecond.

MR. McGAUGHY: Typically, it is used as a millisecond. But, typically, when we are loading a structure, we will rise it up even more quickly than that, just so we can make sure that we get the dynamic portion of that rise --

CHAIR POWERS: Mr. Conservative here.

(Laughter.)

MR. McGAUGHY: Exactly.

MEMBER STETKAR: Just make sure they got your name.

MR. McGAUGHY: Oh, I'm sorry, this is Chris McGaughy.

DR. HAMBRIC: Okay. So, a millisecond is typical, and they go even faster for conservatism.

CHAIR POWERS: Thank you.

DR. HAMBRIC: And that will give you the structure's, once you apply that load to a structure, you will get the impulse response, but, also, the static response. We are more interested in the dynamic terms because they are the limiting terms, as I will talk to you about in a moment.

They determine jet shapes using standard thermodynamic analyses, not ANS 58.2.

CHAIR POWERS: So, why do you use a thermodynamic analysis? For a real jet, what am I doing? What error do I make in using a thermodynamic analysis instead of a full-blown dynamic, kinetic analysis? I tend to make my jet rounder?

DR. HAMBRIC: Compared to like a full-up computational fluid dynamics assessment?

CHAIR POWERS: Yes.

DR. HAMBRIC: I'm not sure myself.

DR. LINDAU: I think what this refers to is determining what the thermodynamic state of the jet is. And then, based upon that, go into certain spreading rates and other things that are determined in the literature.

So, it is not that there they are replacing thermodynamics for fluid mechanics. They are just using thermodynamics to determine the state of the jet as it is issuing from the break.

CHAIR POWERS: Yes.

DR. LINDAU: And then, depending upon the state, there are some rules that are conservative about spreading rates that they will go on.

CHAIR POWERS: I would think it is just making it rounder, but I don't know. If I did it for real, it would tend to be a narrower, more ellipsoidal jet, and I make it rounder when I go to thermodynamic bounding analysis, I would just guess. But I honestly don't know.

DR. LINDAU: Chris, you can jump in.

DR. HAMBRIC: Yes, the main benefit is that, if you look at ANS 58.2, that just assumes a set spreading rate, no matter what the source pressure ratios were. It was clearly inaccurate. So, here they are at least bringing the physics of the source fluid and the receiver fluid into play when they determine the spreading rate.

MR. McGAUGHY: Yes, this is Chris McGaughy again.

And really, for using a thermodynamic analysis, really, we were just trying to keep a simple-type analysis to do this. Even if we did CFD analysis, for a simple jet, it would still be 2D and you are still assuming that it is a round jet. So, it doesn't really change very much by doing hand calculations to figure out what your jet looks like versus doing CFD for that type of thing.

It is really, for us, the important thing is the force coming out of the jet. The diameter of the jet really is just to figure out what you are hitting. And the outer edges of the jet really don't have that much force in them, typically, anyway. So, we are really concerned about the core of the jets during calculations.

DR. HAMBRIC: Okay. So, as Chris mentioned, once we have a jet shape, they can determine the targets. They do include a single reflection up to a limiting angle. So that, if a jet hits a wall, reflects off, it can strike another target.

And there are two analyses that are conducted once the loads are applied to the structure. One is the static initial impulse, which we have already mentioned. Industry has been doing that for decades.

What is new to AREVA's approach is they are now applying the oscillatory loads, the dynamic loads, pulsating loads, onto the structure. And they do that over certain said distances. For two-phase flows, they go up to 10 diameters for the diameter of the pipe break, and for steam jets, up to 25. That is conservative based on what we have in reports and open literature.

The next steps, if the target is lightly constructed, they will protect anything that is lightly constructed with barriers and shields. And the barriers and shields are assessed for their response to the impinging jet as well to ensure they survive.

And the next step is probably the biggest one. It looks at really the worst cast that an oscillating jet load can be. And that occurs when resonance appears, when acoustic waves that bounce off the reflected surface reinforce the jet itself and amplify it, sometimes significantly.

The community that perhaps has dealt the most with that is short takeoff vertical lift vehicles. They will destroy the launching pads underneath them, just because of the oscillatory loads that are applied to them.

The same thing can happen with a jet in a nuclear power plant. The good news is that there is really only certain conditions when that resonance can occur.

No. 1, the pressure ratio can't be too great, less than 3.8. So, that means that if you do have a resonance, it is typically going to occur later during blowdown, and AREVA will assess these jets throughout the blowdown process all the way through.

Also, the source has to be reasonably close, within five pipe diameters, but the applicant goes further than that. The actual number is in their report. So, they are being conservative again.

The next steps are key, and the applicant has, as we mentioned before, taken the route of extreme conservatism, which is fine. So, at resonance, if a resonance occurs, rather than use computational fluid dynamics to assess what the actual pulsating loads are, they are assuming a worst-possible oscillatory load, essentially twice the source pressure, the static source pressure. And that is dramatically higher than any loads we have been able to find in the literature. Again, even though that is inaccurate, it is conservative and certainly acceptable.

The next key parameter is what frequencies is the jet loading oscillating at. What they do is, based on measurements and simulations performed in the literature, they are computing a minimum jet resonance frequency, the lowest possible frequency that the jet can resonate at for a given break. And they do this for multiple pipe diameters and multiple source velocities.

And when they find resonance, they then apply these amplified forcing functions to structures in their plant. When the structures are simple, pipe supports, jet shields, whip restraints, and they can simulate them as essentially single-degree-of-freedom oscillating structures, masses on top of springs, if the resonance frequencies are 40 percent below the jet loading frequency, they are allowed to use a static calculation and a dynamic load factor. That is a standard dynamic analysis approach in the industry.

However, if that is not the case, if they have got structures where the resonance frequencies are within 40 percent of the jet frequency, then they do a structural analysis that is a little bit different, depending on whether they have a plate or a shell structure or a beam-like structure. But, in either case, they are looking for all the resonances in their system that might possibly be coincident with the jet frequencies.

If a jet frequency is anywhere near a structural resonance, they line them up; they align their jet frequency with their structural frequency to maximize the structure's response to that postulated jet load. That is also certainly conservative.

Regarding the amplitude of the structural response, they are using the lowest amping that you will find in the literature for these sorts of problems. That is 1 percent of critical. That will maximize the structural response amplitude.

As they do their stress calculations, they ensure that the stress models or finite element models are converged in high-stress regions. That is an important topic. And once they have a converged worst-case oscillating stress, they, then, compare those stresses to various industry standards, depending on the type of structure in the industry or society standard that goes along with that type of structure, ASME, and so on.

So, in summary, their jet loading approach is conservative. They consider both the typical static as well as dynamic loads throughout blowdown. They look for resonance conditions. When they find resonance conditions for jets, they apply the worst-possible amplitudes at the worst-possible frequencies to align with structural resonances. They, then, use a minimum-possible structural loss factor of 1 percent damping. And once they have converged stresses, they assess them against the applicable standards.

Further questions?

MEMBER SKILLMAN: Approximately how many targets does this effort identify, please?

DR. HAMBRIC: We haven't gotten the number of targets, but we did have them give us a list of potential source conditions. So, I would have to defer to AREVA on the possible number of targets.

MR. McGAUGHY: I can't say exactly what the number of targets is. We do have a list of terminal end-brakes in our FSAR. Generally, each one of those is going to have a target of some sort. So, that is probably about as good of an answer as I can give you.

MEMBER SKILLMAN: Are you communicating tens, hundreds, thousands?

MR. McGAUGHY: I would say tens, not hundreds, hopefully, anyway.

MEMBER SKILLMAN: Okay. Thank you.

MR. MIERNICKI: Okay. Let's move on, then, to the next --

CHAIR POWERS: As long as we have got

these experts here, I just have a question. The shock that we are forming here is a steam-driven shock. Is there a literature on this, on these kinds of shock waves?

DR. HAMBRIC: The literature that exists is typically on explosions, which we discussed earlier.

CHAIR POWERS: Yes. What I am looking for is really steam-driven depressurization shocks.

DR. HAMBRIC: If there is, we are not aware of it. The literature that we do have is from a worldwide industry group that looked at explosions within a variety of plants, mostly in Europe, and reported that, yes, indeed, shock waves can destroy structures. And we provided that to the applicant, and all the applicants that we have been reviewing. So, they have that.

But it is highly anecdotal. There is not a lot of research-grade data out there.

CHAIR POWERS: Yes. I mean, it would be a hard test. It may be hard to do.

DR. HAMBRIC: Dangerous.

CHAIR POWERS: You know, explosions are easy, but explosive depressurizations are just hard tests to do.

Okay. Thank you.

MR. MIERNICKI: Okay. Thanks, everyone.

Okay. The next technical topical area of interest is the seismic and structural design. For that presentation, we have Jim Xu from the Structural Engineering Branch.

CHAIR POWERS: We've seen him before. We know this guy.

(Laughter.)

MR. XU: Okay. Good afternoon. As Mike said, my name is Jim Xu. I am a Senior Structural Engineer from the Structural Engineering Branch in NRO.

I will brief you on both 3.7 and 3.8 pertaining to seismic analysis and a contingent design, as well as designs for other Category I structures and foundations. So, all the structure part is in these two sections.

CHAIR POWERS: Jim, I've got you here. I've got to ask a question.

(Laughter.)

MR. XU: Yes. Before you ask me any questions, let me introduce my experts.

CHAIR POWERS: Okay.

MR. XU: These are two big sections in

Chapter 3, and I have experts/consultants from both NUMARC and the Brookhaven National Laboratories.

First of all, let me introduce the one from NUMARC, Dr. David Foster. Please acknowledge yourself.

And Dr. Carl Constantino, sitting in the back. I know you know him. He is everywhere.

And Mr. Thomas Houston.

And from Brookhaven, Mr. Joseph Braverman and Dr. Manuel Miranda.

Okay. You're on the slide.

MR. TESFAYE: You are going to be asked a question before you start, right? Dr. Powers has a question.

CHAIR POWERS: He said he had to get through some stuff first.

MR. XU: I've got to get through some stuff.

MR. TESFAYE: Oh, okay.

CHAIR POWERS: He spent all the time to make this slide. Let him get through it.

MR. XU: Yes. I guess before I get into discussion, as the previous presentation mentioned, I went through use the regulations. We use guidance from SRP 3.7 through 8 and the related Regulatory

Guides and applicable industry standards to meet the regulation GDC 1, 2, 4, 5, 16, 35, 62. I think that is about it. So, that is the regulatory aspects.

So, let's get to technical topics of interest. So, I am going to follow the flow in the SRP format. Okay.

This discusses 3.7.1, which is three subjects that relate to design parameters, design ground motion, dampings, and soil profiles.

As AREVA has presented, and they also provided the graph for the seismic ground input motion, which consists of three Euro spectrum plus one high-frequency spectrum in one of their potential sites in the eastern U.S.

Collectively, the ground input with the multiple spectrum represents a comparable range of site conditions and is consistent with the guidance in SRP 371. Therefore, it is acceptable with staff. We have no open issues with this section. All the issues were resolved. That is the first topic.

The second one is the damping used for the structural analysis and, also, used for developing in-structure response spectra. AREVA followed pretty much the Reg Guide 1.61 guidance, except there is an open item that AREVA is expected to demonstrate that the stress level in the structure is adequate for the use of SSE dampings. This is an open item because the design is yet to be complete. They haven't finished the design yet. So, they could not demonstrate that the stress level is appropriate for the damping, the higher damping you had used for the structural analysis.

MEMBER SKILLMAN: If I could ask, please?

MR. XU: Sure.

MEMBER SKILLMAN: For the staff evaluation relative to design ground motion, since this is a design certification to be used anywhere in the country, is there any area, any technical area, in the design ground motion discussion where the staff had reservations, had concerns?

MR. XU: In terms of the ground motion itself?

MEMBER SKILLMAN: Yes, yes.

MR. XU: We compared the ground motion with the Reg Guide 1.60 spectra, and the ground motion spectra shape is accountable to the Reg Guide 1.60 and, also, it includes a lot of the potential hard rock sites in the eastern U.S. So, that is all basis for accepting the definition for this CSDRS. We think they pretty much cover a wider range of a potential site, yes.

MEMBER SKILLMAN: If I interpret your answer, I interpret your answer to be, no, there is not an area where you had concern.

MR. XU: I may have had a concern if this is applied to the California coast. I would not do that. But if this plant built in the central/eastern U.S., I think the ground motion input is appropriate.

MEMBER SKILLMAN: Well, let's explore that a little bit. If you had concerns that the ground motion may not be enveloping for the West Coast, then why would you be willing to approve a design certification?

MR. XU: Well, the regulation requires that the standard design, to demonstrate it is applicable to multiple site conditions. Okay. It doesn't mean it does cover exclusively all site conditions. Okay. I think AREVA has demonstrated that the ground motion they selected are appropriate to multiple site conditions potential for this particular design.

MR. TESFAYE: Potential COLA applicant sites.

MR. XU: Yes. Yes, but the COLA also needs to demonstrate that the design is applicable to that site.

MEMBER SKILLMAN: Yes, I understand.

MR. XU: So, if someone wants to build this plant on the California coast, then that COLA probably has the difficulty to demonstrate that.

MEMBER SKILLMAN: I understand. Thank you.

MR. XU: Well, now we move to the next slide.

MEMBER STETKAR: Again, I am not a seismic guy; I am not a structural guy. On the open item that you have on the cable trays, I read a little bit about that.

MR. XU: Yes.

MEMBER STETKAR: As I understand it, the damping is also a function of the loading of the cable tray, isn't it? Or is it not? I mean, I need a little education here.

MR. XU: Yes, it depends on if the cable tray is empty or full. And I think AREVA has demonstrated through testing that the damping that is selected is appropriate for --

MEMBER STETKAR: But if it is a function of the cable tray loading, does it then become a COL information item or ITAAC, or something like that, to demonstrate an appropriate loading in the cable trays? Because a lot of cables are field-run.

MR. XU: I know, yes. Yes, lots of them. But if they are filled, then you can use a higher dam piece. But if it is empty, actually, you can use lower --

MEMBER STETKAR: Yes. Okay.

MR. XU: It is the other way around.

David Foster wants to clarify something.

DR. DAVID FOSTER: Hi. I'm David Foster from NUMARC Associates.

Is this on?

MR. XU: It's not on.

DR. DAVID FOSTER: Okay. Can you hear me now?

MEMBER STETKAR: As long as the recorder can hear you, that is the most important thing.

(Laughter.)

I can hear you.

DR. DAVID FOSTER: Yes, 15 is the max allowed in the transverse direction. In the FSAR, there is a curve presented such that, for cable trays that are empty -- let's say, when you first build the plant, the tray was empty -- I believe they are using 7 percent damping in the transverse direction. And for trays up to 50 percent, I believe the number is 10 percent. And then, full trays, they are allowed the 15 percent.

MEMBER STETKAR: Fifteen percent?

DR. DAVID FOSTER: You are correct. For partly-loaded trays, they are not allowed 15 percent.

MEMBER STETKAR: Okay. Thanks.

MR. XU: Thank you.

Okay. The next slide now.

Okay, 40, soil profiles. AREVA has included or the EPR has included the soil profiles which cover a wide range of site conditions. AREVA has presented from very soft to very hard rock.

To the extent practical -- and that is how we look at the standard design -- therefore, it is acceptable to the staff. I mean, it is up to the COL applicant to demonstrate that the site-specific soil profiles, that will be enveloped by the profiles in the standard design.

CHAIR POWERS: The question that I was trying to understand, because I don't know, I don't understand propagation of shear waves through solids, is in their profile they have a fairly dense material, and the shear waves coming through that dense material. And then, it encounters this decrease in density, more fluffy material, and the shear wave velocity drops way down.

MR. XU: Yes.

CHAIR POWERS: And if I am a little gremlin sitting on the shear wave and I am propagating along, what do I see when it comes into that low velocity?

MR. XU: Well, it will amplify.

CHAIR POWERS: I go up in amplification?

MR. XU: Yes.

CHAIR POWERS: And so, that gives it the amplification factors?

MR. XU: Yes.

CHAIR POWERS: Okay. I don't see a change in the frequency. I just see a change in the amplification --

MR. XU: The frequency will change as well. It is a functional frequency with respect to soil column.

CHAIR POWERS: So, I have basically got a Bernoulli problem, except it is in a solid. I have got to change things because I have got to get the same amount of energy through in the same amount of time.

MR. XU: Right.

CHAIR POWERS: Okay. Thank you.

MR. XU: See how easy it is?

CHAIR POWERS: Yes.

MR. XU: Now we are through 3.7.1.

CHAIR POWERS: These things are easy, but I just have to --

MR. XU: Okay. The next slide on 3.7.2, which is the seismic system analysis. It pertains to structural response to seismic motion.

For this section, we have five topics. The first deals with the analysis methods. The EPR uses time history analysis, response spectrum, and the complex frequency response methods, which is usually the necessity for soil interaction analysis. Okay. They are consistent with the SRP 3.2.

And as a result, all the open issues with respect to the method is resolved. Of course, we will have issues with the modeling aspects. That is the next slide. I know you have a question on that one.

Next slide, please.

Okay. This slide addresses the procedures used for analytical modeling, which is the finite element models. AREVA presented the evolution of the modeling process in the past few years, going through from surface environment, local mass, stick model, to embedded stick model, and then to full-blown plus 3D finite element embedded model. Okay.

And the reason for using these 3D detailed, the finite element model, is because AREVA included rock high-frequency ground motion input. And the only way to predict the response to the high-frequency input is to have a much finer mesh. So, that is the reason you move from stick model to --

CHAIR POWERS: Your mission has to be commensurate with the wave length?

MR. XU: The transition of the wave, yes.

CHAIR POWERS: Yes.

MR. XU: Yes. And normally, you need, for soil, you need at least about four to five elements per wave length.

CHAIR POWERS: Okay.

MR. XU: It depends on the frequency. If you have very high frequency, the wave length is getting smaller, and the mesh has to be much finer, obviously, not coarse.

CHAIR POWERS: Yes. Yes, it gets horrible.

MR. XU: Oh, yes. Yes, it could get way out of control, beyond the capability of --

CHAIR POWERS: The computational

capability.

MR. XU: Exactly.

CHAIR POWERS: You just flat can't run the calculation?

MR. XU: That's right. Well, you could -- well, it depends on what --

CHAIR POWERS: Oh, we have got a computer at the National Labs that will handle it.

MR. XU: Yes, right.

CHAIR POWERS: But nobody has it.

MR. XU: That's right, yes. Yes, yes.

CHAIR POWERS: So, replication is kind of a problem.

MR. XU: Yes, yes, especially if you have a much bigger model and you may not be able to -- you may run to the limit of implicit algorithm, of the motion implicit algorithm.

CHAIR POWERS: What is a typical noting for one of these high-frequency calculations?

MR. XU: I think it is like half a minute.

CHAIR POWERS: In half a minute?

MR. XU: Yes. It is very, very large. It is very large.

Yes, but if you have that many degrees of freedom and if you want one program, the complex frequency response method, which is based in the complex domain, instead of 60 degrees of freedom, you will quadruple the outcome.

CHAIR POWERS: Uh-hum.

MR. XU: And that is a substantial increase.

CHAIR POWERS: Yes. I mean, even just understanding the output becomes a real problem.

MR. XU: Exactly. Yes, problematic.

CHAIR POWERS: Yes. I mean, you end up having to do these virtual reality things just to read the output on these things.

MR. XU: That's right.

CHAIR POWERS: I understand. And I am not a believer in that. I think that 90 percent of our reactor safety questions can be answered by a back-of-the-envelope calculation, and if they can't, then you are probably doing it in too much detail.

MR. XU: You are, yes. In terms of modeling, this depends on the results we are looking for, right? You know, I mean, that is the objective. What is the result you are looking for?

If you are looking for global response, obviously, we can make a much coarser model.

CHAIR POWERS: Yes.

MR. XU: And if you are looking for a detailed response, you need finer. Or if you look for a local response, you may need a separate model.

CHAIR POWERS: Yes. Yes, the subgroup models.

MR. XU: That's right, yes.

CHAIR POWERS: Yes. One of the questions that I posed to the applicant was that it has these structural models, and they are relatively -- I mean, at least I recognized the names. I have to admit, I have never used either one of them. How do we know they're right?

MR. XU: Well, as I said, you start out defining the objective, your scope, what you are looking for. Okay. I mean, if you are looking for a complete behavior failure mode for a pump, then you should go to a detailed model for that pump. And if I am interested in structural response, not interested in the particular failure mode for the pump, I may not include that detail, that level of detail in my structure model, right?

CHAIR POWERS: Right.

MR. XU: So, I would rather do a separate analysis.

CHAIR POWERS: I mean, absolutely.

MR. XU: But it is a local analysis, right?

CHAIR POWERS: Yes, you have got to be careful about that --

MR. XU: Exactly.

CHAIR POWERS: -- how much you are asking for.

MR. XU: Right.

CHAIR POWERS: Here we are asking kind of global questions. And so, discounting the frequency problem, which gives us a specification of the loading. But let's take a fairly coarse model, fairly nominal frequencies, you know, a few Hertz kinds of frequencies.

How do I know that these structural models are giving me a good answer, a reliable answer? Or maybe a conservative answer? How do I know that?

MR. XU: Well, that depends on the type of analysis you want to do. Let's say, if I want to understand the dynamic behavior of the structure --

CHAIR POWERS: Yes.

MR. XU: -- I have a shear type of structure, right?

CHAIR POWERS: Yes.

MR. XU: So, I can estimate approximately what frequency that structure has, right?

CHAIR POWERS: Uh-hum.

MR. XU: That is the first thing. I will do a modal analysis first to develop all the relevant frequencies and the node shapes and the mass participations, so that it will give me an idea of the dynamic behavior of that structure before I embark on the very detailed sophisticated model without understanding the underlying --

CHAIR POWERS: Okay. So, I can do that. At the crudest level, I can do that by hand.

MR. XU: Yes, you could do that. You could do that by hand. And you could use that as a separate check, okay, to ensure that the detailed model is doing what it is supposed to do.

There are many different ways of checking the detail, whether the detailed model will do its job. But I wouldn't start it out with a detailed model --

CHAIR POWERS: Yes.

MR. XU: -- without understanding anything about the underlying structure.

CHAIR POWERS: You want to know some sort of physical understanding.

MR. XU: Yes.

CHAIR POWERS: And I can do that. I mean, I think I can do a beam. I am not sure I can do anything else.

MR. XU: Well, you can do a beam, right? A beam is continuous.

CHAIR POWERS: Yes.

MR. XU: Okay. If I only want to know the first node of that beam, I can model that beam with a lollipop, with one mass, if that is the only thing I am interested in.

CHAIR POWERS: That's right.

MR. XU: So, that is my objective. But if I am interested in more than that, you know, the third, the fourth node, then I need to go into much detail.

Okay. To model to a beam, you can model a beam an infinite number of ways. It all depends on your end objective. What results are you looking for? You have got to define that first.

But, once that is defined, then you know what to model because you understand the dynamic behavior first. Right now, for this structure, okay, the only thing I am interested in is the frequency below 10 Hertz. Then, I don't even want to worry what is going to happen beyond 20 Hertz. Why do I need to worry about that, right?

CHAIR POWERS: Yes.

MR. XU: That is someone else's problem. That is not my problem. My problem is, as long as I model the structure that would give me a solution with high fidelity for a frequency range below 10 Hertz, that is all I am interested in. So, once I understand that, then I can do my structural model and everything will fall in place.

CHAIR POWERS: And the models will predict, they predict some sort of stress level? Or do they actually predict failures?

MR. XU: The actual failure has to be -- it depends on the criteria. But, I mean, the model only gives you whatever you prescribe, right? You know, if I prescribe the model as a linear behavior, it can go on forever. Okay.

CHAIR POWERS: Uh-huh.

MR. XU: If I prescribe the material behavior in the nonlinear fashion --

CHAIR POWERS: By putting some sort of situation --

MR. XU: This thing keeps going, right?

CHAIR POWERS: Yes.

MR. XU: It is not going to stop until

either it runs out of numerical problems or you prescribe something. So, if you want to stop failure, then you have to prescribe what a failure means.

CHAIR POWERS: So, do they run these models largely in Hooke's Law limits or do actually put in failure criteria on them?

MR. XU: I think for Section 3, the scope is to establish that with demand. So, you don't deal with a failure yet.

CHAIR POWERS: Yes.

MR. XU: It just establishes whatever load --

CHAIR POWERS: They run it like an elastic --

MR. XU: Right. If you go to 3.8, then you have to prescribe what constitutes as a failure, and that would be the requirement --

CHAIR POWERS: Even if I run it in elastic, I can just look at the output and say, yes, this exceeded my failure criteria.

MR. XU: Right. Yes, that will be 3.8. 3.8 has to put all the load in place in the load combination and then compute the combined, the demand, and then compare that with the capacity, and to establish that the design, whatever section, with the thickness of the liner --

CHAIR POWERS: So, really, the only question comes down to whether I believe or don't believe the constituent relationship that they put in for the elastic properties, the constituent elements of the structure? And none of these constituents are particularly unusual at this level of calculation?

MR. XU: That's correct.

CHAIR POWERS: Got it. Thank you.

MR. XU: Thank you.

CHAIR POWERS: That clarifies a lot.

MR. XU: Oh, thank you. That's what we are here for.

(Laughter.)

CHAIR POWERS: That's right. I appreciate it.

MR. XU: Okay. We have two open issues, two remaining issues. One deals with whether we look at the model developed by AREVA. We have gone through a very detailed review. Actually, the staff has been looking at every minute difference to try to figure out whether there is something correct or not.

So, the two remaining issues, one deals with the connection between the superstructure and the basemat. The superstructure wall is modeled with the shell type of elements, which in each node you have a 60-degree freedom, three translations, three rotational degrees of freedom. And the basemat is modeled with the break elements, which means in each node you have only three translational degrees of freedom.

So, whether the connection is modeled adequately to allow the low transfer from superstructure to the basemat, and we have a question to ask the applicant to justify or demonstrate whether the load can transfer from the superstructure to the basemat. So, that is one remaining issue.

The second one is AREVA has developed this gigantic, very detailed ANSYS model, their static. Okay. It is to model probably as detailed as possible the nuclear island structures.

And then, if you do a different type of analysis, what they do, they take this model, you know, the model appropriate for that type of analysis. And for the soil-structure interaction, they used the program SASSI, which can only allow a certain number of degree of freedom. So, you have to use some simplifications before you can move this model to one using SASSI.

So, the second open item is we asked AREVA to compare the dynamic behavior of the ANSYS model, which is the basis for their SASSI model, so whether they would match, because they made certain simplifications.

CHAIR POWERS: In your ideal situation, you know, you have what, six degrees of freedom?

MR. XU: Yes.

CHAIR POWERS: Three translationals and three rotationals?

MR. XU: For the shell, yes, for the shell --

CHAIR POWERS: And so, you start dropping those off as you simplify?

MR. XU: Right. Yes, because if you connect the plate elements with the break elements, okay, you connect them in modes, but for break elements this can only see the translational because it doesn't recognize rotations.

CHAIR POWERS: Yes.

MR. XU: It is blind. You couldn't see the freedom. So, the question is whether the basemat modeled across the thickness a sufficient number of the break elements that would allow the transfer of the moments from the superstructure to --

CHAIR POWERS: I understand, yes. Yes.

MR. XU: So, that is one issue.

CHAIR POWERS: I'm getting it.

MR. XU: Yes.

CHAIR POWERS: And you go to the simplification because you need more nodes?

MR. XU: Right.

CHAIR POWERS: Yes.

MR. XU: Yes.

The second one is compare the SASSI model with ANSYS. I think, so far, the data provided to us have demonstrated that they match, in terms of frequency, they match very well.

CHAIR POWERS: Okay.

MR. XU: Okay? But we do have some questions on some of the flow response action. There are some peaks that are not matching as good as they should. So, we still have some questions on that. That is an open item.

CHAIR POWERS: But matching between codes is really an engineering judgment sort of thing, right?

MR. XU: Yes. But if you do analysis in different -- well, even though you use the same elements, say, for example, they all use the plate elements. It depends on the formulation within the code.

CHAIR POWERS: Sure.

MR. XU: Okay? It could be very different. It is just a numerical model. So, you can model different code models differently.

I believe the SASSI is using the formulation --

CHAIR POWERS: Well, it is like you say, it depends on the question you are answering.

MR. XU: That's right.

CHAIR POWERS: How you compare two codes, I mean, there is an engineering judgment, but the first question is --

MR. XU: Yes, yes.

CHAIR POWERS: -- what question am I really asking here?

MR. XU: That's right, yes. But we do check. The first thing we want to check is to make sure the two models are dynamically equivalent.

CHAIR POWERS: Yes.

MR. XU: That is what we want to see.

CHAIR POWERS: I understand, yes.

MEMBER SKILLMAN: For your first open item --

MR. XU: Yes?

MEMBER SKILLMAN: -- the compatibility between the nuclear island mat and the superstructure, what would be the success path for the staff to say this is acceptable?

MR. XU: The success path would be if the connections get adequately transferred depending; that is what we are looking for. Obviously, you can transfer shear because both the breaks and the shell elements model the translation of the degree of freedom. So, you can get the shear forces correctly transmitted from the superstructure to the basemat.

But we don't know, if we don't look at the details of that connection, whether the moment can be correctly transferred. Because if I just use one break element for the basemat, that basemat cannot take any bending, right, because there is no bending capabilities in it, because across the seconds you have only one break, and the break does not take bending. It will take only translational forces.

But if I model across the thickness, for example, if I take four elements or five, okay, collectively, they will be able to take a bending moment, and that is what we are looking for and to make sure. Because the basemat does have bending capabilities. But if you don't model it properly, you will not be able to capture that behavior.

MEMBER SKILLMAN: That load?

MR. XU: Yes, that's right. Yes.

MEMBER SKILLMAN: Thank you.

MR. XU: You're welcome.

Okay. I think we are done with this slide.

Okay. The next slide discusses soil structure interaction. AREVA used SASSI computer code, and this is a very old code. It is a code originally developed at UC-Berkeley. It is now being used by all applicants for soil structure interaction analysis, considering embedment effect.

But there is one method in this code which is called substructure methods. And it was recently identified to produce unconservative seismic response. It depends on the configuration.

The issue was originally identified in the seismic analysis for some of the DOE, Department of Energy, facilities. Now, because AREVA has used substructure methods, now this is one other issue they have to resolve.

We have two open items. Maybe I will go through the first one first, which is the tendon gallery, because AREVA used the post-tension containment. And the tendon gallery extended below the basemat. The gallery may take most of the load before during the seismic motion. The tendon gallery may take the most below, before the passive pressure on the side is activated, because passive pressure can only be activated in certain deformations. Okay. But before that deformation takes place, most of the load will have to be taken by the tendon gallery because that is the shear key on the bottom. So, that is the issue.

I think it is an open item. AREVA will demonstrate the fact that the tendon gallery is actually designed to withstand the seismic load.

Okay. The second issue is the issue associated with the subtraction methods. We have had discussions with AREVA on this issue. AREVA has presented an approach for resolving this issue. We think it is promising, but we will see the details when they present us with some preliminary results, and this will be in phase 4. So, they are not going to do that now. The latest schedule is to provide it, this will be done by late October this year.

Any questions on this slide?

(No response.)

Okay. Next slide.

This slide addresses interaction between Non-Seismic Category I structures with Seismic Category I structures. For this issue, for this topic, it turned out to be a very difficult issue for one of the non-safety-related structures, which is the nuclear auxiliary building. This building is located in the corner of the nuclear island between the fuel building and the safeguard No. 4, okay, right in the corner there.

AREVA has performed the 201 analysis, and I think it has difficulty with respect to justifying the total pressure to withstand the rotational node of the motion. So, this is still an open item. We expect that AREVA will provide a full justification that the NAB will not impact the nuclear island structures. I think that is the only issue we have with 201.

CHAIR POWERS: We asked specifically about piping and cabling in the past between structures on different mounts. And the applicant indicated, yes, he was aware and worried about that issue, and I guess you guys also worried about that issue.

MR. XU: Yes. All the umbilicals, the things that connect between the buildings, that is the issue we have currently. You know, we review to ensure that they are not an issue here.

And also, I believe there is a COL information item, an ITAAC that they need to worry about.

CHAIR POWERS: Yes.

MR. XU: The next slide.

MEMBER SKILLMAN: Before you go on --

MR. XU: Okay.

MEMBER SKILLMAN: -- is what is going to be the certified design -- deficient is not the word I want to use, but it tends in the right direction. Is there an inadequacy here because of the spatial difference between the NAB and the access building and the turbine building to the seismic Class 1 structures? Is this a weakness in the design?

MR. XU: No, it is not a weakness of design. But, you know, when you have a structure that is designed to a certain quality, but you have another structure located in the proximity for it, but there is not a circular structure, it is probably not designed to the same level of standard.

So, the issue is, is that structure either too close to this one or in a certain way you have got to make sure that that building is not going to fall all over the safety-related structure to interfere with its function. So, that is the issue we always have to address.

MEMBER SKILLMAN: I understand that. This is a nested-building problem where you have got different building classifications --

MR. XU: Right.

MEMBER SKILLMAN: -- that can result in interactions that are adverse to the overall quality of the facility.

MR. XU: Right.

MEMBER SKILLMAN: I understand --

MR. XU: Yes, but we didn't care about the other structure, the non-safety-related one.

MEMBER SKILLMAN: As long as it can't take out the safety-related one?

MR. XU: Right. As long as the safety-related is protected, but that is the issue here. So, we want to make sure. SRP has three criteria there. Either demonstrate that the sufficient distance exists. We call this what happened to the non-safety-related. It is not going to even touch the safety-related structure. Or they demonstrated that if it is clamped on the safety-related structure, but it will not damage it. It is going to be difficult to do. It is not practical. It is difficult to demonstrate that aspect.

MEMBER SKILLMAN: So, this becomes, if you will, a financial issue for a future licensee, but it is not necessarily a safety design issue?

MR. XU: No, it is not safety. Or it is one aspect you have to check in the design. It is one part. You know you design much structure that is safety-related, but I have to worry about where were my neighbors, right? All my neighbors had to behave properly. I have got to have good neighbors, make sure they don't do anything to damage my properties.

(Laughter.)

MEMBER SKILLMAN: I accept that argument, except where you must have your neighbor in order to operate the facility.

MR. XU: Exactly.

MEMBER SKILLMAN: That is where it becomes a real complication.

MR. XU: But except I don't care what happens to that neighbor.

(Laughter.)

MEMBER SKILLMAN: Thank you. I understand. Thank you.

MR. XU: Stability, the next one is on stability. Well, we have done several standard designs already. As you know, the stability analysis is always a difficult aspect to demonstrate for standard design.

I think the reason for that is the standard design uses multiple ground motions and a wide range of shapes, and that tends to overpredict the demand, the seismic demand. On the other hand, the design is always conservative. So, in terms of capacity, it is always under-prescribed. It is always for the lower capacity. That is the nature of design.

So, as a result of that, the stability is the demand overcapacity. And then, you check whether it is the rock overturned or slag, and then you compare with the criteria prescribed. That is always difficult for the standard design to demonstrate. It would be much easier to demonstrate for any site-specific design or for generic design, but this is a difficult aspect.

I just want to point now that part. We did spend a lot of time with applicants to resolve all of the related issues. We don't have any open items on the stability analysis.

Okay. We have finished 3.7.2.

CHAIR POWERS: Very good. I am going to declare a break between 3.7 and 3.8.

MR. XU: Okay.

CHAIR POWERS: I truthfully enjoy listening to Professor Xu here.

(Laughter.)

But I think my Committee has an inherent retention problem that needs to be addressed. So, we will recess until three o'clock.

CHAIR POWERS: Let's come back into session.

The professor will continue his lecture.

(Laughter.)

MR. XU: Thank you.

This slide addresses 3.7.3, which deals with the --

MR. TESFAYE: Oh, I thought we were done with this.

MR. MIERNICKI: He hasn't touched this slide yet.

MR. XU: I didn't talk about this.

CHAIR POWERS: Barely, I cut him off and that is just one of my prerogatives, I guess.

(Laughter.)

MR. TESFAYE: I heard him say 3.8. That's when you stopped him.

CHAIR POWERS: Yes. I always learn

something when he talks.

MR. XU: Okay. This section deals with the subsystem responses from the perspective of seismic demands that would be computing the in-structure response spectrum. Applicants follow the Regulatory Guide 1.122 and the Reg Guide 1.92, which is all they need to do in terms of developing this sort of response spectrum.

And we have resolved all the issues in this section. We don't have any remaining issues here.

Any questions?

(No response.)

If no questions, okay, we have finished Section 3.7. Now we go to 3.8, which is the containment design and the design of other Category I structures and foundations.

Okay. I lumped 3.8.1 and 3.8.2 together, which deal with concrete containment and 3.8.2 deals with the steel containment. As you see from AREVA's presentation, EPR used the post-tension concrete containment with grouted tendons.

For this section, as AREVA presented this part already, Regulation 52.47(c)(1) required the DCD application provide essentially a complete design.

The initial review by the staff did not identify any criteria for identification of critical sections.

Applicant subsequently developed the detailed methodology, which we believe is the first of its kind. It is very good methods, provides systematic selection criteria for critical sections.

The only open item on this slide is the design of critical sections or remain to be completed. So, therefore, the number of critical sections could change. So, if there are no questions, we will move to the next slide.

This is an important slide which deals with the design and analysis procedures. We have identified a number of issues with respect to design and analysis procedures.

The first bullet deals with the nonlinear finite element model which was originally used for the design of the superstructures. The reason for using this model by the applicant was to account for the uplifting effect, and they also used nonlinear soil scorings. But this is inconsistent with the linear design philosophy. I mean, to this date, I still don't understand what nonlinear design is, right?

If I would come for multiple loads from internal and external hazards, if you don't use linear design, how are you going to combine them?

CHAIR POWERS: Yes, you can't do superposition or anything.

MR. XU: Exactly.

CHAIR POWERS: Yes.

MR. XU: That is the basic principle behind --

CHAIR POWERS: Yes. Okay. I understand that's a problem.

MR. XU: That is going to be a problem. That is why you can use the linear methodology for evaluation purpose or you can use linear methods for design of local phenomenons such as foundation design. You can do that. But superstructure sees a whole different load at different places. You have to use linear methodology because you have to employ a superposition principle.

So, again, the second bullet is the 100-40-40, which is also based on superposition. You know, it is not applicable to nonlinear analysis.

So, applicant originally, when they used the nonlinear finite element model, they tried to modify the 100-40-40 methods, which we don't think is correct.

And also, the original design employed the so-called equivalent static seismic analysis methods with modification factors. Okay. This is also the first-of-a-kind which had never been used before in the design of a nuclear facility. At least I haven't seen it.

Okay. And the staff also performed a confirmatory analysis of the reactor building internal structure to demonstrate that the use of this modification factor is inadequate. But, in the end, AREVA changed to a different approach which followed the linear methodology for the superstructure design, that the next bullet is that the superstructure design will be based on a linear model which is consistent with the principle of the superposition, and the basemat model will account for the various nonlinear factors.

Uplifting will be an evaluation, because, I mean, you don't rely on uplifting to compute the seismic demands, right? You do a design and you can evaluate that design, whether that will survive the uplifting effect.

And for the three-directional load combination from seismic events, AREVA will use SRSS rule, which is the square root of solid squares, for a superstructure model and algebraic summation for the basemat model.

They eliminate 100-40-40 rule, which we still have some questions. This particular load, the combination methods are being addressed by ASC4 Working Group. So we are still waiting for some study to be done before we finalize the requirement in ASC4.

CHAIR POWERS: Okay.

MR. XU: And also, they eliminated the modification methods.

Next slide.

There are some other technical issues we have identified that I will review. One issue, described in the first bullet, is associated with the evaluation of the containment pressure generated from hydrogen gas and the burn issues.

Reg Guide 1.7 I believe is the last guidance, Reg Guide 1.7, asking to demonstrate that the structural analysis be performed to demonstrate ASME service level allowable is not exceeded by the pressure loads generated from 100 percent fuel clad-cooling reaction following the hydrogen burnings.

The original analysis by AREVA did not perform the analysis. They simply stated that their design pressure is 72 psi, which is higher than the minimum 34 psi pressure stated in 1.7.

The second bullet says they account for concrete cracking effects, which is one of the uncertainties that needs to be considered in the seismic analysis and analysis for determining the DBA pressure and temperature load, because the concrete will crack. And the question is whether you account for that effect in the design.

And the third bullet says the ISI, the in-service inspection program, the original FSAR, Rev. 0, basically says we will use Reg Guide 1.90, but we are going to use different testing schedules and we are not going to do monitoring of non-grouted test tendons.

Okay. And also, on this particular subject, we have very limited U.S. experience because there are only two plants that were designed using grouted tendons. One is the Three Mile Island, which was shut down right after it was built, was operated. The second is Robinson. I believe they used on the grouted tendons for the vertical.

MEMBER SKILLMAN: Would you explain the first bullet again, please? I thought you said 37 pounds, but your slide shows 75 psi for that.

MR. XU: Oh, yes, the 37 psi is the pressure that is calculated from the hydrogen due to

100 percent fuel clad-cooling reaction for the hydrogen burning.

MEMBER SKILLMAN: Okay.

MR. XU: That is calculated later. In their Rev. 0, they did not do any analysis. They simply stated that the design pressure, which is the 62 psi, is greater than 34 psi, minimum requirement stated like at 1.7.

MEMBER SKILLMAN: What is the 75 psi on that line?

MR. XU: The 75 psi is the pressure calculated from the hydrogen gas. So, that is what they need to demonstrate with that pressure, with the 75 psi, the air service level allowable is not exceeded for the liner. For the liner ASME limits for the liner, it is a .03 percent. Okay. For the membrane strain, and for membrane plus bending, it should not exceed 1 percent.

MEMBER SKILLMAN: Thank you. I understand.

MR. XU: And the last bullet says the lack of design details. AREVA did not provide any of the penetration designs for the containment because they are part of the containment pressure boundary. So, we believe they should be, as a part of the pressure boundary, they should be included in part of the steel containment, that that steel containment addresses, the permutations.

Okay. The next slide.

The staff evaluation, the first bullet states that AREVA has done, after we identify the issue, AREVA performed nonlinear analysis and basically established the pressure for hydrogen gas is 75 psi and demonstrated that the containment liner is within the ASME service level C allowables.

And AREVA also performed the additional finite element analysis to account for concrete cracking effects and the seismic demands for containment and, also, for the model that is used to demonstrate the robustness from the DBA pressure and temperature load.

For the ISI and the grouted tendon procedures, AREVA is now going to follow Reg Guide 1.90 and Reg Guide 1.107 without exceptions.

And the last bullet, AREVA has completed the design of the major steel penetrations as a part of containing the pressure boundary.

Next slide.

This slide addresses the containment internal structures. For containment internal structures, we don't have any remaining technical issues except the localized model is not complete for internal structures. That will be complete when the design is finished during phase 4. So, that is an open item.

We are satisfied with the global models, which containment includes the internal structure as a part of the global model. But the localized effect will be analyzed with a local model which is not complete yet.

Next slide.

3.8.4 deals with design for other Category I structures, which all the issues that were raised for containment apply to other categorized structures. So, we did not repeat it here.

The only item, the issue, we put it on this slide actually is the one AREVA hasn't addressed yet. This deals with the fuel rack structural analysis design. AREVA covered these aspects in Chapter 9, which is part of tomorrow's presentation.

CHAIR POWERS: One of the issues we are running into in connection with Fukushima is that in their spent fuel pools they have for one of the plants some aluminum racks, and they dropped a bunch of concrete in there. Of course, concrete in water, you leach out the calcium hydroxide. It makes the solution basic.

MR. XU: Yes.

CHAIR POWERS: And basic solutions and aluminum are basically incompatible with each other. Do we have some more problems here?

MR. XU: I don't think that is even within the scope of their rack design for standard or for this. No one addressed that issue.

I mean, we do address the accidental drop during operation.

CHAIR POWERS: Yes. I mean, that is a design basis consideration.

MR. XU: That's right, yes.

CHAIR POWERS: I think we are coming down to you just really should not put aluminum in these spent fuel pools, not so much from a DBA consideration, but just because of beyond DBA considerations.

MR. XU: Right. I think maybe tomorrow you can ask that question for the Chapter 9.

CHAIR POWERS: Yes. Yes, I just kind of feel that somebody will raise the question.

MR. XU: That is a good issue. That is a good issue.

CHAIR POWERS: Yes.

MR. XU: But I don't think, you know, even the operating plants don't address that.

CHAIR POWERS: Yes. Steel is such wonderful stuff.

MR. XU: It is rare. It is probably extremely low probability.

CHAIR POWERS: Yes. I mean, quite frankly, I hadn't thought about it until somebody asked me, you know, what happens with all that concrete in there? And I said, oh, everything's fine as along as you don't have aluminum in there. And they went, oh, whoops.

(Laughter.)

MR. XU: Okay. I mean, we give you the staff evaluation here before you have an opportunity to hear what the applicant will present with respect to spent fuel rack designs.

So, I will probably just give you some preview on that. So, what is involved in here is the spent fuel rack is a rectangular-frame-type of a structure with a plates on all sides and the poison plates inside to make the cell tubes which houses the fuel assemblies. And the rack is supported by legs and it is freestanding. It is not anchored. So, it is freestanding and it is submerged in the pool. So, that is the rack.

And the challenges with this type of design is it is extremely nonlinear because it is freestanding.

CHAIR POWERS: Yes.

MR. XU: So, the seismic analysis is difficult because of the high nonlinearity. You can see the sliding, tipping, and all the interaction effects, the full-structure interaction, and the cell wall interaction with the fuel assemblies and the rack-to-rack interactions. It is just all the possible interaction effects had to be conceived of.

So, it is very complex. The typical analysis for this type of situation, people use the defined type of computer code to do the explicit algorithm to include all their facts.

As we know from others, the issue from other designs, the integrity of fuel assemblies, okay, the applicant will have to demonstrate that the fuel assembly actually maintains the integrity, although it is a proxy. By the design of the rack, the fuel assembly probably should be maintained. But now they have to explicitly demonstrate this, whatever the stress, or stress is not exceeded, or whatever allowables for the fuel assemblies. So, it is complex.

And if you move to the next slide, we have looked at the variety of the nonlinear aspects associated with this design. You know, the friction coefficient is selected from .2 to .8, which is typical for other designs as well.

CHAIR POWERS: The friction factor is kind of critical for the sliding around.

MR. XU: Yes, because at .2, the lower friction will control the sliding. But the upper bound controls the tipping.

CHAIR POWERS: Okay. So, damned if you do, damned if you don't sort of thing.

(Laughter.)

MR. XU: So, you have to consider the entire range. That is why it is a difficult subject, and you have to make different cases.

The other design certification will even develop a matrix of what -- which cases.

CHAIR POWERS: I mean, there is even more to the issue. If your friction factor is critical, too high or too low, then you have a construction/installation/inspection problem.

MR. XU: Right.

CHAIR POWERS: Because how do you know that what you actually put in there, indeed, has the friction factor within the critical range?

MR. XU: Well, to make sure your design is conservative enough, as long as the friction coefficient is limited within this range, the design allowable will not be exceeded. Okay? But that is very important.

I see Joe wants to add something, Joe Braverman from Brookhaven National Laboratory.

MR. BRAVERMAN: Yes. Hello.

MR. XU: It's on.

CHAIR POWERS: You're on.

MR. BRAVERMAN: It's on? Okay.

Joe Braverman from BNL.

To answer your question about the adequacy of the friction coefficient, I believe the applicant's fuel racks from various past submittals have referred to actual test data of stainless steel on stainless steel submerged in water. And surprisingly, the range of the coefficient of friction is very wide. So, the .2 represents the low bound, based on actual tests, and .8 the upper bound.

In this case, the applicant also considered an intermediate value of .5, based on staff questions. And I think they have even a few cases of randomized coefficient of friction values at different rack legs as well.

CHAIR POWERS: Why the range?

MR. BRAVERMAN: Excuse me?

CHAIR POWERS: Why the range? I mean, stainless is stainless is stainless, except in the area of friction. I mean, 304 is God-awful when it comes to friction.

MR. BRAVERMAN: Well, I am not an expert in that area, but I suspect a major factor is how you finish the surface of the stainless steel material. I don't think the water has a factor. It is not clear how much --

CHAIR POWERS: Yes, the water wouldn't be important.

MR. BRAVERMAN: As far as how much dead weight you have on it, that could be a factor of stainless steel and water, but I suspect that primary factors may be the finish of the surface.

CHAIR POWERS: What I know for sure is 304, and 304 gall like crazy. The friction factor just goes astronomical on that. And 304 and 447 slide like butter. I mean, they are just really smooth on each other.

So, I suspect is an alloy-to-alloy problem, at least one of the factors. I mean, load clearly makes a difference.

Interesting. What a problem. Okay.

MR. XU: But, in the actual case, it is not going to have a friction coefficient in this wide range. This is a conservative way of doing a standard design because, as I said, the lower bound controls the sliding; the higher bound will be controlled by the tipping.

MR. BRAVERMAN: Yes, I'm sorry. This is Joe Braverman again from BNL.

What I also meant to say is we don't really need to know the exact coefficient of friction. The fact that they are considering low bound, upper bound, intermediate, and enveloping of the results, in that way I think it is a conservative approach. Wherever the number falls, it should be bounded by these analyses.

CHAIR POWERS: Yes. I mean, the question is, because high friction has a problem and low friction has a problem, you need to make sure that, indeed, you are covering the spectra.

MR. XU: Just make sure you cover the power curve, right?

CHAIR POWERS: Yes.

MR. XU: There is no way out.

(Laughter.)

MEMBER STETKAR: It is a really intriguing issue.

MR. XU: Yes, it is intriguing because there is no way out, unless you do a specific design and you know exactly what the friction coefficient, you know the uncertainty, and you can do it in a range. Otherwise, you have to do it conservatively. So, this is the only way I guess they could do it.

The second bullet deals with all the interactions which AREVA had to provide justifications to us. AREVA is also going to demonstrate the tolerance on the gaps is adequately considered.

We also haven't seen all the results yet. So, they will provide all the results for various components of the reactor.

So, the last three bullets, those three bullets in the next slide are three open items for the rack.

Okay. We will go to the next slide. This slide addresses the design of the foundations, Category I foundations.

MEMBER SKILLMAN: Let's go back to 54,

just one slide.

MR. XU: Okay.

MEMBER SKILLMAN: Why isn't there another bullet which is the identification of an action to make sure that the applicant is addressing the interaction between the outermost rack and the pool liner?

MR. XU: It should be covered in the first bullets.

Okay, Joe will provide the clarification on that.

MR. BRAVERMAN: Excuse me? If you could clarify your question, do you mean the outer rack and the pool wall or do you mean beneath the rack leg and the pool floor?

MEMBER SKILLMAN: The outermost rack and the stainless steel liner on the wall.

MR. XU: The liner on the wall.

MR. BRAVERMAN: My understanding -- and maybe AREVA can correct me -- is that they did about 15 different analyses with these different permutations like coefficient of friction, different time history sets, different fill of the racks, and then the envelope on the results.

I believe, with few exceptions, the

outermost rack did not impact the walls because there was substantial dimensions or gaps between the rack and the wall. They didn't slide that much.

There were, I believe, a few cases, but those impact forces were not significant. And even if it did, the liner is backed by concrete. So, unless you have a sharp point, you are not going to likely penetrate the liner.

MEMBER SKILLMAN: Does AREVA want to respond to that?

MR. GARDNER: We don't really have anybody here today.

MEMBER SKILLMAN: Can we talk about it tomorrow?

MR. GARDNER: Tomorrow.

MEMBER SKILLMAN: Thank you. Good.

MR. XU: As I said, you see there the staff evaluation first before you hear from the applicant.

MEMBER SKILLMAN: I was concerned that our chance left us this morning.

MR. GARDNER: It will be talked about in Chapter 9 tomorrow.

MR. XU: Yes, that will be in Chapter 9 probably.

CHAIR POWERS: That is no problem. I mean, that's fine.

MEMBER SKILLMAN: That's fine. Okay. I'm good.

MR. XU: But we will be here. I think in the morning we will be here, if you have any questions from staff.

MEMBER SKILLMAN: I would have seen it more addressed in 3.8 as opposed to seeing it in 9, but either is fine, as long as we talk about it.

MR. XU: Right. Yes, we thought they would do it in this, but --

MEMBER STETKAR: If we had had 9 today, they would have said, well, it's 3.8.

(Laughter.)

MEMBER SKILLMAN: I want to make sure the train hasn't left the station.

CHAIR POWERS: McIntyre is in charge. They do that sort of stuff, yes.

(Laughter.)

MEMBER SKILLMAN: Thank you. I'm good. Thank you.

MR. TESFAYE: For some clarification, the staff addressed this in Chapter 3, but AREVA gave us a technical report that covers all this in Chapter 9.

MEMBER SKILLMAN: Okay. Then, we will talk about it in 9.

MR. XU: Yes, because we are the one who reviewed the structural design for the rack. It is a logistic issue; it is not technical.

MEMBER SKILLMAN: Thank you.

MR. XU: Yes.

CHAIR POWERS: There's lots of questions to ask the applicant.

MR. XU: That's right.

CHAIR POWERS: We may change this whole thing around.

(Laughter.)

MR. XU: Okay. For foundation, the first issue is the stability analysis, which we already covered in 3.7 and the coefficient of friction. The sliding was pretty much in the lower bound; .5 is low enough to cover most of the soil slide.

And in terms of design, they incorporated tendon gallery as shear key. And also, shear keys are included for EPGB.

ESWB has not completed yet design. Okay? And they also make design changes for ESWB because of the stability issue.

Okay. Next slide. We have two more

slides to go.

Okay. This is a good issue. The design of the foundation needs to account for the load from differential soil settlement and the construction sequences. The soil settlement and construction sequences really are a site-specific issue. But how the standard is designed to account for the load from this fact is a difficult subject.

So, there are two issues involved in this. First, the design be conservative enough to account for differential settlement effect.

The second is the construction has to be in the minor, to ensure that whatever settlement you see due to the soil differential settlement, would not -- the stresses in the foundation due to the differential settlement at the different stages of construction will not exceed the stresses in the design, the design allowables. Okay. So, there are two parts in there.

The standard design was the first aspect, which is the design that accounts for potential differential settlement. And the standard design has to postulate a construction sequence. Okay? And they design conservatively to make sure site-specific differential settlement will not induce the stress in the foundation that will exceed the design allowables. And that is a challenge.

Okay. And the design also has to provide an adequate detailed guidance for the COL as to what the COL will do, the staff, the monitoring programs in place to ensure the design is adequate for the construction.

CHAIR POWERS: This seems to be an issue. What you have talked about here is guidance for the COL applicant. I think the staff has some guidance to pass on to the inspection people here. Because what you are raising is an issue of the sequence of construction itself has to be watched fairly closely.

MR. XU: Yes, that's right. Yes.

CHAIR POWERS: I mean, that is a key insight here.

MR. XU: Yes.

CHAIR POWERS: I guess we need to figure out a way to flag these things, because it is not clear to me that anybody just setting up an inspection monitoring program would catch that particular issue.

MR. XU: Right. That is why in DCD the applicant should provide sufficient details to ensure that you have all the steps and that you have all the information that will be necessary for the COL to make that call, that during the construction the stresses, the strain will not exceed allowables.

CHAIR POWERS: You are sure making a floating nuclear power plant sound a lot more interesting.

(Laughter.)

McIntyre doesn't even smile. Tears come to his eyes.

(Laughter.)

MR. XU: So, this is an issue that needs to be addressed both by the DCD application and the COL.

CHAIR POWERS: Yes.

MR. XU: Okay. So, it is an important issue, an important aspect to ensure the foundation is adequate. So, once you pour the concrete, then you are in deep trouble, right? You don't want that.

(Laughter.)

CHAIR POWERS: A big, large crack appears.

MR. XU: No, no.

Manuel Miranda from BNL wants to chime in on that aspect.

DR. MIRANDA: Yes, this is Manuel Miranda from BNL.

I just wanted to maybe clarify a couple of things that Jim was expressing.

First is in the FSAR there is a postulated construction sequence which is described in terms of steps that were basically assumed in the design in order to generate induced stresses that were taken as loads for their design. That is the first thing.

And the second thing is the set of settlement profiles that go along with those construction steps. So, these settlement profiles were incorporated as part of the FSAR, so that the COLA would have them and would be able to use those in order to compare what they are actually getting on the site. So, that is the mechanism that was incorporated in the FSAR. That was as a result of this staff review.

CHAIR POWERS: And it is all very good, and I thank you for pointing this out because it is certainly something I would not have caught. I mean, I would have read this sequence, and I said, eh.

(Laughter.)

MR. XU: The applicant has done a good job in addressing these difficult challenges.

CHAIR POWERS: Congratulations to all in that case.

MR. XU: And staff's persistence.

(Laughter.)

CHAIR POWERS: Quite frankly, good catch, guys. We really appreciate that. That is something I would not have thought of.

MR. XU: And this is an important issue. I mean, there is a gap in terms of the guidance to address this issue. There is ASC, one Working Group that will take that challenge to see if there is some requirement that we can prescribe in the standard for this process.

MEMBER SKILLMAN: Could we go back to 55 for a second, please? On the third and fourth bullets, tendon gallery as shear key for the nuclear island basemat --

MR. XU: Yes.

MEMBER SKILLMAN: -- and shear key is credited for sliding analysis of the emergency power generation building basemat.

MR. XU: Yes.

MEMBER SKILLMAN: In the Standard Review Plan, and I suspect in Tier 1, there are factors of safety for sliding and overturning.

MR. XU: Yes, 1.1.

MEMBER SKILLMAN: Do these two bullets point to a modification in the base design in order to assure that the factors of safety for sliding and overturning are maintained?

MR. XU: Yes, they are credited because they need to meet 1.1, factor of safety.

MEMBER SKILLMAN: So, without these --

MR. XU: Without that, they may not be able to meet. They have a range of soil conditions. So, for some of the conditions, they may not be able to meet them.

MEMBER SKILLMAN: So, these shear keys will be a required design feature in order to meet the Tier 1, sliding and overturning factors of safety?

MR. XU: I think it is their design features, yes.

MEMBER SKILLMAN: Okay. Thank you. That's all. Thank you.

MR. XU: Go to the next slide, please, the last one. Yes, this is the last slide. Okay.

This slide addresses the soil pressures on the wall and, also, the varying pressure capacities. AREVA considered the pressure using the SSA analysis because their whole model considered environment. So, that would address the pressure induced on the side.

And also, AREVA uses the SC-498 guidance there, requirements, which is the elastic solution, which is considered as upper bound in terms of the soil pressures, is the elastic absorption. So, it is considered upper bound.

And also, the wall will be designed to the passive pressure capacities, and that is conservative.

Okay. But there is an open item because they haven't finished the design yet. for all the structures, for the NI and the non-NI Cat. I structures. So, in terms of bearing pressures and the pressures on the wall, they haven't finalized that yet. The design has yet to be completed.

CHAIR POWERS: I am intrigued by your nomenclature, Boussinesq effects.

(Laughter.)

That is because your loads are on the edges in the oil cans in between? Is that what you are talking about there?

MR. XU: Yes.

CHAIR POWERS: So, you get a little more deflection in the middle?

MR. XU: Right. Yes.

CHAIR POWERS: Once again, I come back to floating nuclear power plants.

(Laughter.)

Has anybody ever thought of that before?

MR. XU: That's my last slide.

CHAIR POWERS: I understand, by the way, that the Russians are trying that again.

Are there any more questions on this subject?

(No response.)

Well, again, for the record, that was an extraordinarily informative presentation and very helpful. Very helpful, indeed.

Okay. We are coming to the end of the day's session.

MEMBER STETKAR: Dr. Powers?

CHAIR POWERS: Yes, sir?

MEMBER STETKAR: I have questions on other parts of Chapter 3 that weren't covered.

CHAIR POWERS: Tomorrow morning we will go over --

MEMBER STETKAR: But, in terms of the staff making sure they have the correct subject matter experts here, I thought it might be useful --

CHAIR POWERS: That would be very useful.

MEMBER STETKAR: -- to quickly do that. Otherwise, we are going to address them Thursday morning.

CHAIR POWERS: No, you are quite correct, it would be very useful right now --

MEMBER STETKAR: Thank you.

CHAIR POWERS: -- to expand extensively on that.

MEMBER STETKAR: Just to make sure Getachew knows the right people.

Dick and I brought up one already that I think you have, this notion of classification of SSCs according to safety-related, important-to-safety, risk-significant, whatever that issue is, that one open item, and how that relates differently perhaps to seismic classification versus analyses that are performed for protection against flooding or wind or other sources of damage.

The one that I brought up earlier this morning related to straightline wind loading and the basis for acceptance of a 100-year return interval for straightline wind loading versus what the Reg Guide seems to say is 10-to-the-minus-7 criterion. So, whoever it the wind-loading people would be good for that one.

Bear with me until I find the rest of my notes here.

External flooding, questions about margins to probable maximum flood level and what a probable maximum flood might mean; in particular, what the exceedance frequency of a probable maximum flood might be. So, whoever your external flooding folks are.

Turbine missiles, the question that I raised with the applicant regarding why this is concluded to be a favorably-oriented plant.

And then, the one minor one that I brought up regarding in-service testing of main steam isolation valves, the conclusion that it isn't necessary to check leakage in the reverse direction, because that was a response to an RAI. I guess I don't understand the conclusion on that.

I think that is all the major ones that I have. Okay. Thanks.

CHAIR POWERS: Any other questions that we should pass on to the staff?

MR. TESFAYE: I have a question for clarification on Question No. 2 on straightline wind-loading, the 100 --

MEMBER STETKAR: Yes. I don't know if you were here this morning, but let me see if I can clarify.

MR. MIERNICKI: Which section of the SER was that in?

MEMBER STETKAR: Oh, it is SER 3.3.1.4.1, is sort of the general section, but it is 3.3.1.

And the question is that Reg Guide 1.221 for design basis hurricane wind speed cites a return -- it actually cites what is called an exceedance frequency. So, let's talk about exceedance frequency of 10 to the minus 7 events per year, which is consistent with the exceedance frequence for design basis tornadoes. In fact, the applicant has based their tornado wind-loading on a 10-to-the-minus-7 exceedance frequency or once in 10-million-year recurrence interval, if you want to think of it that way.

However, the design basis straightline wind-loading, which is based on a 3-second gust from a straightline wind, the design basis for this design is derived from an ASCE SEI standard, which basically takes a 50-year recurrence interval, multiplies it by a factor, and says, well, that is equivalent to a 100-year recurrence interval.

And the concern is, why are we using a 100-year recurrence interval for the design basis? And I have seen arguments made, well, that is a rare event. Well, if the plant operates for 60 years, if it is a once-in-a-hundred-year event, there is a 60 percent probability that we are going to exceed that design basis, which to me is not a rare event. It is sort of a countable event.

So, that is sort of the notion of that line of questioning --

MR. TESFAYE: No, I got it.

MEMBER STETKAR: -- of, are we being consistent here in establishing the straightline wind-loading for this design versus tornado or other parts of the guidance?

MR. TESFAYE: Thank you.

MR. MIERNICKI: No other questions? Okay. We will try to bring those back first thing in the morning then, if I can track down the staff.

MEMBER STETKAR: I just wanted to make sure you had, because you need to go see if you have the right people here, or whether they are even physically here.

CHAIR POWERS: Well, that brings the session for today to a close. I thank everyone for extraordinarily good presentations. It kept us right on the edge of our chairs throughout. Most interesting and quite enjoyable, actually.

With that, we will recess until tomorrow.

I will remind you that our Thursday agenda is a bit disrupted because the members of the

Subcommittee have a briefing to attend with the Commission, which somehow outranks us. I don't understand quite why.

(Laughter.)

MR. TESFAYE: Actually, we are ahead of time. We have completed a day-and-a-half worth of presentation.

CHAIR POWERS: Yes. I don't think we are tight, by any means on this.

MR. TESFAYE: Yes, yes.

CHAIR POWERS: And that is a bit by design, thanks to Ms. Weaver's excellent guidance and suggestions. We would be rudderless without her.

So, we will see you all tomorrow morning bright and early and chipper and bright-eyed and bushy-tailed.

(Whereupon, the above-entitled matter went off the record at 3:52 p.m.)

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
U.S. EPR Subcommittee

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Wednesday, February 22, 2012

Work Order No.: NRC-1468 Pages 1-242

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

U.S. EPR SUBCOMMITTEE

+ + + + +

WEDNESDAY

FEBRUARY 22, 2012

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ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Dana A. Powers, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

DANA A. POWERS, Chairman

CHARLES H. BROWN, JR., Member

MICHAEL T. RYAN, Member

STEPHEN P. SCHULTZ, Member

JOHN STETKAR, Member

GORDON R. SKILLMAN, Member

NRC STAFF PRESENT:

KATHY WEAVER, Designated Federal Official
JILL CAVERLY, NRO
GORDON CURRAN, NRO
GREG HACKETT, NRO
BRAD HARVEY, NRO
PETER HEARN, NRO
RAUL HERNANDEZ, NRO
JOHN HONCHARIK, NRO
JASON HUANG, NRO
PETER KANG, NRO
MICHAEL MIERNICKI, NRO
AMRIT PATEL, NRO
HAHN PHAN, NRO
THOMAS SCARBROUGH, NRO
JOHN SEGALA, NRO
GETACHEW TESFAYE, NRO

ALSO PRESENT:

GREG BANKEN, AREVA NP
BILL BRACEY, AREVA NP/Transnuclear
DAVID FOSTER, NUMARC
DARRELL GARDNER, AREVA NP
GEORGE IFEBUZO, AREVA NP
MIGUEL MANRIQUE, AREVA NP/Transnuclear

IAN McINNES, AREVA NP/Transnuclear

BRIAN McINTYRE, AREVA NP

PRAKASH NARAYANAN, AREVA NP/Transnuclear

DENNIS NEWTON, AREVA NP

TODD OSWALD, AREVA NP

NITIN PANDYA, AREVA NP

TIM STACK, AREVA NP

PAVAN THALLAPRAGADA, AREVA NP

DENNIS WILLIFORD, AREVA NP

C-O-N-T-E-N-T-S

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

8:30 a.m.

CHAIR POWERS: The meeting will now come to order. This is the second day of our meeting of the Advisory Committee on Reactor Safeguards U.S. EPR Subcommittee. I'm Dana Powers, chairman of the subcommittee.

ACRS members in attendance are Steve Schultz. Welcome Steve. This is your first EPR meeting.

MEMBER SCHULTZ: This is my first.

CHAIR POWERS: Well, we have an excellent group of presenters here and a more than adequate subcommittee so you'll enjoy yourself. I guarantee it. Dick Skillman, John Stetkar, Mike Ryan, Kathy Weaver.

Of the ACRS staff and still a designated official for the meeting and Charles Brown is here, even if he is neglected in my opening statement.

MS. WEAVER: Sorry I neglected you, Charlie.

MEMBER BROWN: Just transparency, that's all it is.

CHAIR POWERS: That's right. It's one of those digital things, it's on or off with things like that.

MEMBER BROWN: Nobody sees us electric --

CHAIR POWERS: That's right. All of the constraints I talked about yesterday still apply -- you were Kathy. We do encourage participation in the meeting, both from the presenters and those in the audience that have something to contribute.

However, you are required to identify yourself and speak with sufficient clarity and volume so that you may be readily heard. We request that participants on the bridge line also identify themselves when they speak, and keep their telephone on mute during times when they are just listening.

Portions of this meeting may need to be closed to the public in order to protect proprietary interests.

I will ask the staff and the applicant to be careful to identify when they need to close the meetings because I will not know, so you need to alert me to that fact. And we will verify that only people with required clearance and the need to know are present.

Today we will continue where we left off our discussions yesterday and that's with the latter portions of Chapter 3, where the committee had some questions that need to be addressed. And so I will call on Getachew Tesfaye to begin the meeting.

MR. TESFAYE: Thank you, Mr. Chairman. Like indicated yesterday, we had provided the background information on EPR Design Certification Phase 3 activities.

Yesterday we finished the formal presentation of Chapter 3. And today we will start with the staff responding to the five questions that was asked at the end of the presentation, Mr. Stetkar. And then we proceed with Chapter 9 presentation this morning.

CHAIR POWERS: Okay. We're going to go with you guys first on 9?

MR. TESFAYE: We're going to go first and then AREVA may want the opportunity to address some of the questions after us on Chapter 3. And then we start with AREVA's Chapter 9 presentation.

CHAIR POWERS: Okay. Yes, we're going to have several questions but let's go ahead and get started.

MR. TESFAYE: Okay, Mike?

MR. MIERNICKI: Okay. This is Mike Miernicki on the Chapter PM for Chapter 3. As Getachew said, we're going to start with responses to some of the questions that the ACRS had yesterday, five questions particularly. And we're going to try to take them in order so staff can go to other meetings that they have scheduled.

CHAIR POWERS: What, you mean they would prefer to be someplace else?

MR. MIERNICKI: They actually have some other meetings.

CHAIR POWERS: But they could be here with us.

MR. MIERNICKI: Well, they may come back after their other meetings.

CHAIR POWERS: Oh, I see, grab their coffee and come in here.

MR. MIERNICKI: Yes. Okay, the first one we're going to start with, which is a question Mr. Stetkar had, which was related to the design basis wind loading for the EPR and what was described in the SER. We have Grant Harvey to discuss that. That question had to do with design loading and probabilities of light. So, Brad?

MR. HARVEY: Okay, yes, my name is Brad Harvey. I'm from the hydrology and meteorological branch with the new Office of New Reactors. And I have handouts -- can we work off of this?

CHAIR POWERS: Yes, we can do that.

MR. HARVEY: I apologize. I don't think I have enough to go around for everyone in the audience. This came up as a little short notice. I'll wait for the committee members to get their copies.

CHAIR POWERS: That's okay, just charge right ahead.

MR. HARVEY: Okay. What I'm giving you is a handout from a presentation that was made last August to ACRS Subcommittee meeting on regulatory policy and practices, was in the August time frame and had to do with the subcommittee review of a new Reg Guide 1.221 on design basis hurricane and hurricane missiles.

And what I'm trying to show here on this slide is that there are basically two design points when it comes to wind loading, a severe environmental load, and the extreme environmental load.

And these definitions are from ACI, American Concrete Institute Standard 349-97, which has been endorsed by Reg Guide 1.142 which describes the accepted methods for design and safety made of concrete structures.

And basically there are two wind design points. One is the severe environmental load, sometimes called the operating basis wind, which is a 100-year return period or 10^{-2} per year return frequency.

The other one is called an extreme environmental load, otherwise sometimes known as the design basis tornado, and that's been defined in Reg Guide 1.76 as a 10^{-7} per year probability.

So we've got two design basis wind loads and basically they're used in different load combination and load factors when you're evaluating the capacity of the SSCs to survive severe winds.

If you look at the operating basis wind, you'll see a combination of different load factors, dead loads, live loads, fluid loads, soil loads. But you also see that there's a 1.7 times wind load. So there's a load factor, 1.7.

You can look at it again, the definition of a severe environmental load from the ACI standard, it's an environmental load that could infrequently be encountered during the plant life. So it is a load that you can, on occasion, expect to be exceeding.

As opposed to an extreme environmental load that is considered credible but highly improbable. So that is a load that you generally would not expect the plant to experience.

So you see for these three environmental loads, the W term there in the last column has got a load factor of 1.7. But if you go down to the extreme environmental load, you have basically somewhat the same combination of loads being considered simultaneously, but without any load factors in front of them.

Now this column on the right is not necessarily what the EPR is designed to. But it is what's load combination, load factors that are from the ACI standard.

So the operating basis for wind load, I understand is 145 miles an hour for the EPR, which is basically a Category 3 storm, if you look at the ASCE standard. And the 10^{-7} per year wind speed with tornadoes is 230 miles an hour.

MEMBER STETKAR: I'm not a structural engineer by any way, shape or form, you said that the EPR is not necessarily designed to the wind loading combinations in that right hand column, is that --

MR. HARVEY: Yes, that was --

MEMBER STETKAR: Do you know, do they apply these factors?

MR. HARVEY: I'll have to leave that to my Chapter 3 cohorts.

MEMBER STETKAR: I mean my question was, since I don't have a sense of how these load factors apply in practice, if they were designed to this, I was going to ask what would the equivalent wind speed be if the factor, including the factor.

In other words, how does that 145 mile per hour wind scale-up, accounting for the 1.7 load factor? It's the square of the speed.

MR. HARVEY: Yes, mathematically.

MEMBER STETKAR: And this were, so I didn't do that so I don't know what --

MR. HARVEY: I confess, I haven't done that before but --

MEMBER STETKAR: Not a lot. It sounds like it would be about 155 or 60, I assume.

MR. HARVEY: No, I think it would be higher than that.

MEMBER STETKAR: Would it be higher?

MR. HARVEY: I think it would be higher than that.

MEMBER STETKAR: I didn't know. I didn't do the math. But if they didn't design it to this then I'm not sure what --

MR. HARVEY: Well, I think it's also designed to an extreme environmental role.

MEMBER STETKAR: It is, but only a certain set of buildings. That's my concern, is the rest of the buildings, is my understanding, the design to the, let's call it the 145 with something wind right now. And since I don't know where every piece of equipment and electrical cable is routed in the power plant.

My concern was what margins do we have for damage to structures that may not contain "safety-related" equipment and cables, that may contain equipment and cables that could be important to risk, just because I don't know where they are.

So I'm interested in what sort of margin do we have given that 145 mile per hour starting point, if you want to call it that, with a nominal 100-year return period. And that all goes into what factors they've applied on the loading and how the analysis was actually done.

MR. HARVEY: Yes, I'm going to pretend there's a Chapter 3 so I don't pretend to know that for sure. But I do know for the design basis tornado, you are taking into consideration structures by that.

MEMBER STETKAR: They did and then they took into considerations the impacts, but only from the perspective of protecting the Class 1 structures, not for essentially pardoning the non-Class 1 structures.

MR. HARVEY: Right. I do not have an answer for you. That's not really in my --

MEMBER STETKAR: But this helps at least to give some confidence that there are margins for that, as you characterized, an operating basis load, so that even if it does have a once in 100-year reference period. Or it, as I had mentioned yesterday, that translates into a 60 percent probability of exceeding that wind over a nominal 60 or lifetime of the plant.

Even with that there's still some margin. Now it's a matter of understanding in their design what that margin is and how does it translate into an expected reference interval, expected concedence frequency.

CHAIR POWERS: Well, I find this exceptionally confusing. This just has not helped me at all. I must be missing something. For the operating basis, we put a lot of factors in front of a bunch of terms, which presumably give us margin. And for the design basis, we don't.

Some of those terms, I presume are constants. Dead loads, I presume don't change and whatnot. But then some of them do. And we introduce a new factor into the design basis, a T naught factor and we replace W with W sub t.

And when I go to the next page, I learn that WT equals W sub p, except when it doesn't. WT then equals W sub w, plus a half of W sub p plus W sub m, which suggests to me that W sub w plus W sub m equals one-half W sub p, which makes no sense when I look at the definition.

I can't imagine that there's any relationship between the two. So could you help me understand what I'm looking at here? What is the wind load associated with the design basis tornado?

MR. HARVEY: The second page here shows you, you're looking at, I believe both the two equation shown as taking the more severe of the two. Or making sure you can withstand both. So the first one, WT equals WP is a change in pressure associated with a tornado passage.

CHAIR POWERS: Yes, that's what it says.

MR. HARVEY: Okay, so we've got certain rooms that if they're not designed to be vented, to reduce the difference in pressure between the atmosphere and the room, then they should be able to withstand that pressure change.

CHAIR POWERS: Okay. I believe that.

What is the wind pressure difference for 10^{-7} tornado, and how would one ever determine that?

MR. HARVEY: It's a site parameter.

CHAIR POWERS: How could anybody possibly determine a 10^{-7} tornado?

MR. HARVEY: Well, we have a Reg Guide on that and the NUREG looking at a statistical --

CHAIR POWERS: I'm sure you do. I'm still wondering how could one possibly determine, it's three orders of magnitude extrapolation from any database you could possibly have.

MR. HARVEY: The way that it's done is it's two-fold. Number one, we looked at the probability of a strike at any given structure facility point, typically that may be, you look at it for a given year, the area was covered by tornado strikes, dividing by the size of the area of concern.

And typically that's maybe 10^{-4} per year probability, typically throughout the United States, certain areas are higher. And then once you have that tornado strike, then you look at the 10^{-30} wind speed that would have occurred.

And you see a combination of the two, is how you come to the 10^{-7}. So there is a database of 50, 60, 1,000 tornadoes that have occurred since 1950 through 2004 or '05, which was used in the NUREG to come up with the statistics for that wind speed.

MEMBER STETKAR: The ten to the minus, you can actually compute 10^{-7}, according to the NUREG, which it basically overlays geometries, 10^{-7} strike probabilities for high winds, depending on how you do the math, whether you use exceedance curves or things like that from 50 years worth of data, even within a reasonable area. That's possible to do.

It's not possible to do for some sites in more tornado-prone areas. It's a little more difficult. It's really difficult to compute 10^{-7} straight line wind exceedance frequencies. That's much, much, much, much, much more different, difficult.

And that's some of the reason for my concern about, because you do apply in the NUREG Guide, you know, a 10^{-7} hurricane wind exceedance frequency, we had some discussions regarding that with the Reg Guide.

The fundamental problem is that a 10^{-7}-type screening criteria is applied for a lot of things, not every external hazard these days.

And when you see exceedance frequencies on the order of once in 100 years, which is substantially above that 10^{-7} threshold, then you start to think about what could be damaged by those winds. And what kind of margin do you have for that damage.

And you either get the square root of 1.7, it comes out to 189 miles per hour, which is a pretty substantial wind. But I'm not a structural engineer and I don't know what they did.

At least from my perspective it helped me understand a little bit more about the types of margins that may be put into the design for these operating basis means, that's helped a bit. I'd like to understand a little bit better what EPR did with their design. And I think perhaps somebody, who had somebody standing up there who might help with that.

MR. OSWALD: Good morning, this is Todd Oswald from AREVA. We do use the ACI 349 load combinations. I thought I heard some discussion that we may not be using them.

MR. HARVEY: I don't know what you used or didn't use.

MR. OSWALD: Okay, right. I just want to make it clear that we are using the ACI 349 load combinations and we do apply the load factors in concrete design.

MEMBER STETKAR: Todd, could you back out for me because as I said, I'm not a structural engineer. Without the load factors, what is the equivalent wind speed that those buildings were designed to? In other words, if there weren't the load factors applied?

MR. OSWALD: Well, in the operating basis, it is that 145 mile an hour wind. And then we add the load factor, the 1.7.

MEMBER STETKAR: But the 1.7 is not a direct scale on the wind speed is it?

MR. OSWALD: No. It's on the pressures.

MEMBER STETKAR: It's on the pressures. So just for my help, if you didn't -- how to explain this -- what is the equivalent wind speed for your design if you didn't have the load factors applied? Follow what I'm asking? In other words, if the equation had no load factors applied, you have a design?

MR. OSWALD: Correct.

MEMBER STETKAR: I mean you have the design that's based on those load factors. Can you back out the equivalent wind speed for that design, just the basic wind load?

MR. OSWALD: Yes, but the wind loading is a function of the square. The velocity, I could probably work backwards and --

MEMBER STETKAR: That's what --

MR. OSWALD: But the basic wind speed is 145 and then we use the 1.7 on top of that. So I could go back and work for a few minutes and come up with a --

MEMBER STETKAR: Yes, that's what I'm asking. If you could do that, that would help a little bit because it would --

MALE PARTICIPANT: Use .15 also.

MEMBER STETKAR: That's why I'm asking and I don't know which loading is the driving force. So if you could kind of go back through your calculations and back out an equivalent, just direct wind speed load.

MR. OSWALD: Okay.

MEMBER STETKAR: That would help me, at least, understand a little bit of the design margin above this 145 mile per hour wind speed, which is a, you know, a calculated one in a 100-year return period. And if there's quite a bit margin, that'll help me at least understand, in regard to the design.

MR. OSWALD: Right.

MEMBER STETKAR: Again, if you can't do it today, fine.

MR. OSWALD: Right, I understand.

MEMBER STETKAR: We're here tomorrow morning, if you can't do it by tomorrow morning, I'll defer to Dr. Powers here as the Subcommittee chairman, that we can revisit it at another meeting.

MR. OSWALD: Okay, all right.

MEMBER STETKAR: Thanks. Is that okay, Dan?

CHAIR POWERS: Yes, and then you can explain to me what in the world is going on here. This is basically opaque to me. Please continue.

MEMBER STETKAR: At least we're not talking about floods.

CHAIR POWERS: Oh, you say floods are more difficult? I want to float this nuclear plant.

MEMBER SCHULTZ: But Brad, on Page 2 of the presentation you mentioned that the combined tornado load, a factor --

MEMBER STETKAR: Brad, just be careful that you're --

MEMBER SCHULTZ: -- are governed by the two equations. And the approach would be to take the maximum --

MR. HARVEY: Yes, make sure, yes.

MEMBER SCHULTZ: -- for the total tornado load, which it generally governs, of those two equations?

MR. HARVEY: I would suspect the second but I don't know for sure. I would have to ask the structural people if they can give a more definitive answer.

MEMBER STETKAR: The key here, Steve, you weren't here yesterday, I don't want to prejudice anything, but I understand what they do with a Class 1 and the design of those are always dominant. I'm not sure which of the two equations are dominant or control the loading. But they're determined by the tornado wind loading which is 230 miles per hour and that's a really good tornado.

MEMBER SCHULTZ: That's the first consideration in --

MEMBER STETKAR: So in terms of the certified design bounding sites in the U.S., but tornado loading, which always dominates straight line wind loading on Category I structures, you're okay.

The problem is there aren't a lot of Category I structures. There's a lot of non-Category I structures that make the auxiliary building, that waste building which is from a real safety perspective, probably isn't all that important, turbine building, don't know what's in the switchgear building, stuff like that.

MEMBER SCHULTZ: I understand what you're looking for.

MEMBER STETKAR: And there I'm not sure where we'll have the margins because they don't have to account for the tornado wind loadings on those, except for structure interactions, but those are fairly easy to demonstrate, not claim to damage the Category I.

DR. FOSTER: You are designing --

MEMBER STETKAR: If you have something, you actually have to go on the record here.

DR. FOSTER: David Foster, consultant to the NRC. In the FSAR, AREVA has committed to design the NAB for the full tornado load.

And the access building, turbine building, it's a conceptual commitment in the FSAR, that they also will be designed for the full tornado load. But the COLA has to confirm that the access building and turbine building will not interact, either under seismic or tornado loads that the seismic Category I structure.

MEMBER STETKAR: But from what I, in fact, I asked earlier about that yesterday. And my understanding is those structures are designed -- AREVA will have to help me here -- are designed for the tornado load only to the extent that tornado loading will not cause structure/structure interactions.

So for example, if the NAB, let's pick an example, in fact, in the FSAR, they also had the turbine building in there. If the NAB is hit with a 230 mile per hour tornado, will the NAB survive?

DR. FOSTER: You are correct. The NAB has two requirements in the FSAR. One is that it will have the equivalent, I don't know if I've got the words exactly correct, but equivalent factor safety or designed to the same standards as a seismic Category I structure for a tornado. So for a tornado load, it has to be designed to take the full tornado load.

Secondly, AREVA said there could be either sliding or uplift, and for that they have to verify that there will be no interaction with a seismic Category I structure.

So first, for structural integrity it has to be designed for the full tornado load. And secondly, they have to verify that there's no interaction, due to the tornado wind on the NAB that would cause an interaction with a seismic Category I structure.

MEMBER STETKAR: Is that also true of the turbine building?

DR. FOSTER: For the turbine building and access building, as far as design requirements go, the conceptual information in the FSAR, is that they will be designed as if they were seismic Category I structures for tornado load.

MEMBER STETKAR: Yes, see I excerpted a response to an RAI that basically says that.

DR. FOSTER: Yes.

MEMBER STETKAR: You know, July 29, 2010 response to RAI 384, question 030302-5, the applicant stated that the NAB, nuclear auxiliary building, ACB, access building and TB, turbine building would be analyzed and designed using Reg Guide 1.76, tornado wind characteristics. And would be designed to the codes and standards associated with seismic Category I structures, so that the margin of safety is equivalent to that of a seismic Category I structure.

And I was pretty happy with that except that I asked AREVA about this yesterday and perhaps I misinterpreted it, but I thought that they said that that's only for building/building interactions.

Well, let me just ask, is your turbine

building designed to withstand a 230 mile per hour tornado wind loading without structural damage?

MR. OSWALD: This is Tom Oswald with AREVA. Let me clarify yesterday, the structural design is per the Nuclear Safety Codes, and load combinations, and the design loading values.

We do that because of the potential for structural interaction. I think where the confusion is coming in, yesterday we were talking about the nuclear auxiliary building and the components in there would be designed per Reg Guide 1.143.

So all of the items that are rad waste, you know, contain rad waste material would meet the requirements of Reg Guide 1.143, which is essentially one-half the SSE. But because of structural interaction, the structural design will be per ACI 349, AISC N690, and all the associated load combinations.

So that's the only way we can show the, right now, the same margin of safety, is to go with the Nuclear Safety Codes.

MEMBER STETKAR: I'm sorry. I'm not a structural engineer --

MR. HARVEY: Can I, is it okay if I leave?

MEMBER STETKAR: Yes, and thanks a lot.

I'm neither a structural engineer nor an attorney. So I'm mostly interested in, if by hit, the nuclear auxiliary building, since you want to focus on that first, with a 230 mile per hour tornado, will that building have any structural damage?

MR. OSWALD: No. Todd Oswald, it will be an elastic response --

MEMBER STETKAR: Thank you.

MR. OSWALD: -- for the nuclear case.

MEMBER STETKAR: That's good. How about the turbine building?

MR. OSWALD: It will also be an elastic response for the Nuclear Safety related codes. It will not be damaged.

MEMBER STETKAR: Okay, thanks. Thank you. That helps. If you can back out those equivalent wind loads, I'd appreciate it, the equivalent wind speed. But that helps a lot. I'm sorry, Dan.

CHAIR POWERS: That's fine.

MEMBER STETKAR: I'm being dense.

CHAIR POWERS: You're dense? I don't understand it at all. It helped you. It just confused me. Well, the last statement --

MEMBER STETKAR: Oh, that's right.

CHAIR POWERS: The statements are

confidence builders at least.

MEMBER STETKAR: That's right. I get to write the letter, don't I?

CHAIR POWERS: Yes you do. Please continue.

MR. MIERNICKI: Okay. The second question we'd like to address was the external flooding question, the margin to the probable maximum flood level and how that is used by the staff. And with me here we have Greg Hackett and Jill Caverly to address that question.

MR. HACKETT: Greg Hackett, again. The chief of the hydrology and meteorology branch. I'm not really sure who asked the question, but if you could clarify for me the specifics of your concern, maybe it will help me respond in a more appropriate way?

MEMBER STETKAR: Yes, what I'm trying to understand is margins and how we understand those margins, kind of in the context of the same discussion we just had on winds.

We design plants based on probabilistic seismic hazard curves, based on a certain ground acceleration at a certain annual frequency, or exceedance frequency. We have criteria for tornado wind loads that are based on a 10^{-7} recurrence interval for a tornado of a certain severity.

We design plants according to straight line wind loading, which was the discussion we were just having about a nominal 100-year recurrence interval with some margins applied.

For external flooding, all I know is that the elevation of something called a probable maximum flood is one foot below finished grade. And we had some discussion yesterday about finished grade versus thresholds. But there's some margin there.

The question is what is the frequency of the probable maximum flood? Is it a once in ten-year event? Is it a once in a 100-year event? Is it a once in 10,000-year event, a once in 10 million-year event? What is it?

MS. CAVERLY: Well, although it starts with probable in the title -- Jill Caverly, I'm hydrologist in Greg's branch, Jill Caverly, C-A-V-E-R-L-Y.

It's a deterministic approach. And it's based on a method that was developed by a group of federal agencies in the 1970s. They were updated in the 1970s, but it's been an ongoing approach.

It's endorsed by the Army Corps of

Engineers and the NOAA. And it's an approach to develop a deterministic maximum flood based on hydrometeorological parameters.

So it would be, you know, the amount of moisture in a water column in a given area. And it's also based on historical events. So all of this information together provides us with a value of a rainfall curve. And using that, we developed what we think is the largest event possible in a given geographic area. So there's not a probability associated with it.

That's in part because probability in the meteorological sense, there's not a lot of data to support a probabilistic approach in developing a storm of that magnitude right now. There are agencies that are trying to go that direction, but we just don't have that sort of information.

MEMBER STETKAR: I submit that we do it quite extensively in the seismic area.

MS. CAVERLY: Yes.

MR. HACKETT: We understand that but we do it deterministically.

MEMBER STETKAR: Okay, that helps a little bit. And I understand, at least for the design certification, that it in some sense is an interesting question at this stage of the game.

Because the design certification simply sets a level. It's up to the COL applicant to justify that the site-specific meteorology, and hydrology, and dam failures, and whatever else can cause an external flood will not produce an elevation above that level.

I'm just trying to understand, from a certified design perspective, what fraction of the sites in the United States might be prone to floods that could exceed this level. Follow me? If it's something like 50 percent of the sites, which I doubt --

MS. CAVERLY: Well, let me just clarify --

MEMBER STETKAR: -- then there would be a question about have they specified that margin appropriately in the certification process.

MS. CAVERLY: And I should clarify, when I was speaking before, I was talking about a probable maximum precipitation approach. And so that would be the rainfall that input into a system.

Then you have to translate that rainfall into a flood. So then there's a hydraulic modeling approach that you would look at to develop an elevation of a flood.

And presumably this is the most extreme

event that we will see at a site, which is the PMP, would translate it using very conservative parameters. The PMF flood is the most extreme flood that we will see at a given site, at a location that we're analyzing.

MEMBER STETKAR: Since it's only precipitation, doesn't it account for dam failures or dam over the top, and the event kind of stuff? Would we consider it --

MR. HACKETT: We're starting to get down a different line of questioning. But at the end of the day we look at all "flood causing mechanisms." So it is precipitation, dam failure, you know, a dam failure coincident with a seismic event, the PMF. And through that process, tried to establish the design basis flood for the site and end site, and then correlating that back to the design certification.

We don't do an extensive review at the design cert phase with respect to, the safety philosophy is to evaluate where protection is going to be provided for systems, structures, components according to safety.

And then take that parameter, if you will, and see if that parameter envelopes any site characteristic that then is established through the analysis in that particular site, in that particular watershed. And, of course, they're all different.

And if, in fact, the site is not dry necessarily, right, then flood protection measures, at some acceptable level, would have to be provided. And that's from a design philosophy, from a safety philosophy, right.

Whether it's above that one foot elevation or below it, if it's above it, you still have to provide some protection. And that doesn't mean that if the designer comes in and says the PMF would be one foot below site plant grade, it doesn't mean that the SSCs are one foot above. They could be higher.

At the end of the day we still have to go through the assessment and say given all that we know, and if you would go back and look at some of the, they call them the HMRs, you go back and get the reports.

As the years have gone by, since the beginning of the evolution of life and plants, that data information has become more robust. It's updated and then you can take that information and apply it.

And as you'll see in the coming years, months, that information is going to be applied to the 2.1 recommendations under the Fukushima stuff. Because we have now newer information and we have more, better techniques than we had when we first started doing these analyses.

MEMBER STETKAR: Yes, that helps. And then I realize, as I said, that some of this discussion, obviously is more pertinent to the COL because it is a very, very site-specific issue.

For the purposes of the design certification, I was only trying to understand a bit of the notion of, is there a frequency sense to the probable maximum flood? And what sort of margin do we have in the certified design, on sort of a frequency of exceedance notion?

In the same way that we think of the certified design of margins for frequency of exceedance, applied tornadoes, straight line winds, seismic events and so forth. It's sort of a different --

MR. HACKETT: Even at this stage of this particular design review, and I haven't looked at it in great detail, as that design continues to evolve, trying to understand where the SSCs are going to be located.

If you don't know where they're all located right now, conceptually, because I don't think design is 100 percent, that margin that you're asking for is also involved at some level.

But again, it becomes very critical at the COL stage to understand how you would decide it. And if you look at various applicants, they can make changes to those designs, ever so slightly, or in a nuance sense.

It changes what those elevations are. So even in that sense, right, you'll see a change in how the design and licensing basis is applied for a particular applicant at any particular site.

MEMBER STETKAR: Okay, thanks. That helps.

CHAIR POWERS: We also have to get to that other meeting. Aapparently it has something to do with external events.

MR. MIERNICKI: Thank you very much. Okay, next question I wanted to address is the one with respect to 2513, with respect to the turbine orientation of relative, the EPR turbine orientation relative to the central servicewater buildings. And to address that, we have John Honcharik from the component integrity branch.

MR. HONCHARIK: Good morning. My name is John Honcharik and I guess, as Mike said, if two out of the four emergency servicewater buildings are in the load trajectory path of the turbine building, and basically the question is how could that be, I guess considered, maybe for orientation. That's a very good question. I also asked --

MEMBER STETKAR: One for three is not bad.

MR. HONCHARIK: I also asked that question in RAI and the, basically even though those two are in the load trajectory path, they're two that are not. And each of those two are sufficient to have a safe shutdown of the reactor.

MEMBER STETKAR: John, let me interrupt because I read that in the SER. It's my understanding, we've had some discussions about this with the applicant. This plant is actually, from a design basis perspective, four 50 percent capacity trains. So a single train doesn't have adequate capacity to shut down the plant, you need two.

In fact, the PRA has identified, not only that it's based on two, and it has identified some subtle asymmetries because of requirements to cross-connect, at least electric power supplies, and I can't remember whether it's cooling or ventilation.

I think it's chilled water supplies, that not all four divisions are actually equal. Some combinations of divisions are more important from risk. So the statement in the SER that any one train can safely shut down the plant seems at odds with the safety analysis and, in fact, with the PRA, which gave me some pause to thought.

MR. HONCHARIK: Okay, yes that's something new, because basically that was AREVA's response and they even sent me to the chapter in the EPR, their safety evaluation, safety analysis report, where basically it said that redundant safety systems, one of each safeguard will physically separate into four divisions, okay. And they go on.

MEMBER STETKAR: That's true.

MR. HONCHARIK: And then say with four safety divisions, one division can be out of service for maintenance. And one division can fail to operate, while the other two remaining divisions are available to perform the necessary safety function, even if one of the two remaining becomes inoperable during an initiating event. So based on that, that's what I was basing it on. So if what you say is different --

MEMBER STETKAR: Tim, can you help?

MR. STACK: Yes I can. Tim Stack from AREVA. A few things on this event in particular. In general, it takes two safety safeguards trains to achieve cold shutdown.

When we look at these events and you look at the turbine missile trajectory issues, basically the initiating event is going to be a turbine generator trip. When we look at it, it will not generate a LOCA. It will not generate a feed bind --

MEMBER STETKAR: I'm sorry. It looks like a really big steam line break outside containment. It's not a turbine trip.

MR. STACK: And it will be --

MEMBER STETKAR: Turbine didn't trip.

MR. STACK: And it will be isolated though by the MSIV closure --

MEMBER STETKAR: If they close.

MR. STACK: If they close, that's correct. When we sit and we look at the event though, to keep the plant hot and stable, we really only require one division to keep the plant hot and stable. One of the four to keep the plant hot and stable. To take it cold, you require two.

MEMBER STETKAR: Okay, that helps a little bit. However, I come back to the notion that the guidelines in Reg Guide 1.115 -- if I'm in the right, yes, I'm in the right Reg Guide -- are basically screening criteria.

They're screening criteria that are applied on frequencies that have been concluded through some sort of process as providing an adequate margin of safety, without the need to do a detailed analysis of the actual, the real turbine missile ejection, the real probability of striking a particular target, the real damage to the target.

And in a risk assessment sequence, an evolution-type process, the sequences could evolve out of each of those possible damage scenarios.

Essentially it's a way to say that if you have a favorably oriented turbine, meaning according to the Reg Guide, the missile is ejected out of the appropriate angles, can not hit any safety-related equipment.

Then all you need to do is justify that your turbine is good enough to meet a 10^{-4} event per year missile ejection frequency, looking at events that could cause over speed, failure of the turbine stop valve controls, all that other kind of stuff, mechanical failures of the rotor, probabilistic fracture mechanics of the raw materials, and so forth that goes into those analyses.

If it's an unfavorable oriented turbine, and the Reg Guide's pretty clear, it says no essential equipment is within that foot path. Then you're allowed to show, or if it's -- I'm babbling too quickly -- if it's unfavorably oriented then you have to show a factor of ten better margin of safety on the ejection of those missiles.

You don't have to do anything else. You don't have to qualitatively justify what the scenarios might be or where you might need to go. It just says you need to justify 10^{-5}.

People have been doing this at numerous plants for many years. In my opinion, if you want to make arguments about the types of scenarios that can evolve from different damage conditions, the likelihoods of those scenarios, that's fine, that's a probabilistic analysis. You can do that. People have done that.

They typically don't do it qualitatively, with questions about what might be required out of how many divisions that maybe remain, but are undamaged by a particular missile strike.

And that's my whole question here is the Reg Guide, at least Rev 2 of the Reg Guide, because of this issue, is very explicit. It's say no safety-related equipment is within that foot print.

MR. HONCHARIK: But I think part of it was that, I think in the SRP there is a statement in there that says basically, that all or almost all, because I think they realize that if there are redundant systems, not all of them. As long as citizens are available for safe shutdown --

MEMBER STETKAR: I've got a plant that has two trains. Is one train almost all?

MR. HONCHARIK: Well, if it's --

MEMBER STETKAR: Three trains. Is one, South Texas that's three trains.

MR. HONCHARIK: But if it's capable of shutting down the reactor. And also, in Rev 2 of the Reg Guide, in the Appendix, you know, we do have in there what structures and components should be protected and part of it is systems, or portions of systems, considering a single failure that are required or obtained for safe shutdown.

MEMBER STETKAR: Yes, in fact, AREVA pointed me to the words in the Reg Guide this morning. I didn't look at the words in the Reg Guide, I tend to look at the, I'm sorry the SRP, which is not consistent with the Reg Guide.

MR. HONCHARIK: Well, I think the newer version is somewhat consistent.

MEMBER STETKAR: You know, somewhat? I'm

sorry.

MR. HONCHARIK: With that inclusion of the Appendix A, about the systems, considering a single failure, so I think that's trying to highlight that it's a single failure. So if you do have well, trains --

MR. GARDNER: John, this is Darrell Gardner. I just want to add from an AREVA perspective, that Reg Guide also talked about essential and I think that's the key word, is that those additional analysis you were speaking of were in the context of essential systems.

In our response to the SER and to the RAI was, is that only two of those were essential. The other two in the path were not essential under that guidance.

MEMBER STETKAR: Right. We'll have to, I think, Dan I'll defer to you here but I think from a subcommittee perspective, instead of taking up more time on this, I think we understand what was done.

We just have to decide what we recommend, we'll probably discuss this during the full committee, I would imagine. I don't know where you're at. I'm at a quandary here. I'm not personally inclined to imply that certified design has a problem with turbine missiles in terms of safety.

I am trying to imply the fact that they should not be given a pass at 10^{-4} turbine missile ejection frequency. Because my understanding of the Reg Guide is that they should satisfy a 10^{-5} turbine missile ejection frequency.

Or perform appropriate analyses to justify if their frequency is higher than 10^{-5}, why their damage to safety-related, essential, whatever words you want to use, which is another question we're going to be getting into here.

The combination of the missile ejection frequency, the strike probability, and the condition of the damage probability remains less than 10^{-7}. Those are analyses. If they can do those analyses to show that for all the missile ejection trajectories and possible strike targets, they still can satisfy the basic premise, that's fine.

MR. HONCHARIK: But I think --

MEMBER STETKAR: Or so that the turbine missile ejection frequency is less than 10^{-5} which some plants have to do.

MR. HONCHARIK: Right, but I think the basis premise was that you protect systems, structures, and components that are essential for safe shutdown.

So if you have other things that can make up for those systems, if you don't need for a safe shutdown, then even if they are in that path, it still would be considered favorable because the whole point of it, I think is to insure the safe shutdown.

MEMBER STETKAR: Usually essential servicewater and decent generators are pretty important to safe shutdown. Two of the diesel generator buildings, the corners of them are within the foot path also. Well, they're the ends of the buildings, I don't know what --

MR. HONCHARIK: Right, and those are the fuel tanks.

MEMBER STETKAR: Okay.

MR. HONCHARIK: But the other two aren't.

MEMBER STETKAR: That's right.

MR HONCHARIK: Yes.

MEMBER STETKAR: If this were the South Texas plant that has three trains and they had one train within the footprint and two other trains available, what turbine missile ejection frequency would be required?

MR. HONCHARIK: Well, I'm not sure what each train is capable --

MEMBER STETKAR: Because you need to do an assessment of the possible damage to see what the actual functional requirements are.

CHAIR POWERS: Okay, I think we understand where you stand on that. Let's move on.

MR. MIERNICKI: Okay, the next question for the staff to address was relative to the in-service testing of the MSIV. And there was a question regarding what the leakage criteria was, or back-leakage through the MSIV was considered. And for that, responding to that, we have Tom Scarbrough, also from the component integrity branch.

MR. SCARBROUGH: Good morning. This is discussed in Section 10.3 of EPR FSAR. And these valves are double-disk gate valves, these main steam isolation valves.

And by the requirements in the FSAR, they are required to be capable of closing against 1,320 psid in either direction. So they have that requirement as part of their design requirements.

And it also specifies that the valve supplier leak test these valves in both the forward and reverse flow directions. So they're required to do that with that pressure.

And then, as part of the periodic testing, they are listed in the IC table for a leakage testing on a two-year interval, right. And how they are described is, they actually pressurize the cavity between the disks.

And so they'll pressurize it and then they'll, what you can do is you can monitor the leakage and decay over time. So they're actually testing the seam and surfaces on both sides of the valve out. And so that's how they do that.

MEMBER STETKAR: Okay, thanks Tom. Because again, I was reading in the FSAR or I'm sorry, in the SER -- you may want to check, I don't know whether you did this or someone else.

In Section 3.9.6.4.2.2, there's a summary of an RAI response and what got my attention was it said the applicant indicated failure of the MSIVs to isolate the reverse flow direction does not result in or increase the severity of any credible event.

The applicant stated the MSIVs are not required to isolate in the reverse flow direction. And they are leak tested only in the forward flow direction. And that's what got my attention about this reverse flow.

Now from what you described, for the way they do the test and indeed, if that's the way they do the IST, indeed they are testing that valve in the reverse flow direction also, which is fine with me if that's what they're actually committing to. It's just a matter of straightening out the justification here in the SER.

MR. SCARBROUGH: Yes, we'll take a look at it --

MEMBER STETKAR: Revise it, why, what, their --

MR. SCARBROUGH: You want to give me the number again?

MEMBER STETKAR: Yes, it's 3.9.6.4.2.2, that's the SER section. And it refers to a response to RAI 49, question 03.09.06-5. So you can go look up the rest that are in there. Thanks, I'm good with that.

MR. SCARBROUGH: Okay. We'll fix that.

MEMBER STETKAR: If they actually do perform the test the way you described it --

MR. SCARBROUGH: But it's in the --

MEMBER STETKAR: It doesn't make any difference what the words say here. They're doing the test.

MR. SCARBROUGH: Right.

MEMBER STETKAR: Because it's clear that

they do need to isolate reverse flow for a blowdown event.

MR. SCARBROUGH: Yes and it's clear in the record, so I will check and make sure the language is correct.

MEMBER STETKAR: Thank you.

MR. MIERNICKI: Okay, and the last question that we have jogged down for the staff to address was related to how the non-safety-related components, that are risk significant, are dealt with and the guidance to applicants with respect to that whole general area.

And with that, I think we had Hahn Phan is going to address that -- yes, here he is. And Hahn Phan is with the POA branch.

MR. PHAN: Good morning gentlemen. My name is Hahn Phan, elite reviewer of PRA Chapter 19, and Section 17.44, Reliability Assurance Programs.

The reliability assurance programs of Section 17.4 captures safety-related and non-safety-related risk significant SSC. The quality control of 10 CFR Part 50 Appendix B, Quality Assurance Programs applied to all safety-related SSC, that were becoming to be risk significant.

Non-safety-related SSC that are committed to be risk significant as subjected to the quality controls stated in the SRP Section 17.5 Part V, entitled Non-Safety-Related SSC Quality Controls. So am I answer your question or any additional --

MEMBER STETKAR: No.

MR. PHAN: Okay.

MEMBER STETKAR: The concern was in, and I was trying to understand the staff's philosophy, if you will, in Section 3.2.1 of the SER and 3.2.2 of the SER, there are just quite a bit of discussion about the topic of quality group classification and seismic classification of equipment that is variously termed.

I understand what safety-related equipment is. Other terms that appear are equipment important to safety, and the term non-safety-related risk significant SSCs that are important to safety. That's another kind of long term.

I think the important to safety, and there's a discussion that the universe of things that are important to safety is largely then the subset of safety-related equipment. Is that right? Am I interpreting that correctly, that safety-related equipment is a subset of the SSCs that are "important to safety?"

MR. PHAN: Yes. I am here to answer your

questions from PRA's perspective. In PRA space, we only use two terms, safety significant and risk significant.

However, the term important to safety, we've been discussing among the staff. So at this point I don't have the clear answer to your question, how to define that term.

MEMBER STETKAR: Let's just focus, and I recognize the words are fluid and Dick, very well, highlighted that yesterday. It's important to understand what the words mean. So let's get away from the words. There is a D-RAP list?

MR. PHAN: Yes.

MEMBER STETKAR: The D-RAP list has numerical criteria, at least from the PRA perspective, there are also subjective criteria for populating the D-RAP list. But there are clear numerical criteria for populating that D-RAP list. So let's just talk about the non-safety-related equipment that's in the D-RAP list.

MR. PHAN: Yes

MEMBER STETKAR: Because that is, as you state, a numerically definable set of things. There will be a list. There is a D-RAP list.

From the perspective of seismic

classifications, which is my understanding of several of these questions, and quality group classifications, what is the staff's concern regarding the equipment on the D-RAP list?

I honestly couldn't quite understand what the genesis, or the intended endpoint would probably be better, for the questions and kind of the ongoing discussion, as I understand it, I think that there is an open item sort of in this general idea.

I'm trying to understand what's being negotiated by that open item. Is it the seismic classification quality group classifications for, in particular the equipment on the D-RAP list? Or is it something broader than that or narrower?

MR. PHAN: Right now it is broader than that because in the D-RAP list the staff identifies systems that we believe are important to the plant. And the list is finalized by the panel, not by PRAs or any others.

But that includes qualitative and quantitative assessment. So for us right now, we could group by systems level, not just at the component level. So for us, when we include, we include the entire systems, doesn't matter that the seismic qualified components are not.

MEMBER STETKAR: Oh, okay. That is an issue obviously, because we've had some discussions about this in the past, that the quality of the PRA at the design certification stage may not be adequate to, from the PRA part of that process, determine very precisely the risk significance of an individual component.

I'm looking at a particular motor operated valve let's say, determining whether the Fussell-Vesely importance of that valve is .0049 or .0051 --

MR. PHAN: Yes.

MEMBER STETKAR: -- requires perhaps a level of detail and scope in the PRA that may not be developed in the design certification stage.

So at least from the PRA perspective, identifying the individual components, which I think I'm hearing your concern as far as quality for that motor operated valve or seismic classification for that motor operated valve, is quite difficult. Okay.

I don't know. There is an open item on this. I'm not sure how it will progress. The second, kind of a related question is sort of my, I understand now a bit more of kind of your concern.

The second question though was, that if this issue is pertinent to seismic classification and quality group assignments, why is the staff not concerned, in the same sense, for protection against things like flooding and other damage sources?

For example, if I read the SER with regards to internal flooding protection or pipe failures, in those areas it is very explicitly restricted to only safety-related equipment.

There are no questions in there that say well, what about jets from high-energy piping that might affect important to safety equipment rather than only safety-related equipment. What about internal flooding that might affect, or external flooding, that might affect important to safety equipment, not just safety-related. It's strictly focused on safety-related.

So in that sense, I'm a bit concerned from a sense of consistency, that if we're having these very, very detailed discussions about seismic and quality group classification on the one hand and not, for other hazards, are we as an agency being consistent.

MR. PHAN: Yes. Actually you see from EP RPI, these bottom PIs, especially in the flooding PIs, when EPR assumed that any piping failures would take out entire locations, that includes pipe whip or jet impingements.

So with that, all the components in the locations assumed to be failed. So that's why we not take to a next step on details of the modelings of the flooding in that sample. So the seismic qualification, for example, is not specifically addressed in the PI.

MEMBER STETKAR: Right, right. Okay, Dan, I think in the interest of time, they do have an open item on this sort of issue related to the seismic stuff. I guess the best thing to do is just to see how that plays out.

CHAIR POWERS: Yes, we'll sort of flag it.

MEMBER STETKAR: Yes, the other stuff about the flooding, and jet impingements, and all those types of things are, in my mind we need to get some consistency on those. But I think it's better to wait to see how this open item plays out. But thanks, I at least better understand the concerns related specifically to the seismic and quality group questions.

MEMBER SKILLMAN: I would like to weigh in to this for a minute or two, please. The terms safety-related, important to safety, non-safety-related, risk significant, safety significant, seismic one, seismic two, conventional seismic seem to me to be not the terms that, unless clarified, will leave the design certification, and future users of the design certification, approximately where the industry is right now.

When the operating plants are trying to figure out yes, we know that seismic one is a risk significant, is it important to safety? And I would just offer this discussion has been going on since Reg Guides 126 and 129 were published in the early '70s.

The NSSS members dealt with. The operators are dealing with it even today, for some of those older plants. And as I suggested yesterday, my recommendation is that there be a lexicon that clarifies what these terms mean.

And more importantly what those terms apply to. I think if that type of lexicon or matrix were provided, then John's issue would be resolved. My concern about ambiguity and clarity would be resolved. But I think that the design certification would be more robust. Thank you.

MR. PHAN: Thank you.

MR. MIERNICKI: Okay. And with that, I believe we've addressed all, hopefully these questions from yesterday.

CHAIR POWERS: We had at least two other questions.

MR. MIERNICKI: Okay.

MR. TESFAYE: Todd Oswald has something.

MR. OSWALD: Mr. Chairman, Todd Oswald with AREVA. Mr. Stetgar, we, in fact, calculated the wind velocity. If you take the factors that we apply to our wind loads for concrete design, you come up essentially a factor of approximately 1.95 on the design loads itself, being the pressure.

And that back calculates to a wind velocity, a multiplier of about 1.4 onto the basic wind speed. So our equivalent wind velocity, if you might call it, would be about 202, 203 miles an hour.

MEMBER STETKAR: Thank you.

MR. MIERNICKI: I think the other questions --

CHAIR POWERS: In 3.9.4, the applicant indicated that they had tested the CRDM, control rod drive mechanism for seismic conditions in Europe. And that they had shared the testing data with the staff. And the question was, did the staff review the test or just the data? That is, they look at the test procedure and things like that.

MR. MIERNICKI: Okay, we'll have to get

back.

CHAIR POWERS: Right. That's fine. On Section 3.11, Post-LOCA Environmental Conditions, we raised the question of the testing was done with radiation and steam and temperatures separated.

The staff has found synergisms between steam and radiation have certainly come up. And they come to the floor strongly in connection with the Fukushima environment. The question is why is that acceptable testing for environmental qualification.

The other question was athat the environmental qualification does not recognize acid formation. We were told that the plant does not use chlorinated hydrocarbon insulation on its cables.

But that still leaves open the issue of nitric acid formation in the environments. So the question is why is environmental testing without acid formation acceptable?

MR. TESFAYE: Yes, we're not ready to respond to that today.

CHAIR POWERS: That's fine.

MR. TESFAYE: Do you want to take some of these questions, Darrell?

MR. GARDNER: I think we had, Tim, you want to come up? I think we had at least one that we could respond to, Dr. Powers. I think several of the ones were answered by the staff today or by dialogue. We had one more question though.

MR. STACK: This is Tim Stack from AREVA. Yesterday we had questions from John Stetkar related to questions on internal flooding of the reactor buildings, and whether we had any safety-related SSCs located below the flood level, versus the SER saying that we had no safety-related SSCs required to mitigate the accident located below the flood level. And basically, which was correct.

And based on our current design of the U.S. EPR, there are no safety-related SSCs that are located below the flood level inside the reactor building.

However, since we have not completed a detailed design yet, we have taken a COL item that establishes a requirement that they'll perform a flooding evaluation and confirm that there are no safety-related SSCs below the flood level.

If that evaluation determines that there are one or more safety-related SSCs that are, in fact, required to mitigate the accident and they're located below the flood level, then that equipment will have to be designed accordingly.

MEMBER STETKAR: Thanks. But at least if the --

MR. STACK: There's a COL item, correct.

MEMBER STETKAR: Yes. But for the certified design, the answer is no?

MR. STACK: That is correct.

MEMBER STETKAR: Thanks. Thank you very much.

DR. GARDNER: Dr. Powers, I'd suggest giving the time we might consider a break before we start Chapter 9?

CHAIR POWERS: Is that convenient for you?

DR. GARDNER: I'm sorry?

CHAIR POWERS: That's convenient for you? Fine, we will recess until 10:00.

(Whereupon, the meeting in the foregoing matter went off the record at 9:46 a.m. and went back on the record at 10:02 a.m.)

CHAIR POWERS: I'm going to come back into session. Darrell, it's your show.

Did you want to give an introduction to this?

MR. TESFAYE: No. I've given that --

CHAIR POWERS: All right, we're moving on to fuel handling here.

MR. TESFAYE: Yes.

CHAIR POWERS: We had so much fun in Chapter 3, we'll move now to, what is this, Chapter 9?

MR. GARDNER: 9.1. This is a follow-on from my --

CHAIR POWERS: Yes, this is the one part we haven't done.

MR. GARDNER: Today's our discussion, be it an overview of Section 9.1. We provided the rest of the material in Chapter 9 to the Subcommittee on November 14th.

Our presentation today will provide an overview of the fuel storage and handling systems including the spent fuel cask transfer facility, fuel racks and associated analysis, fuel pool cooling system and the heavy load handling system.

AREVA's presentation for this subcommittee is nonproprietary. However, as we discussed earlier, portions of the material that AREVA has used to support the fuel rack analysis are contained within a proprietary technical report submitted to the staff for review.

Should member questions involve material that AREVA considers proprietary, we would request that this session be closed, and I would remind our presenters that it's our responsibility to identify that.

CHAIR POWERS: And do not rely on me. Do any of you guys use things like class guides, classification guides and things like that? Okay, poor guys.

MR. GARDNER: So our presenters today will be Pavan Thallapragada, and he'll be supported by Nitin Pandya for our initial presentation. And we'll bring up our team from AREVA Transnuclear, Ian McInnes, and we have other presenters that I'll introduce when the time comes.

So with that I'll turn it over to Pavan.

MR. THALLAPRAGADA: Good morning. My name is Pavan Thallapragada. I've been a supervisory engineer in the comparative analysis group at AREVA. I've worked with AREVA for about ten and a half years now. I've been involved with in one capacity or the other with various aspects of the fuel handling and storage system. And Nitin Pandya, on my left, is our subject matter expert on the fuel storage and handling systems.

(Off the record comments)

MR. THALLAPRAGADA: The fuel storage and handling system for the U.S. EPR is very typical to any PWR plant. It essentially provides for receiving and handling new fuel assemblies, load and remove fuel assemblies from the reactor vessel, store spent fuel assemblies and remove the spent fuel assemblies from the plant.

And this is a layout of the system. On the right hand side is the reactor building, and on my left hand side is the fuel building. The fuel storage pool is the middle of the left hand side of the slide. There's a fuel transfer pool which connects to the reactor building to transport the fuel assemblies to and fro from the reactor building.

There's the cask loading pool, the top right corner. There's a new storage fuel area on the left hand side to that. There are two gates between the cask loading pool and the fuel transfer pool in the spent fuel pool.

The spent fuel cask transfer facility, this design is unique to the U.S. EPR. It has evolved from similar designs in Europe, especially France. This is really the only part of the fuel handling and storage system which is a little bit different from what is currently in the U.S. operating plants.

The design basis for the handling system, the new and spent fuel storage racks, the transfer tube, the isolation devices and expansion joints, the cask loading pit penetration assembly, the spent fuel cask transfer machine, the spent fuel cask transfer facility fluid and pneumatic systems are the safety related and designed to seismic Category 1 components in this system.

The overall design of the fuel handling system conforms to the requirements of GDCs 1, 2, 5, 61 and 62. The design is based on the guidance in ANSI/ANS 57.1, design requirements for light water, the actual fuel handling systems, to essentially prevent based on prevention of criticality, protection from just physical damage to the fuel assemblies and radiological protection.

All the next few slides, they will describe the spent fuel cask transfer facility. This slide essentially shows the fuel building layout. We have Slide 9. And Slide 10 is the fuel building section. The green rectangles essentially represent the fuel assemblies. The left hand side, blue, bottom corner, blue structure is the spent fuel cask transfer facility and the spent fuel cask transfer machine itself. And what we later on describe as the loading hall is essentially looked at it in that general area.

And the spent fuel cask transfer facility primarily consists of three major components, the spent fuel cask transfer machine, the cask loading penetration assembly, the spent fuel cask transfer facility fluid and pneumatic systems.

The facility operates at four stations, the lifting station which is outside the fuel building. There are three stations within the fuel building in the loading hall which are the handling opening station, the biological lid handling station and the penetration station.

The spent fuel cask transfer machine itself is a trolley which moves on rails. Its main purpose is to carry the cask in a vertical position between the lifting station and the three work stations in the loading hall.

The safety related function of the machine is when it is during cask loading it provides essentially the support, structural support to ensure the spent fuel pool fluid boundary remains intact at all conditions including during and after a seismic event. Next slide, please.

This is a sketch, I'm on Slide 13, this is a sketch of the spent fuel cask transfer machine. On the top as indicated in blue color are the penetration docking devices. On my left is the elevator.

On the right hand side is the biological lid support. The green rectangle in the middle represents the cask location. And the two gray rectangles roughly in the middle of the structure are the lateral guiding devices and the anti-seismic locking devices.

There are two sets of train units at the top and the bottom which hold the cask. And on this Slide 14, we have a picture on my left hand side of a spent fuel cask transfer machine. And on the right hand side is the exploded view of the two major components of the machine.

MEMBER STETKAR: In the, back to the photograph, please. As I read it, there are lateral locking devices or some sort of support on the machine to provide lateral stability under seismic events.

Are those on this photograph about, could you point those out on this photograph so that I don't assume what they are?

MR. PANDYA: Yes. These are the ones. These two, one and two.

MEMBER STETKAR: Okay.

MR. PANDYA: And actually this is the point where it is hooked up to the guiding rails.

MEMBER STETKAR: Okay, so this photograph is taken with the machine in whatever the position is where you take the bottom cover off.

MR. PANDYA: That is right. There's a front wheel.

MEMBER STETKAR: If it's directly under the loading pit it would be toward us with those --

MR. PANDYA: Yes.

(Crosstalk)

MEMBER STETKAR: Thank you.

MR. PANDYA: Very good.

MR. THALLAPRAGADA: Next slide, please. The penetration assembly, the cask loading penetration assembly provides a leak tight connection within the cask loading pit and the internal cavity of the cask.

It essentially consists of an upper cover, which is really at the bottom of the cask loading pit. The penetration assembly itself with various piece/parts in it, and the lower cover at the lower end of the penetration.

This is a picture of the penetration assembly when it's essentially connected to the cask. I'm on Slide 16. The lower pink structure represents the cask. The top pink rectangle is the cover. The bellows are the screen-like structures.

CHAIR POWERS: Those are part of the

transfer or are they part of the pool assembly?

MR. THALLAPRAGADA: The bellows are part of the penetration assembly. They're part of the building.

CHAIR POWERS: So they're there all the time?

MR. THALLAPRAGADA: Yes, sir.

CHAIR POWERS: They're stainless steel?

MR. PANDYA: Yes. And these two are the stainless steel bellows with a double barrier. So there are two barriers in the bellows.

CHAIR POWERS: So it's a double barrier shielded?

MR. THALLAPRAGADA: There are two bellows essentially, two stainless bellows.

CHAIR POWERS: But is the outer part shielded?

MR. PANDYA: Actually not the outer part, but the inner part is being protected from any kind of drop from above. So when these bellows are not in use they will be compressed backwards or in a position at the upper level, and when you want to use it those will be pulled down with a docking mechanism. Outer one, outer side is not that much protruded when they are just resting, so they're not protected.

MEMBER STETKAR: What does this look like? I mean this shows the cask in place if you're loading it. What's the configuration of this during normal operation when the bottom cover, the bottom plate is in place? Do you have a diagram that shows that? Where does the bottom cover fit on this thing?

MR. THALLAPRAGADA: These are essentially the bellows, right?

MEMBER STETKAR: Right.

MR. THALLAPRAGADA: And when there's no cask being loaded, during normal conditions, the bellows essentially are compressed. They go back essentially in here. The upper cover is closed and there's a bottom cover here.

MEMBER STETKAR: At that location?

MR. THALLAPRAGADA: At that location.

MEMBER STETKAR: Okay.

MR. THALLAPRAGADA: So the bellows are compressed. They are sandwiched essentially.

MEMBER STETKAR: Got you. That's sort of the way I understood it, but I wanted to make sure that I had the geometry correct. Thanks.

MEMBER SCHULTZ: And the bellows are a assembly. There's two sets of bellows, is that what I heard?

MR. PANDYA: No, actually there is a one-bellow assembly with a dual wall.

MEMBER SCHULTZ: Dual wall?

MR. PANDYA: Yes, two walls. Assembly will be only one.

MEMBER SKILLMAN: Where is this design in use today and what is its operating experience?

MR. THALLAPRAGADA: The design is in use in 16 plants in Europe. All the N4 plants in France have this design and the later versions of the P4 plants all have this design, have this spent fuel cask transfer facility, this under cask loading pit kind of design in operation.

MR. GARDNER: Since, I'm going to start at mid-80s?

MR. THALLAPRAGADA: Mid-80s is when the earliest thing, I think Cattenon was the earliest plant that was certified there, licensed there with 200 years of operating experiences worth.

MEMBER SKILLMAN: And what has the experience been relative to connection and disconnection linkage, and experience on fatigue on the bellows seals?

MR. THALLAPRAGADA: From what we know there haven't been any instances of fatigue on the bellows themselves. I think there was one instance where there was a slight misalignment of the cask, and there was one other instance where there was thermal expansion of water and some of the water essentially seeped out. I think that is the operating experience that we have.

MR. PANDYA: And I think right here I would like to add something more to that on your question about that misalignment of the bellows and all. Those have not been occurred during the cask loading operation has been started so that will not have any concern on the safety of fuel assembly or personnel in or around. Those were at the time of connecting the cask to the bottom penetration.

So during that process some misalignment occurred, but at that time no cask loading operation was started, no upper cover of this loading pit was open. Everything was fine, I mean.

MEMBER SKILLMAN: Thank you. Let me ask another question, please. On your Slide 6, if there were to be a catastrophic leak, how much of the fuel pool would be emptied through the opening and what are the flooding consequences down where the carriage rails are?

MR. PANDYA: This loading penetration

whole assembly is a safety related component. And that is being designed as seismic Category 1, safety related component. So catastrophic failure of any component as penetration assembly, I would think it's a beyond design basis accident.

MR. GARDNER: But if it occurred, we have looked at that and I think you can --

MEMBER SKILLMAN: Yes.

MR. GARDNER: The level, you're asking where does the level drop to.

MEMBER SKILLMAN: Yes, how much shielding do we lose out of the pool and what is the internal flooding consequence, no matter how well it's designed, if it leaks?

MR. PANDYA: Okay, got you.

MEMBER SKILLMAN: What happens?

MR. PANDYA: Okay, let me show you the section, we have diagram which will give you more idea about the level of the gates which separates the cask loading piece.

MEMBER SKILLMAN: Your Slide 10 is the best one.

MR. PANDYA: Okay, thank you. Yes, that's got it, yes. This is the section view of the spent fuel and the loading pit, and these are the gates separating both of these two areas.

If suppose there is a catastrophic failure of the bellow penetration assembly, then the water start pouring through a very big hole but eventually it will go up to this bottom of the gate level. So at this level it will stop.

MEMBER STETKAR: What's that elevation relative to the top of the --

MR. PANDYA: This is above the fuel assembly, and I believe it's around, I'm not exactly sure, but a little bit around one foot on top of the fuel assembly.

MEMBER STETKAR: It was two and a half feet in the FSAR.

(Crosstalk)

MR. THALLAPRAGADA: It's two and a half feet, yes.

MEMBER STETKAR: So you can drain the fuel pool either through the cask loading pit or through the reactor fuel transfer canal if there was some leak in the other direction, down to two and a half feet above the active fuel?

MR. PANDYA: Exact. But --

MR. THALLAPRAGADA: We are talking about a scenario where the cask loading is happening essentially, and the gates are open only when there is cask loading. There are two gates between the cask loading pit and the spent fuel pool.

So during normal circumstances when there is no cask loading, the two gates essentially prevent any kind of, even if the assembly were to fail for some reason.

MEMBER BROWN: I'm trying to understand. Where are the two gates?

MR. PANDYA: At this location. The other two gates, one is --

MEMBER BROWN: There's two there?

MR. PANDYA: Yes. And I can show you the plant view. This is one gate which is a slot gate, I mean lifted by the crane up and down, and this is the swivel gate which is opened manually by handwheel cranking.

MEMBER STETKAR: You mentioned one thing I didn't see. The slot gate, it's not a motor operated gate. It's lifted, it's a crane --

MR. PANDYA: By crane, yes.

MEMBER STETKAR: It's by the fuel building crane?

MR. PANDYA: Yes.

MEMBER STETKAR: Okay.

MR. PANDYA: In the case of any beyond design with this catastrophic failure of the bellow penetration assembly, one can very well close this gates which is a manual cranking, which is seismic Category 1 component.

MEMBER STETKAR: Manual cranking, human being manual cranking?

MR. PANDYA: Yes.

MEMBER STETKAR: Can a human being actually crank that gate closed against the water forces that would be going through that tube?

MR. PANDYA: Yes, absolutely, because these gears are designed and they have very a good gearing mechanism.

MEMBER STETKAR: Well, under static conditions. But if you have water flowing through that space, I guess once it gets out into the flow stream, the flow stream will tend to help it, but getting it there might not be all that easy.

MR. PANDYA: I note your concern, yes. But --

MEMBER STETKAR: I guess if you have a design basis really big guy at the plant.

MEMBER SKILLMAN: If this unforgiving event were to occur, what is the consequence of the internal flooding?

MR. GARDNER: There's no safety related equipment down there, right?

MR. THALLAPRAGADA: There is no safety related equipment down there. And then when then the flooding occurs --

MEMBER SKILLMAN: Are there safety related people down there?

MR. GARDNER: Yes.

MR. THALLAPRAGADA: No, not in the loading hall.

MEMBER SKILLMAN: Underneath? Now what I'm envisioning is a catastrophic failure for whatever reason. I salute your design, it seems dandy. But let's just assume that the seal fails or the mechanics fail, and now I've got 2,000 gallons a minute running out of the slot into that underlying area. Where does that water go? What is the internal flooding consequence, please?

MR. PANDYA: Okay. I would like to mention that the down below area from the loading pit, they have a very well designed flow drainage system. And the drainage pipes exist in the loading hall area. Let me show this section view. And so water pouring into the floor in this area --

MEMBER SKILLMAN: Yes.

MR. PANDYA: This is the area which has a nice drainage system. So in case of a leakage from this penetration this drainage system is capable of taking away the water. That is one thing.

Second thing, this leakage from the seal only when the total failure of the seal will give a leakage rate of one can utilize that number. Those leakage rate is not that big values.

MR. THALLAPRAGADA: We looked at cases where our design, beyond design basis, even cases where there is failure in the seal itself. Okay, we did not consider really the whole penetration upper cover and lower cover dropping off.

But we calculated that there was what, eight hours, if I remember right, for the spent fuel pool to lose inventory up to the level of the gates, at the bottom of the gates. And our calculations ensure that any operator actions to close the gate would take most about half an hour or so, so there's plenty of time from losing inventory from the spent fuel pool point of view.

And as Nitin pointed out, there are drains in the bottom which essentially would take the water away from the loading hall, but the loading hall itself is not full of water.

MEMBER SKILLMAN: Where would that water go?

MR. PANDYA: Drainage system, I don't know where it leads to finally.

MR. GARDNER: We can get an answer for you before --

MEMBER SKILLMAN: Yes, I would like an answer to that. The design seems to be robust. It sounds like you're using the right words relative to its quality level and its safety significance. But I have an aversion to losing my shield on fuel. I have an aversion to losing coolant on fuel. And I have an aversion to drowning innocent people.

(Crosstalk)

MR. GARDNER: There's no personnel, I mean maybe you want to speak of personnel.

MR. PANDYA: Yes, as far as operating personnel are concerned, this facilities are remotely operated from especially designed control room. So no operator will be below this loading hall or the loading pit when this cask loading process is going on. So there won't be any person moving in this area. They will be in the control room.

MEMBER SKILLMAN: Well, I have this other idea that they're in the process of using this fairly complicated piece of equipment and the equipment isn't functioning precisely as they anticipate that it will, and some capable mechanic, he or she goes down to adjust it, adjust a valve or to adjust an actuator, and now I do have a person who is at risk.

MR. THALLAPRAGADA: Yes, that scenario --

(Crosstalk)

MR. PANDYA: You're right.

MR. GARDNER: You would anticipate that before you took that kind of an operation where something wasn't, that you would not be moving any fuel and those gates would be closed. In other words, you wouldn't intentionally create a scenario of performing maintenance that would give you that kind of a --

(Crosstalk)

MEMBER SKILLMAN: Okay, and if you were to close the gate in that circumstance, I think what you've done is you've limited the inventory, but you still have a hydrostatic head that is significant and you can get a very substantial leak.

MR. GARDNER: And certainly I think depending on, as you well know your maintenance procedures would consider it a hazard and determine whether they would pump that pit dry before they performed that activity from a personnel safety standpoint.

MEMBER SKILLMAN: Well, I would like to know where the water goes, if there is a catastrophic failure. I understand cranking the swing door closed. My hunch is that that might be false comfort. With a large enough leak I think one would see that pool level begin to drop rapidly. And one might say, gee whiz, we just couldn't catch up to it.

MR. GARDNER: But I think we would want to emphasize again that we don't see credible scenarios that an entire penetration assembly fails. It's a passive component certainly built to all the standards that we've talked about.

With the seals, we have looked at a catastrophic beyond design basis failure of those seals, and you get the times that he spoke of earlier which are in the range of eight hours. So the amount of water moving through there we're going to talk about in some later slides here. The rate is not as high as you would, it's not that high.

MEMBER SKILLMAN: Thank you.

MR. PANDYA: You're welcome.

MEMBER BROWN: Want me to go? The cover, that's where you're talking about the seals, the little rings on the cover that's sitting up there? That's got to be open obviously to put the stuff down in.

MR. PANDYA: Yes.

MEMBER BROWN: Through the transfer channel there.

MR. PANDYA: Yes.

MEMBER BROWN: How is it moved? I mean you said it was a static. I heard you say that a minute, it's a static. Is it a lever arm? Is it sliding? I mean I presume it's a rotating lever arm type thing.

(Off the record comments)

MR. THALLAPRAGADA: I'm sorry, the presentation is in two parts and we are trying to figure out, can you go to the other part of the presentation, please?

MEMBER BROWN: I'm trying to figure out, and a little bit of Dick's question about how does that fail? I mean you've looked at the seals but the idea is that cover has to be moved somehow. So that's an interesting looking set of pulleys and ropes or chains or whatever those are. Is that what I get out of that?

MR. PANDYA: Yes, that's correct. This is the hoist here. This hoist will lift the cover up and down.

MEMBER BROWN: So that's done when it's full of water? Or is that done --

MR. PANDYA: Yes.

MEMBER BROWN: Is that cavity always filled with water?

MR. PANDYA: No, actually the cavity does not remain full with water, but we have a way to store the water to facilitate operating --

MEMBER BROWN: Okay. The point I'm just trying to figure out, when you want to go from moving stuff from the spent fuel pool and now go put it in the casks, you fill that cavity up?

MR. GARDNER: Yes.

MEMBER BROWN: So the cover's closed?

MR. PANDYA: Yes.

MEMBER BROWN: Then you open up the cover after you've got the cask and everything put with the bellows and all that, and all the water pours into the, water's got to get, it's a big hole. Where does the --

MR. THALLAPRAGADA: No, no, no. The cask

gets filled so there's no pouring of the water.

MEMBER BROWN: The cask is filled with what?

MR. THALLAPRAGADA: Yes, with water.

MEMBER BROWN: Well, that's what I mean. It comes down in the bellows area.

(Crosstalk)

MEMBER BROWN: It's brought in filled with water?

MR. GARDNER: It's pumped in. It's a connection that pumps water in before you open the, into the bellows. So there's a connection that fills the cask before you open the cover.

MEMBER BROWN: So it's filled up to the bottom of the cover?

MR. GARDNER: Yes.

MR. PANDYA: And when there's a pressure equalization on both side, at that time only this upper cover is allowed to get open.

MEMBER STETKAR: Otherwise, it's pretty heavy on water. It's got to be a pretty stout hoist.

(Crosstalk)

MEMBER BROWN: That's why I was trying to figure out how this operated. I mean I got lost in the beginning. I'm not a spent fuel pool, I came out of the Naval and Nuclear program. We don't do any of this stuff, take the whole core out and put a whole new one in.

CHAIR POWERS: Or sink the submarine, one or the other.

MEMBER BROWN: So I mean --

CHAIR POWERS: Whichever is easiest.

MEMBER BROWN: I finally figured out you were talking about now the tail end after you've finished and the fuel's cooled, and now you want to put it in casks and haul it away somewhere, and I kind of got lost in the transition. So now I was trying to understand the pictures. This is a better picture.

I still share my colleague's concern with having a giant hole in the bottom and doing everything from the bottom side. It just seems to be counterintuitive to, you're just kind of setting yourself up for having a problem, that's all, regardless of the 200 years worth of marvelous experience in 14 plants, which means about eight years per plant or nine years or something like that. Is that right, 14?

MR. THALLAPRAGADA: Today it's 15 years.

MEMBER BROWN: Okay. All right, you answered my question. Regardless of what my conclusions are, there's another, I'm sorry, Dick for interrupting you, if I did.

MEMBER SKILLMAN: Thank you, I'm fine. I'm good.

MEMBER STETKAR: I have a couple more, and this is not the right slide. If you go back to the, you know, the original presentation where you showed the cask loading hall and the machine, I wanted to follow up a little bit on Dick's question.

MR. GARDNER: Slide 14?

MEMBER STETKAR: I guess.

MR. PANDYA: That's Slide 14, okay?

MEMBER STETKAR: No. That might have been the one. You had one that showed the cask loading hall. It actually doesn't make too much difference as far as that particular slide. Slide 10 is good enough.

MR. PANDYA: Okay.

MEMBER STETKAR: Something that Dick was asking about, I want to follow up on a little more specifically. All of the fuel pool cooling and makeups are located at the bottom elevation of the fuel building, is that correct?

Just nod your head yes, it is correct. They are located at the bottom elevation of the fuel building.

MR. PANDYA: I believe they are. I believe --

(Crosstalk)

MEMBER STETKAR: The question is, and you know where they are, they're at the bottom. Trust me on this, I found the rooms. Can water from the cask loading hall find its way down to those rooms?

MR. PANDYA: Please repeat your question.

MEMBER STETKAR: And don't talk about design basis drainage. It's just, can water from the cask loading hall find its way down to the basement of the building where the fuel pool cooling pumps and makeup pump, purification pumps are located?

MR. PANDYA: I believe that can if we don't have a nice and good design flow drainage system.

MEMBER STETKAR: So it's the cask loading hall is not somehow hermetically isolated from the rest of the building?

MR. PANDYA: Yes, not from other part of the building down below.

MEMBER STETKAR: Okay. My question arose, I was concerned about internal flooding, which is Dick's concern, draining the pool, the cask loading hall question about the hall itself. The bottom of the hall pretty obviously is at grade level because you have to get this big monster thing in and out of the building.

MR. PANDYA: Yes.

MEMBER STETKAR: I'm assuming the building has some sort of door on it.

MR. PANDYA: Yes, that's absolutely right.

MEMBER STETKAR: Is this thing, I don't know whether it's specifics of the design, is this basically a rail, you said it's a rail mount?

MR. PANDYA: Yes, it is a rail mount.

MEMBER STETKAR: So it comes out of the building on rails. How do you seal that door from external flooding?

MR. PANDYA: Actually that door is a shielding door which provides also the shielding and it provides a robust structure for external missiles impact and all that kind of stuff just like building, spent fuel building.

MEMBER STETKAR: Is it water tight?

MR. THALLAPRAGADA: Yes, it is.

MEMBER STETKAR: How do you seal little rails to being water tight?

MR. THALLAPRAGADA: The rails are removed.

Yes, that will explain it. The rails are removable essentially as part of the preparation of the cask loading. You open the door, put those rails on, machine comes in. And after it's done --

MEMBER STETKAR: You can do it that way.

MR. PANDYA: Yes.

MEMBER STETKAR: Okay, thank you. That doesn't solve the internal flooding but it does answer my question about the external flooding. Thank you.

MR. PANDYA: You're welcome.

MEMBER STETKAR: I had another one. Are you going to talk about the calculated leakage rate through the seals?

MR. THALLAPRAGADA: Yes. At one of the later presentations we have.

MEMBER STETKAR: I'll let you get to that then, thanks.

MR. THALLAPRAGADA: We have a couple of those scenarios discussed.

MEMBER STETKAR: Thank you.

(Off the record comments)

MR. THALLAPRAGADA: Essentially we are at Slide 17.

MEMBER STETKAR: I'm sorry. I did have one more. The visual aids help some of these things.

So if you could show your slide, it's just I might as well get these out of the way while we have the visual aids in place. Your Slide 16 that shows the bellows. There.

As I understand the operation, the cask, the machine comes in to some intermediate location before it gets to the actual under the bellows location.

MR. THALLAPRAGADA: Yes.

MEMBER STETKAR: At that point the bottom cover is removed and it's put over into a little storage area, as best as I could understand.

MR. THALLAPRAGADA: That's correct.

MEMBER STETKAR: And then you move the machine into, you know, into its index position and complete the hookup and open up the top cover and what not.

MR. THALLAPRAGADA: That is correct.

MEMBER STETKAR: Is there anything that prevents, are there interlocks such that I cannot remove the bottom cover unless the top cover, the pink cover here, is closed?

Suppose it was open, suppose it was partially open, and my big guy goes in there and starts to remove the bottom cover and a lot of water starts pouring out. Is there anything to prevent me from opening the bottom cover with the top cover not being fully closed and sealed?

MR. PANDYA: Yes. Actually this bottom cover is opened and closed manually.

MEMBER STETKAR: That's why I said my big guy.

MR. PANDYA: Yes. And then it will be open only when this interspace is empty. So operator will get a clearance. It is in the operating procedure when the cask transfer facility is being used. Last time after that this area will be drained and everything will be sealed and there's a bottom cover placed.

Now again, after next year when you want to go for cask loading process, the bottom cover will be manually opened. So at that time there's no chances of anything, water left out over here. And at the same time, this bottom cover has a drainage line connector to that one.

So if at all there's any water left out, all the seepage can go through this drainage line of the bottom cover and it will be drained through the drainage system. And at that time this upper cover is already in a closed position from the previous cask transfer facility loading operation at the end.

MR. GARDNER: There's also a position indication on the top cover, right?

MR. PANDYA: Yes. Actually this top cover has a position indication that it is closed or open like that but not the bottom cover.

MEMBER STETKAR: I understand all that. I'm just trying to understand if there are any provisions of the design other than relying on, you know, operators following the correct procedures.

(Crosstalk)

MEMBER STETKAR: If that top cover, yes, but I mean if the top cover --

(Crosstalk)

MR. GARDNER: There's leak detection between the seals, right, so --

(Crosstalk)

MR. GARDNER: -- the position indication, you would have leak detection between, past that seal.

MEMBER STETKAR: That might be --

MEMBER BROWN: You mean the two little black dots between the two little black dots all the way around the --

MR. PANDYA: Yes, that's right. These are seals, these black dots. And this interspace of these seals are being pressurized with the compressed air and that pressure will be monitored. So if at all there is any seal leakage or seepage, you will come to know because of this air pressure failure into the system. So that way the seals are monitored for the leakage.

MEMBER STETKAR: Okay, thanks.

MR. PANDYA: And that is also with the case with the bottom cover. There are two seals at the bottom cover also.

MEMBER BROWN: Is that all you had, John?

MEMBER STETKAR: Yes.

MEMBER BROWN: You said that when there's no cask in there that bellows is compressed up against the top, did I hear you say that or does it maintain itself in this position?

MR. THALLAPRAGADA: No, it is compressed up.

MEMBER BROWN: So it's squashed.

MR. PANDYA: Yes, compressed.

MEMBER STETKAR: And there's a bottom cover, Charlie.

MEMBER BROWN: Yes. No, and there's a bottom cover that's shown by those two little bottom seals, I would imagine. Although do the little docking flanges go up with the bellows, those little orange things?

MR. THALLAPRAGADA: Yes, the docking flange is part of the bellows.

MEMBER BROWN: So that gets pushed up and then there's a cover where those two little black dots are?

MR. THALLAPRAGADA: That is correct.

MR. GARDNER: Can you speak to the movement, the amount of squishing, well that's not very much.

MEMBER BROWN: Let me ask one --

MR. PANDYA: The docking mechanism, yes.

MR. GARDNER: How much it moves --

MR. PANDYA: Yes. I can talk about this docking mechanism. This is that orange one and this at the operating mechanism screws, so when you want to take this bellows upward after completing the cask loading operation, this mechanism will have a motor and position indicator, and all you do is start pushing this bellows upward up to this point on both sides.

MEMBER BROWN: Okay, those screws don't look long enough to do that.

MR. THALLAPRAGADA: It's an artistic

representation.

MEMBER BROWN: So the screws really go all the way up so that --

MR. THALLAPRAGADA: The screws do go up, it goes all the way up in there. Yes, it does.

MEMBER BROWN: Okay, but the fixed position is at the bottom where the drive unit is, so the screws push this whole docking flange up and then you manually put on the bottom cover?

MR. THALLAPRAGADA: Yes, that is correct.

MEMBER BROWN: The bellows, does that get tested for how many times you can squash it and unsquash it?

MR. PANDYA: Yes, that's correct. Actually we have a design requirement going to be provided that this mechanism will conservatively operate like I said, 60 times in a year, very conservatively. So for fatigue evaluation that number will be used and bellow cycles will be taken into account in the bellow design.

MEMBER BROWN: Is the bellows design a continuous design or is it a welded bellows?

MR. PANDYA: These are very large bellows, so it will see weld joints in its fabrication.

MEMBER BROWN: It will see what?

MR. PANDYA: Welding joints, welding.

MEMBER BROWN: Welded, okay. So each little section or some sections of them are welded circumferentially?

MR. PANDYA: No, not each section, but two half circle will be joined together.

MEMBER BROWN: Okay, this way.

MR. PANDYA: Yes, this way, like that.

MEMBER BROWN: And so you have a vertical weld that puts the two half cylinders together.

MR. PANDYA: Yes, I got you. But bellows will be designed as for standards and all and it will be designed for fatigue, considering number of cycles is required to be the minimum operational.

MEMBER BROWN: So 60 per year times 60 years?

MR. PANDYA: Yes, that's correct, like that.

(Crosstalk)

MR. GARDNER: But you're not doing this every year.

MEMBER BROWN: No, I understand that. I just was doing the math. I can still do that sometimes. Okay, thank you.

MR. PANDYA: Yes, and you're welcome.

Actually, I would like to add that this bellows, this is a picture representation as for I want to say this bellows are not elongating this much. This is too long, I mean too --

MEMBER BROWN: How long is the elongation?

MR. PANDYA: I wish I could actually we knew that, but I can give you, with some time, after --

(Crosstalk)

MEMBER BROWN: It's not five feet.

MR. PANDYA: No, no.

MEMBER BROWN: It's a few inches?

MR. PANDYA: A few inches, that's good. It will be less than one feet, yes.

MEMBER BROWN: Okay.

CHAIR POWERS: The problem, historically, with these kinds of bellows is that with any kind of chloride contamination they corrode and they're very hard to inspect, the corrosion. I mean you're handling it with leak detection, but that's the problem with double bellows is you can't hardly inspect them very easily for corrosion.

MR. PANDYA: About this inspection of the bellows, as I mentioned there are two walls and in between these two walls this cavity is maintained pressurized. So that pressure drop due to any leakage of the bellows or any cracking the bellows, you will come to know up front. So that is one of the mechanism. And in the initial design these bellows would be hydrostatically tested.

MR. THALLAPRAGADA: And before each loading operation essentially the bellows are tested, right?

MR. PANDYA: Yes, that's correct.

MR. THALLAPRAGADA: Slide 17, the fluid and pneumatic systems are located on the spent fuel cask transfer machine and in the fuel building. They're essentially used for filling, draining and drying the cask on the penetration. They also provide compressed air for the pneumatic devices and the seal leakage protection system.

The cask itself is not part of the design certification scope, and we have a seal item that will provide a spent fuel cask design that is acceptable for use with this facility prior to initial fuel loading.

MEMBER SKILLMAN: I understand that the cask is not part of the design certification, but I would ask whether the seal and sealing mechanism is part of the design certification.

MR. THALLAPRAGADA: It is.

MEMBER SKILLMAN: It is? Thank you.

MR. THALLAPRAGADA: We can go to the next presentation. Go to the first slide, please.

Essentially I have a few more slides which describe the operation of this facility. This slide describes, essentially shows the lifting station which is outside the fuel building.

Here the cask would typically come on a trailer in a horizontal position, a gantry crane would hoist it up into a vertical position and place it on the machine itself. And the machine is, using a tractor is essentially pushed up toward into the fuel building, right.

This is the general view of the fuel building, the loading hall and the three stations. The first station is the handling opening station. The second station is the biological lid handling station, and the third is the penetration station.

MEMBER BROWN: What's the number five thing? That little squiggly, rotating worm gear-like looking?

MR. THALLAPRAGADA: Yes, number five is essentially at the biological lid handling station. That is the device which grabs the biological lid on top of the cask and pulls it up.

MEMBER BROWN: That's the intermediate position that you were talking about?

MR. THALLAPRAGADA: Yes.

MEMBER STETKAR: That's where they take the top off the cask and remove the bottom cover from the bellows area and kind of slide it over.

MEMBER BROWN: Then move the cask over underneath?

MR. THALLAPRAGADA: When the machine enters the loading hall it's under the handling opening station. That is the first station.

MEMBER BROWN: That's a non-watered space?

MR. PANDYA: Yes.

MR. THALLAPRAGADA: Yes, at that point essentially the machine is hooked up electrically to the fuel building and the fluid and the air circuits out were connected to the machine and the fuel building. And then it moves to the biological lid handling station.

At that point two operations, two major operations. One, the bottom cover of the penetration is removed and placed on the elevator. And the biological lid itself is removed and pulled up into the recess in the ceiling, if you will.

Then the transfer machine moves to the third location which is under the penetration station. The biological lid is lowered onto the platform, and at that point essentially the docking mechanism comes into play, the bellows are pulled down, machine is start.

Leak tightness tests are performed. Well, then the upper cover is open. The cask loading starts, the assemblies come through the gate, are placed in the cask and the process essentially goes in the reverse order after the loading is done.

MEMBER BROWN: The total sealing force on the cover when it's closed is just a hydrostatic bed above --

MR. PANDYA: Yes, that is that.

MEMBER BROWN: -- above it? That provides --

MR. PANDYA: And the weight of the cover itself. It is a huge cover.

MEMBER SKILLMAN: This cask transports a single fuel assembly for operation? Is this a single fuel assembly?

MR. THALLAPRAGADA: The cask itself?

MEMBER SKILLMAN: Yes.

MR. THALLAPRAGADA: No, a single fuel

assembly is transported at any point from the spent fuel pool into the cask. But the cask itself can hold multiple fuel assemblies.

MEMBER SKILLMAN: So for off-loading, this is a one per fuel assembly operation, the sealing, the inserting, the unsealing and the movement?

MR. THALLAPRAGADA: I'm sorry, I did not explain properly then. The cask, once it's docked under the penetration pit, you essentially pull a fuel assembly, load it into the cask, the machine goes back, loads onto the fuel assembly, goes back --

MEMBER BROWN: From the spent fuel pool --

MR. THALLAPRAGADA: From the spent fuel pool into the cask --

(Crosstalk)

MR. THALLAPRAGADA: Depending upon the cask design, it's multiple number of fuel assemblies. The sealing and unsealing happens for every cask, full cask --

(Crosstalk)

MEMBER BROWN: Thank you.

MEMBER RYAN: Is it always a full cask campaign or do you do partial movements or what's the plan? I mean I know you have a --

MR. PANDYA: Actually the plan is to lower the cask if full, but there is no restriction we can --

MEMBER RYAN: I understand, yes. But I mean your plan is to fill up a cask and move that load of fuel --

MR. PANDYA: And then move it, yes.

MEMBER RYAN: -- wherever you're going to move it to at one time. All right. Thanks.

MEMBER BROWN: So the hole is big enough to bring some number of fuel assemblies one at a time.

(Crosstalk)

MEMBER BROWN: And place them in different locations --

(Crosstalk)

MEMBER BROWN: -- within the cask?

MALE PARTICIPANT: Yes, it's all pretty standard stuff.

MR. THALLAPRAGADA: Yes, there's a rack within the cask. That is --

MEMBER RYAN: What's the provision if you get a fuel element to hang up while you're loading it in the cask, particularly if it's the last one? Because it will hang up in the fuel rack sometimes. How do you deal with that?

MEMBER BROWN: You're talking about being stuck in the cask partway in and partway out?

MEMBER RYAN: Hung up, yes, stuck. Can't get it in, can't get it out.

MEMBER BROWN: It's ugly.

MEMBER RYAN: Have you thought through things like that?

MR. THALLAPRAGADA: If we have a cask of fuel assemblies stuck in the cask --

MR. TESFAYE: That's an open item in the staff study evaluation, so they're addressing that.

MEMBER RYAN: Okay, we'll hear about that a little later I guess.

MR. TESFAYE: Yes.

MEMBER RYAN: Thank you.

MEMBER SKILLMAN: We've experienced bowing over and over again, significant bowing, not just a couple of mils, but fuel assemblies that are actually bowed by an inch or an inch and a half. And getting them in the storage rack or a transfer cask becomes a very great challenge.

MR. THALLAPRAGADA: What I'm just guessing is the bowing, you would know about the bowing when you are pulling it of the storage racks --

(Crosstalk)

MEMBER SKILLMAN: As you were trying to

pull it out.

(Crosstalk)

MR. THALLAPRAGADA: Before you tried to put it in the cask you would know it.

MEMBER SKILLMAN: You know it's bowed.

MR. THALLAPRAGADA: Yes.

MEMBER SKILLMAN: So you do know it's bowed, yes. Thank you.

MEMBER STETKAR: The good news is you hoist it out of there then.

MEMBER SKILLMAN: You hoist it out of there. The bad news is you might not be able to put it anywhere because you ripped all the side sheets off.

MEMBER STETKAR: I suspect the load cells, or that's what they invented load cells for.

MEMBER RYAN: So I guess just to follow up, we'll hear a little bit more later on about recovery from off-normal events, the fuel loading and unloading in the system?

MR. TESFAYE: Yes.

MALE PARTICIPANT: It's still under review.

MEMBER RYAN: If it's under review, that's fine. But we'll maybe capture that on the agenda first down the line. Routine operations with casks are routine, but the non-routine operations are really not routine at all. Thank you.

MR. PANDYA: This essentially concludes our presentation on the --

MR. GARDNER: I think we've answered his question though from earlier about the operating experience.

MEMBER SKILLMAN: You did, thank you.

MEMBER STETKAR: You said you were going to talk about leakage rates from the seals. Is that still later?

MR. THALLAPRAGADA: Yes, it's still later. Yes.

MEMBER BROWN: Talk about what, John? Leakage rates, you said?

MEMBER STETKAR: From the seals, they'll get to it.

MR. GARDNER: So we have a presentation on the racks, so we'll come back and do that.

CHAIR POWERS: I'm not sure whether we're going to discuss it here, but I will caution you that when you discuss this in front of the full committee whenever that is that you will get fairly closely interrogated on the instrumentation you have in the spent fuel pool for measuring level. And so you want to probably plan to explicitly address that. You can understand why you might get fairly closely interrogated on that.

MR. THALLAPRAGADA: Yes.

MEMBER BROWN: Should we interrogate them now?

CHAIR POWERS: Well, I hope they'll touch on it.

MEMBER BROWN: At some point that was, there's a lot more --

MR. GARDNER: Yes, we're going to talk about it in the --

MR. THALLAPRAGADA: We have a couple of other presentations where we talk about the --

CHAIR POWERS: I am not as fanatical as some members on the ACRS on this. I consider the best level of instrumentation for the spent fuel pool a pair of eyeballs.

MEMBER BROWN: You're not supposed to give away the --

MEMBER STETKAR: Just as long as you've got enough water to shield the eyeballs so you can see.

CHAIR POWERS: I don't really worry about that because it's not going to be me, I guarantee you.

MR. TESFAYE: Let's move on to the next one.

MR. GARDNER: Just a few minutes to change out our reviewers here.

CHAIR POWERS: Okay, that's fine. Well, thank you both very much, gentlemen. That's quite an intriguing system and it sounds like you've thought very carefully about it.

Do you guys have to operate it? The first time through maybe?

(Off the record comments)

MR. MCINNES: Okay, good morning, Mr. Chairman, members of the committee. My name is Ian McInnes. I'm the Transnuclear project engineer for the design of the racks. I'm a licensed civil engineer, and as such I'm assisted by Miguel Manrique. Miguel is a seismic expert, and if we get into any seismic questions we'll be depending upon him.

Transnuclear is a wholly owned subsidiary of AREVA, so although I keep using the term "Transnuclear," we are part of the AREVA family.

I've been working in the nuclear power industry since 1967. My first nuclear job was design and development of concrete reactor vessels in

England, and pre-stressed vessels which sort of went the way of the dinosaur.

MEMBER STETKAR: They're still operating.

MR. MCINNES: They're still operating and doing a fantastic job. Designer of various reactor buildings, I've also done a lot of hydrodynamic loads on the Mark I, Mark III containment structures after all the hassles in the '70s with GE.

And for the past 17 or 18 years I've been designing various dry storage transportation systems for Transnuclear. And if you look at one of our dry storage systems, they look remarkably alike, we have baskets or fuel racks inside our containments.

So with that introduction, what I'd like to do is give you a brief introduction to the fuel racks that were developed by Transnuclear for the EPR for the new fuel vault in the spent fuel pool.

This covers an overview of our design philosophy, a discussion of the neutron absorbing materials, followed by a summary of the features of the analysis that we think are unique to this particular design and may be of interest to the committee.

Okay, the fuel racks we're presenting here today represent a new design for Part 50 and Part 52, but are based on almost 40 years of work that Transnuclear has been performing in the design, building and operation of both transportation and dry storage systems, the spent fuel assemblies under Part 71 and Part 72 in the U.S. and in Europe.

Major difference between the storage and transportation cask internals, or our baskets as we call them, and the fuel racks is the baskets are round and supported by the cask or the canister shell, while the racks are normally square or rectangular and supported by the spent fuel pool floor and sometimes the walls.

In both cases we need to consider similar loads for the similar problems to resolve structural, thermal and criticality issues. The basic loading operations for dry storage and for the spent fuel are the same. Fitting a fuel assembly into a square hole as I heard referred to a minute ago, whether it's bowed, twisted or warped presents the same issues.

We face the same criticality in cooling concerns, and we have to deal with these both in wet and dry conditions plus the possible problems caused during removal of water from the cask during vacuum drying.

All of this allows us to produce a rack

design that meets the regulatory requirements and at the same time uses the latest analytical techniques to ensure the safety of workers and the public.

As shown by this figure, the rack modules are designed as free-standing, independent, rectangular structures which vary in size as required to produce the maximum storage capacity in any given spent fuel pool. The maximum size of a module is also governed by the shipping requirements whether by truck or rail, by the available cranes, lay-down space and hatch sizes in the plant.

The rack modules presented here are designed so that the external structural steel frame carries all of the primary structural loads such as the seismic handling, fuel insertion and withdrawal and those due to postulated accident events such as dropped fuel assembly. The actual fuel compartments, or tubes, or formed by an extruded aluminum alloy which provides superior criticality control and holds tolerances better than the equivalent stainless steel tubes.

Each fuel compartment is surrounded on all four sides with a sheet of poison material which is fabricated from metal matrix composite or MMC. MMCs have been licensed for use in dry storage and transportation for about ten years and in spent fuel pools for more than five years, and are available from a number of different suppliers.

CHAIR POWERS: What's our experience on the corrosion of those materials?

MR. MCINNES: Can we leave that question for a minute until I get to it?

CHAIR POWERS: You bet.

MR. MCINNES: I'll try and answer it, but --

CHAIR POWERS: Do you know what the alloy is by the way?

MR. MCINNES: It varies. The alloy is 1100, with some manufacturers, 5000, 6000.

CHAIR POWERS: Okay. It just depends on what they like to use.

MR. MCINNES: It depends what they like to use and it depends what's being developed.

CHAIR POWERS: Yes, the customer's always right on this thing. That's fine. It won't make much difference when we get to the corrosion area.

MR. MCINNES: Okay, we have an answer to your question.

CHAIR POWERS: Good.

MR. MCINNES: In order to meet the

requirements of fresh fuel, freshly discharged fuel and cold fuel, Transnuclear has developed two different rack structures commonly referred to as Region 1 and Region 2.

The Region 1 racks are a medium density rack which include a flux trap around each fuel assembly to maintain criticality and cooling of the fuel assemblies. Each of the compartments is surrounded by poison sheets arranged in an egg crate type structure ensuring that there's a water gap plus two layers of poison between any individual assembly.

The geometry of the fuel compartments is ensured by an external steel frame which goes around the outside, plus the use of internal stainless steel supports at intermediate levels within the module.

The Region 2 or higher density racks are constructed with a similar external steel frame, but in this case what we do is we take the tubes themselves, place the poison between them and then compact them into a very tight array. And what this does is it produces a very tightly packed structure which is flexible, but at the same time able to resist all the applied loads.

The modules incorporate adjustable feet to ensure uniform loading on the pool floor and the feet are arranged in such a way that they don't interfere with the pool leak chase system. We don't want a foot sitting on top of a leak chase.

Each module is free standing, does not depend upon the adjacent modules or the pool walls for any support. And the new fuel storage racks are Region 1 type racks which are supported vertically on the feet. They sit on the floor. And then what we do is we hold them at the top and bottom so that we hold them against the concrete so that there's no seismic amplification just by sitting on the floor and being free standing.

CHAIR POWERS: I thought the pool was completely lined. You said --

MR. MCINNES: No, no. This is the new fuel vault. The new fuel vault itself is just a very small area.

CHAIR POWERS: Okay.

MEMBER SKILLMAN: Please speak for a minute about precision in the rack design from cell to cell, and here's the root of my question. We found in industry unless the bridge and trolley alignment is precise for the dead-center cell, the fuel assembly can be raked as it's being withdrawn from the cell. That can lead to later potential clad degradation where one has actually abraded the clad or bumped the spacer grid to where there's now an etch that becomes a failure location for the fuel pin.

What feature is in the rack to ensure that from cell to cell there is precision, that the rows are aligned accurately in the X and Y axes, and that when the racks are placed adjacent to one another the spacing is such that the rack and trolley plumb is accurate?

MR. MCINNES: Okay, as far as the Region 2 racks it's a really easy answer. There's a stainless steel frame at the top and bottom. It's a welded structure that maintains the squareness of the whole rack that keeps the fuel tubes aligned within a very small tolerance.

MEMBER SKILLMAN: Approximately what tolerance is that?

MR. MCINNES: Probably a 30-second vintage or something like that.

MEMBER SKILLMAN: Okay, thank you.

MR. MCINNES: The Region 1 racks are a little more difficult because of the flux traps, but it's basically the same way. There's a stainless steel grid that's set up. The only difference is that there's parallel plates that are about an inch and a quarter apart. And then the tubes themselves are within that area.

Again the tolerance on that, within a sixteenth of an inch for the fabrication. So within a rack assembly the tolerances are very tight. They have to be in order to keep the whole thing square.

Now the bigger question is between the adjacent rack modules. In that case there is a possibility of slight misplacement, but our racks, the way they're arranged in the pool here, in the EPR, spent fuel pool, there's a nominal half-inch gap between the base of the modules.

MEMBER SKILLMAN: Is that one-half inch spacing accommodated by a change in dimension from the outer edge so that when the racks are aligned there is a clear space from one rack to the next?

MR. MCINNES: Yes. The intention is that the half inch is an allowance for tolerances in the fabrication of the base plate. The rack modules themselves have a slight projection all the way around the edge of the stainless steel frame.

MEMBER SKILLMAN: Can you go back to that? Go back one more, back to the picture.

MEMBER SKILLMAN: Around the base here there's about a half-inch projection of the stainless steel all the way around to allow for tolerances in the fabrication of the rack itself. Then to allow for the tolerances in the cutting of that plate when we put it in the pool, we have another as I said, a nominal half-inch gap between the different modules to try and allow for the fact that you can place all the racks modules in a straight line.

So that when you're placing the -- go back to Slide 29. Just keep going.

(Off the record comments)

MR. MCINNES: When we're placing the racks, we're placing one rack module, you place the others based on, make sure that they finish up in a straight line. So the original placement in the pool is a geometrical placement to keep the alignment for your fuel machines. Because as you say, you don't want them twisted.

MEMBER SKILLMAN: So from my first rack to my second rack, if I cross the bridge between the two racks is the center-to-center geometry identical?

MR. MCINNES: The center-to-center, this one from here to here is not identical. It changes.

MEMBER SKILLMAN: It changes. How is that accommodated in your alignment for bridge and trolley?

MR. MCINNES: That I don't know.

MEMBER SKILLMAN: Okay, it's sufficient for right now. I've made my point. But the real issue is assuring that the racks are vertical, that they're symmetrical and that we are not raking fuel assemblies when we're withdrawing and inserting such that we're introducing future fuel failures.

MR. MCINNES: The vertical alignment is the feet. The feet are adjustable to make sure that any misalignment on the floor is taken care of.

MEMBER SKILLMAN: How do you adjust the vertical element in your last rack?

MR. MCINNES: Very carefully.

MEMBER SKILLMAN: Down there?

MR. MCINNES: They're adjustable from the surface.

MEMBER SKILLMAN: Oh, they are, okay.

MR. MCINNES: So you would hopefully have a survey of the pool floor so that you would do a rough alignment before it went into the pool, but the final alignment would be done from the top of the rack.

MEMBER SKILLMAN: Thank you.

MR. GARDNER: I think maybe your question's also related to indexing of the machine itself, and which is maybe a different person than

Ian. If you'd like for us to bring somebody up to address the indexing for the machine --

MEMBER SKILLMAN: At some point I would, because if this part of the design is done properly then future fuel failures can be reduced or perhaps eliminated at least from a handling issue.

MR. PANDYA: I am Nitin Pandya from AREVA. I am doing the design of this spent fuel machine. And after the conception of the plant, the coordinates of each individual rack will be measured and it will be fit into the software program of the spent fuel machine.

So the spent fuel machine instrumentation and control have all the ready made coordinates for each and every rack locations. And the machine will be, automatically will go and stop at that particular center line with some minor tolerance, and then only the shop will be allowed to lower the fuel assembly or lift the assembly at that particular coordinate. So all the coordinates of this rack will be measured once they are installed in position in the spent fuel pool and fit into the software of the spent fuel machine.

MEMBER SKILLMAN: Okay, thank you.

MR. PANDYA: You're welcome.

MR. MCINNES: This slide basically just shows the arrangement of the modules in the spent fuel pool. There are five Region 1 racks which are on the right hand side of the slide, and then there are 12 Region 2 racks on the left hand side. As configured, the racks provide basically a ten-year storage capacity with space for a full core offload at the end of the ten years.

So the newer fuel racks are not shown here, but one of the slides earlier that Pavan showed had the new fuel vault just adjacent to the fuel pool and there are two Region 1 racks, small Region 1 racks in that vault.

Okay, Slide 30, and hopefully the next two slides will answer your question on the MMC. The fixed poison used in the racks is as I said an aluminum based metal matrix composite or MMC. The material consists of a fine boron carbide particles in a non-porous aluminum alloy matrix.

MMCs are presently available from four manufacturers who each use a slightly different base material. One manufacturer uses an 1100 series aluminum with a slight addition of titanium, but both 5000 and 6000 series based materials have been used.

Transnuclear's specification for the

procurement of MMC specifically excludes copper containing alloys of aluminum due to their poor corrosion performance.

Our experience in this material, we're over 14 years in developing, testing, supplying MMCs for dry storage. We began with what we call a TN-68 dry storage cask which was licensed by the NRC for Part 72 in May of 2000.

And Transnuclear has been very active in the development of ASTMC 1671, which is the standard for practice and qualification for boron materials. This standard was adapted to the environmental conditions for wet storage and is the basis for Transnuclear specification for qualifying candidate MMCs and testing them in production.

Ongoing corrosion testing indicates that special surface treatment or cleaning may be necessary to prevent pitting initiation that iron particles that the boron carbide abrades from the plate rollers. Transnuclear specification stipulates that any surface processing that is necessary to achieve acceptable results from the qualification testing must be documented and duplicated in the production. So that if you qualify it one way you have to make sure you continue that all the way through the production.

The NRC has also approved MMCs for wet storage for the Curtiss Wright NETCO SNAP-IN rack inserts that have been incorporated.

MEMBER SKILLMAN: Let's talk a minute about the chemistry here.

MR. MCINNES: Okay.

MEMBER SKILLMAN: You bring a irradiated fuel assembly over that's been three cycles in the reactor and it is one of the bowed assemblies. It's black as can be and it's at end of life.

But what it brings with it is this metallic coating that is whatever has wasted from the reactor coolant system pressure boundary. It's iron, it's boron, it's --

CHAIR POWERS: Manganese, cobalt.

MEMBER SKILLMAN: Thank you. So now I've put this getter, or this battery next to my aluminum matrix. What research has been done or what data does one have to confirm that I haven't created an electronic cell so that I'm degrading the poison on which I'm depending to provide its subcriticality?

MR. MCINNES: Okay, I'm looking backwards. We have a couple of technical guys in the background, but I don't think we have an answer to that question. I think we have to get back to you.

MEMBER SKILLMAN: I'd like to put that on the record. Aluminum and boron to me is a battery, and here we're introducing another metal. We're introducing whatever has come out of the reactor cooling system and there's nothing we can do to prevent that from coming.

And so now I may have several different couples, the result of which may be degradation of the poison upon which I depend or the structure. So I'd like to understand this a little more clearly, please.

MR. MCINNES: Okay.

MR. BRACEY: And if I may, I'm Bill Bracey from Transnuclear. I think I can perhaps at least give some partial answer at least. There's a lot of experience with using aluminum based neutron absorbers in spent fuel pools already, and that's mostly with a particle, Boral, which is chemically similar to what we're proposing but is different because it's porous, and it has had some problems originating from that porosity, mainly water getting into the pores and then causing blisters to form. The products we have here are not porous so they're really not subject to those problems.

There's been no evidence to my knowledge of significant chemical deterioration or galvanic deterioration of the Boral products that have been used since the mid-1980s in storage, despite the fact that they're coupled directly with stainless steel tubes in most of the racks that have been used up until now.

In our designs, because we're using aluminum tubes we actually have a really large aluminum surface that's in contact that is sandwiching this metal matrix composite and providing enough surface area that they kind of, whatever battery is formed is actually fairly weak because it's diffused over such a large surface area.

The other thing when we looked into this whole question of using aluminum, we looked a lot at the experience at Savannah River and storing aluminum clad spent fuel, mostly a research reactor or military type fuel. And their experience was there that they had a fair amount of pitting, but of significant problems I would say with pitting in the early 1990s, which were entirely resolved by just cleaning the water up and getting themselves down to below 25 parts per million of chloride, which is actually very high by standards of commercial reactors.

So we're fairly confident that the maintaining the water chemistry at the levels that are required in current spent fuel pool practice and in the EPR specification will really resolve the problems that you've raised.

CHAIR POWERS: Savannah River does not have the crud problem that Dick brought up. They don't have that kind of chemistry in their water, so that experience probably really is not useful to address this stuff.

MR. BRACEY: Well, I said it was a partial answer.

CHAIR POWERS: The question that's arisen in the aftermath of the Fukushima actually has to do with your seismic issues that break concrete, drop it into the pool and then your pool starts running basic and you get a corrosion there. That's a little different than the question you've addressed here.

MR. MCINNES: Are you asking a separate question about concrete in the pool?

CHAIR POWERS: Yes.

MEMBER STETKAR: You weren't here yet. Were you here yesterday? This got punted to you.

CHAIR POWERS: Probably because you weren't here. They said oh, this guy will answer any --

MR. GARDNER: We will be talking about a

beyond design basis --

MR. MCINNES: You're way beyond design basis. But first of all, if you've got a significant amount of concrete in the pool I think that the basic or the reaction between the concrete and the aluminum would be the least of your problems.

CHAIR POWERS: Right now it's a big problem in one of the units at Fukushima. I can't remember if it was 1 or 2.

MR. MCINNES: I'm not trying to downplay it. It would be a problem that would have to be resolved, but I think it would be a minor problem in the overall list of problems that would be each solved at the time.

As far as, the source of the concrete would have to be I would guess the roof of the building seeing as that's the only thing that is anywhere near. If the roof came down you've probably got a year or so in the pool of the concrete before they would start getting, pulling concrete out.

CHAIR POWERS: I honestly don't know.

MR. MCINNES: Well, I don't know either. But, you know, on speculating you'd be pulling big chunks --

CHAIR POWERS: It's not days, we know

that. I mean the problem is not big chunks. Actually the problem is small chunks because they leach so much faster.

MR. BRACEY: If I may just poke into this again, is there evidence that there would be sufficient alkalinity to overcome the acid of the boric acid in the pool or the acidity that occurs just from, even if you don't have borated water generally you've got carbon dioxide absorption, so even in a BWR pool it's generally at the somewhat acidic condition.

CHAIR POWERS: First thing that happens, all the carbon dioxide gets precipitated as calcium carbonate. Okay, so you kind of lose that mechanism. You get a little acidification on the radiolysis.

I mean the calcium hydroxide's creating a nice pH 10 local environment and so we're getting corrosion of aluminum rack. Now theirs are literally aluminum rack.

MR. MCINNES: I don't know. We'd have to find the answer.

MR. GARDNER: I don't think we have anything else to say other than --

CHAIR POWERS: Well, I mean the answer's pretty much what you said is, well yes, you've got a problem but you've got time to address it, need to figure out what you're going to address it. We've probably got bigger issues. I mean everything you said is absolutely true.

MR. MCINNES: It's not something that's going to cause direct failure immediately. It's going to be a long term process and you've got --

CHAIR POWERS: Yes, and the only question is what we mean by long term, whether it's months or years, and I don't know the answer to that. Clearly, the boron carbide aluminum composite is most at risk, because I would assume that would corrode most readily. But I don't even know that for a fact. I've never run, I mean I've done a lot of work with boron carbide dispersed aluminum but never to look at it corrupted.

Incidentally, do you know if these guys are making this composite by extrusion or are they using fixotropic melting processes for --

MR. MCINNES: I think they do it both ways.

CHAIR POWERS: Fixotropic is cool.

MR. BRACEY: Again, I can answer that. The reason I'm coming up and talking about this is I've been mostly the one who has been involved in developing these materials for dry storage.

The materials are made by powder metallurgical processes, which we're generally getting away from extrusion. We're doing powder metallurgical processes which are then followed directly by rolling. We are doing it by low pressure.

Doing some work with some new people now who are doing a kind of low pressure intrusion process of molten aluminum into a bed of boron carbide. We're working with one particular company which adds titanium to the aluminum, is doing that as a molten, direct chill casting process. The titanium is added in order to prevent the aluminum from reacting with the boron carbide.

(Crosstalk)

MR. BRACEY: So there's a little series of different processes which have been developed. I mean the materials started becoming commercialized in the late '90s primarily based upon powder metallurgical processes, but people keep coming up with new things.

And that's one of the reasons why we specified, rather than specifying a particular method we've specified a means of qualifying materials, a series of qualification tests including corrosion testing, and focusing on pitting particularly because it's a main problem of aluminum corrosion. General corrosion is not really what we anticipate as a failure mechanism.

And also we've specified a series of manufacturing testing methods, again so we can generically apply them to anyone who comes up with a reasonably good method of producing the material.

MR. MCINNES: Okay. Partially to answer the questions you have been asked is that one of the things we're proposing or we have in the technical report is a program to put a series of coupons into the pool.

And the program would consist of a coupon tree, which would be a piece of pipe or something like that onto which we would attach a bunch of coupons, and these coupons would be retrieved over a period of the life of the plant. And on the slide there's a suggested retrieval time.

Coupons are typically taken from the production material, and we completely measure them and characterize them before they're immersed in the pool. And we take a matching coupon, in other words we have a bunch of coupons, we split them in half.

Half of them go into a dry storage so that we can compare the results of the exposure to the pool with the experience of dry storage to make sure any degradation is determined as it happens.

The other thing we do is we make sure that the coupon tree is placed as close to the hottest fuel as we can within reason about moving it around. We don't think there's any irradiation problems with the material, but it's moved around the pool so that it's always in the radiologically warmest spot.

CHAIR POWERS: There are certainly conditions where warm is not the worst corrosion environment. I'm just trying to think if that were to affect this material. Nothing comes to mind.

MR. MCINNES: When I say warm, it's not the temperature, it's the irradiation minerals in the pool. So the pool temperature would be roughly the same uniform all the way across. There would be very little temperature difference, but it's put in the radiologically hottest spot we can find just in case there's some irradiation damage that's occurring.

CHAIR POWERS: Well, you rack your brain trying to figure out how, but yes, I guess it could. Okay.

MEMBER SKILLMAN: I'd like to commend you for that thought. The challenge that it may be just as important to put the coupon where the oxide layer on the fuel assembly is the greatest. Because that can be where the chemistry in the cell or in a group of cells is most seriously different from the greater area or the greater volume of the spent fuel pool water.

And so I think for this program to have real meaning, the coupons need to be where the radiation level is high but also where there is, if you will, susceptibility of the coupon to whatever the adverse chemistry may be from that irradiated fuel assembly.

MR. MCINNES: Yes.

MEMBER SKILLMAN: So I think the program needs to reflect not just being in a high radiological area, it needs to reflect proximity to a fuel assembly that is significantly crudded.

MR. GARDNER: Okay.

MEMBER SKILLMAN: Thank you.

MR. MCINNES: Okay, the last part of our portion of this presentation just describes the important features of the criticality, structural, seismic and thermal analysis that we've performed. And the only part of this that I want to address is those parts that we think are different.

There's a whole bunch of analysis that you've seen time after time for many different fuel racks. I'm just going to accept that that's a standard method and go on.

Okay, criticality analysis. First of all, I'll say I'm a civil engineer so I'm going to tell you all about criticality analysis from a civil point of view.

MALE PARTICIPANT: Very dangerous.

MR. MCINNES: Separate criticality analyses were performed for the Region 1, Region 2 and the new storage vault rack modules, and also to evaluate the effect of interfaces between the Region 1 and the Region 2 modules. So we did a whole series of criticality analyses.

The criticality analysis for the medium density Region 1 racks was performed using the worst case of pure water in the pool, and while the Region 2 analysis was done with burnup credit and credit for the minimum soluble boron loading in the pool. So the Region 1 analysis is pure water, Region 2 is taking credit for the burnup credit and for the boron. Next slide.

Okay, at the time the rack analysis was being performed, the NRC Interim Staff Guidance or ISG DSS 2010-01 was still in the process of being issued. And the methodology used in the Region 2 analysis was based on the burnup methodology developed by Transnuclear to meet the requirements of 10 CFR 71.

The criticality analysis methodology presented in the FSAR and the TN technical report incorporates all of the requirements of the ISG. The advantages of the methodology that the TN has used include that in previous spent fuel analyses the depletion in criticality code biases and uncertainties were combined in a single analysis since integral methods were used for that analysis.

The methodology we used separates the biases and uncertainties associated with depletion and criticality codes and ensures that the results are conservative that they develop separately.

The use of the isotopic assay dated to benchmark the depletion codes has not been performed for the typical spent fuel full criticality analysis presented in the past, so utilizing this method ensures that the biases and uncertainties are properly characterized and well understood and conservative.

The criticality codes were typically benchmarked to fresh fuel critical experiments and in some cases to the reactor cycle data from the commercial reactor criticals.

The French HDC experiments documented in

NUREG-6979 are representative of burnt fuel assemblies with a similar actinide composition in the spent fuel pool environment.

And in summary, the methodology presented by Transnuclear is more conservative than typical fuel rack and produces, we think, a very conservative result. So if we move on to the next slide, the critical --

CHAIR POWERS: It's your last line on that previous slide.

MEMBER SCHULTZ: What is the variety of misload configurations which are evaluated?

MR. MCINNES: Okay, I need to get our criticality expert up here. Prakash?

MR. NARAYANAN: Hi, I'm Prakash Narayanan, and I'm the manager for nuclear analysis for Transnuclear. The variety of misload configurations that describe the postulated mislocation or mispositioning of fuel assemblies where the misload of fuel assemblies, if I want to call that, is a fuel assembly that is fresh 5,8 percent fuel, and the positions include space between the rack modules, space in a position where a fresh fuel assembly is not supposed to go into a Region 2.

CHAIR POWERS: I mean that's the answer

was looking for yes, you looked at a fresh assembly and brought it around in all the conceivable places somebody should put it.

MR. NARAYANAN: Yes.

CHAIR POWERS: Great.

MR. MCINNES: Okay, on Slide 35, the previous fuel rack calculations have assumed 100 percent credit for boron loading. However, in procuring this design, TN adopted the NRC requirements of Part 71 and Part 72, because that's what we've been working with for many, many years, and assumed a 90 percent credit for the boron.

In addition, when we procure the poison sheets we impose a statistical methodology on the boron loading on acceptance testing to ensure that we have a probability of a 95 percent confidence. All of this makes sure that we have a 15 percent higher boron content than what we actually have in our analysis.

Also in existing fuel rack designs, the spent fuel pool burnup credit analyses are performed using the lattice physics codes for both depletion and criticality.

Our methodology is based entirely on the scale methodology with extensive benchmarking, which results in a much better understanding of the physics and a better determination of the true margins available.

And if you have questions we'll call Prakash back up again.

CHAIR POWERS: What's your standard analysis?

MR. MCINNES: Okay, structural and seismic analysis criteria. The structural design of the rack modules follows the guidance and criteria presented in NUREG-0800 Section 3.8.4 Appendix D. And this Appendix provides guidance on the applicable codes, standards, loads, load combinations, analysis procedures and acceptance criteria.

Following this guidance, the racks are designed, fabricated and examined in accordance with the requirements of Section 3 ASME Code Subsection N and for Class 3 structures.

MEMBER SKILLMAN: If I could ask, please, how do you apply these codes to the aluminum components in those racks?

MR. MCINNES: We don't. The aluminum components are not the main load carrying components. The stainless steel frame is carrying all the loads.

MEMBER SKILLMAN: Okay, thank you.

MR. MCINNES: In particular, the seismic

evaluation of the racks used an analysis methodology that represents a significant advance over the simplified mass model approach that has been used for racks in the past.

The methodology adopted by TN removes many of the assumptions and/or approximations that had to be made in a lumped mass approach and explicitly captures the important parameters affecting the seismic response such as 3D effects, fluid coupling and multi-rack interactions.

As we talked about earlier, the racks are free standing and submerged in the spent fuel pool. And the seismic responses are a function of the dynamic interaction with the neighboring racks or adjacent pool walls due to the hydrodynamic coupling that takes place because of the water in the gaps between the racks. Under seismic accelerations the racks could undergo relative sliding and/or rocking on the pool floor potentially developing rack-to-rack, rack-to-floor impact and must be accounted for in the design.

This largely nonlinear problem is best suited to a code like LS-DYNA which has been used extensively in solving many impact type and fluid interaction problems in the past.

The input to the seismic models is in the form of generic U.S. EPR response spectra for the spent fuel building which were broadened as required by Reg Guide 1.22 and amplified to account for potential changes in the spectra. The envelope spectra was then used as a basis for developing the input time histories.

As required by NUREG-0800 Section 3.7.1, five sets of time histories were developed and applied to the full pool model shown in the bottom left hand figure here. What we show here is the 17 rack modules that are in the pool.

What the picture doesn't show is all the water and the pool walls and everything else around it which are all in the model. On the right hand side, basically it's just an extract from one of the time histories, shows the water sloshing at the surface due to the effect of the earthquake. So that's just a snapshot in time of what the water surface --

MEMBER SKILLMAN: Ian, what does the coloration mean on the faces of the fuel of the 17 assemblies? Looks like there are three racks that are, if you will, to the lower right, two racks to the lower left. There appears to be an imprint of color. Is that a contact pressure or a contact --

MR. MANRIQUE: Kind of. It's what we call volume fractions. That means that water has been squeezed out of that area. And so the coloration means that is less water in that volume of in that gap.

MR. MCINNES: The reason it's only on these three in here is that there's no core wall in this area.

MEMBER SKILLMAN: I see. So that's the squeezing out of water if the rack contacts the wall.

MR. MANRIQUE: No, it's not contacting the wall, but as the rack is moving towards it.

MEMBER SKILLMAN: Towards the wall.

MR. MANRIQUE: Right.

MEMBER SKILLMAN: So that's a reduction in mass. Thank you, I understand. Thank you.

MR. MCINNES: Okay, go the next slide, please.

CHAIR POWERS: In your sloshing modeling, how critical is sloshing in the analysis?

MR. MANRIQUE: Sloshing is not very critical as far as the racks is concerned. The racks are pretty deep in the pool. It's more a concern as far as the wall design of the pool. But that's in effect the rack behavior.

CHAIR POWERS: Well, the question of course is how do you know that it's cracked, because sloshing is a difficult analysis to do.

MR. MANRIQUE: Right. And that's one of the features of the LS-DYNA code, it's able to model fluids pretty well, and in this case basically anything above the surface of the water we have a mesh of void at the beginning of the analysis. And when the analysis starts, as the water starts moving it fills up into that void mesh and that's --

CHAIR POWERS: So you just mesh up the void and it presumes to give you an answer. The question is, how good is the answer?

MR. MANRIQUE: Well, we've validated the code against, you know, standards. We have done a number of validation and mitigation problems including the effect of the sloshing against the ASCE 498 standard, for example. It has provisions for design of seismic related structures.

CHAIR POWERS: Most of the tests that I know of, and I don't make a hobby out of collecting the tests on sloshing, most of them I know of are for relatively small volumes of water compared to the spent fuel pool.

And my perception, accurate or not, is

that sloshing becomes more extreme as the body of water that's set in motion gets bigger. And so I always wonder about how well these codes are doing on the sloshing part.

MR. MANRIQUE: Well, like I said, we've made comparisons with, you know, hand calculated solutions or standard solutions that are in the industry and we get pretty good matching in terms of response.

MR. MCINNES: As far as the racks are concerned it's not critical.

MR. MANRIQUE: Yes, I mean for the racks it doesn't affect it because the racks are way submerged.

MEMBER SCHULTZ: So that's what you're seeing here with regard to the modeling around the racks down below, that there's some hydrodynamic forces but they're not significant or considerable.

MR. MANRIQUE: As far as the sloshing is concerned or you're talking about --

MEMBER SCHULTZ: As far as this model is concerned you're not only doing the sloshing but you're doing the hydrodynamics around the racks too.

MR. MANRIQUE: Oh yes, all the hydrodynamics. The coupling of the water in the gaps in between racks and between racks and the walls and all that is accounted for.

MR. MCINNES: The sloshing is really the secondary effect. We're not concerned about the sloshing. We were more concerned about the effect on the racks than we were about the sloshing.

MEMBER SCHULTZ: Down below.

MR. MCINNES: Right.

MEMBER SCHULTZ: But as you've done the sloshing calculations for the pool, is there anything significant that's been derived from that calculation? Because this is a fairly high level of detail calculation that's being done.

Is there any result that's been shown to be dramatically different than what has been assumed in the past with regard to the spent fuel pool structure?

MR. MANRIQUE: Yes, like I said, the benchmarkings that we have done with the, they used the methods in ASCE standards, for example, are consistent with what we are getting on this analysis.

MEMBER SCHULTZ: So nothing is dramatically different than what's been experienced with other codes previously?

MR. MANRIQUE: Right.

CHAIR POWERS: What I can tell you is that we've had reports that during the recent Fukushima accident from some of the adjacent plants, not Fukushima itself, but they observed wave heights of as much as a meter on the pool.

We were particularly interested in the question of sloshing water out, and so far we have not found any real significant evidence of that but some very substantial waves apparently were formed.

MR. MANRIQUE: I mean we are seeing here, this slide captures the time of maximum sloshing, and if I remember correctly this is, yes, maybe around four feet, four or five feet.

CHAIR POWERS: Four feet?

MR. MANRIQUE: Yes.

CHAIR POWERS: Substantial. Interesting.

MR. MCINNES: It's substantial, but it doesn't appear to go over the top of the pool.

CHAIR POWERS: And that's consistent with what we found at both Japanese earthquake, the 2006 and the one at Fukushima. A lot of slosh but not much water loss as far as we could tell. Please continue.

MR. MCINNES: Okay, next slide. Okay, what this shows is just a basic overview of the LS-DYNA whole pool model, and basically the model accounts for the rack-to-rack and rack-to-pool structural hydrodynamic coupling, the effects of the structural nonlinearities and interactions due to pool-to-rack rocking with the sliding plus the potential impacts between racks and between racks and the pool structure.

And I gather there was a question yesterday about impact on the walls.

MEMBER SKILLMAN: Yes.

MR. MCINNES: The basic answer is that as far as our model is concerned there is no impact on the walls.

MEMBER SKILLMAN: How is that assured?

MR. MCINNES: How is it assured?

MEMBER SKILLMAN: If you were to say that the friction factor is great enough to prevent the rack from translating so it can't hit the wall, I can understand that. But it seems like it's a guess.

MR. MCINNES: We did a whole range --

MR. MANRIQUE: I mean our analysis was done with, for a number of coefficient frictions from 0.2 to 0.8, and some others in some cases random values of some computed values like 0.5. And for all these cases, what we found is that the displacement of the rack is less than the gap that exists between the rack and the wall. So from that we can assume that there is no impact on the liner of the fuel pool.

MEMBER SKILLMAN: How is that conclusion affected by whether the rack is full of fuel assemblies or not full of fuel assemblies?

MR. MANRIQUE: We've done analysis, sensitivity analysis, other analysis with partially loaded racks of different configurations, so that was also looked into.

MEMBER SKILLMAN: Thank you.

MR. MCINNES: So basically that question accounts for most of the slide. You know, the results from the multi-pool model were taken so that we identified the most heavily stressed modules, and we took the results from the whole pool model and applied them to an individual model, a highly detailed model of the rack itself so that we could do a detail and find an element analysis of the rack to just general what the stresses were. So there's two models here. There's an LS-DYNA rack model and then there's a finite element model.

Okay, and finally is the thermal hydraulic analysis. The thermal design follows the guidance and criteria presented in the standard review plan of NUREG-0800, and a position for review and acceptance of spent fuel storage and handling applications.

Conservative methodologies were applied including the heat lost to the pool walls and the pool surface was ignored. The dropped fuel assembly assumed across the rack at the worst possible location.

Offloaded fuel was assumed to be placed in contiguous rack cells to get the maximum heat in any particular area of the pool. The maximum fuel cladding temperature considers the axial peaking factor and ratio of maximum to average decay heat within an offload.

And the slide itself basically just gives you the parameters that we used for the analysis, the 120-degree pool temperature for partial full core offloads, minimum water depth of 23 feet. The maximum temperature, bulk water temperature of 140, assuming the loss of one active cooling train and maintaining the peak fuel cladding temperature below the local saturation temperature of 240 degrees.

MEMBER STETKAR: Ian, I know you qualified yourself as a structural engineer, and I'm not a thermal hydraulics guy either.

MR. MCINNES: But I have an answer for you.

MEMBER STETKAR: If I'm drained down to the bottom of the slots, so I start out at two and a half feet or whatever it is above the top of the active fuel and lose all pool cooling, do you have any sense of the time to start boiling in the pool from those conditions, and the time to drain off until they start to uncover fuel and get fuel damage? Has anybody looked at that?

MR. MCINNES: Well, we have the gentleman that did all our thermal analysis. I'm not sure whether he can answer that question or not.

Greg, do you have a --

MR. BANKEN: Yes, my name is Greg Banken, AREVA Thermal. And what we looked at was boiling time with the minimum water level in it, the 23 feet. And I'd have to look a little bit to find the number, but I believe at full core offload, you know, we just completed a full core offload, I think we had something on the order of four hours to boiling.

Now if we're talking about fuel that's residual fuel and has been allowed to cool for several months in the pool, then the amount of heat is substantially less. But then again we've got much less water, so that particular time frame hasn't been calculated.

MEMBER STETKAR: Okay, I'm sort of interested in that. It's 4.3 hours in the FSAR for the start to boil from your conditions.

MEMBER BROWN: John, is that the point where it's drained down to the level of the gates? That was your question?

MEMBER STETKAR: Are you talking about the cooling trains being, not operating.

MEMBER BROWN: Okay. I was going to ask that.

MEMBER STETKAR: I'm looking at margins here, time margins.

(Crosstalk)

MEMBER STETKAR: I'm looking at time margins in terms of --

(Crosstalk)

MEMBER BROWN: Okay, so the water's down to where the gates are, none of the cooling trays are operational. How long to boiling --

MEMBER STETKAR: How long to heat up to boiling and how long to boil off to --

MEMBER BROWN: Roughly four hours plus change.

MEMBER STETKAR: No, no, no. It's much less than four hours.

MEMBER BROWN: Well, I thought you just said 4.2 hours.

MEMBER STETKAR: If I start 23 feet, other than 23 feet above --

MEMBER BROWN: With the full 23 feet above --

MEMBER STETKAR: Well, it's minimum tech specs level.

MEMBER BROWN: Oh, I'm reading the view graph up there. That's the minimum.

MEMBER STETKAR: Starting from that 23 feet it's 4.3 hours under, you know, full core offload.

MR. BANKEN: Fresh offload, yes.

MEMBER STETKAR: Fresh offload.

MEMBER BROWN: With no cooling systems.

MR. BANKEN: Right.

MR. HERNANDEZ: Excuse me, I want to add something. My name is Raul Hernandez. I'm the reviewer for the spent fuel pool for balance of plant.

Like you mentioned before this would be a beyond design basis event that so we haven't asked for the time to boil on a situation like that. The spent fuel pool cooling system wouldn't be operating because this is the below the minimum level for, in our pressure head for the spent fuel pool cooling system to be operating.

But this plant is designed with safety related makeup from seismic Class 1 tanks and safety related power.

MEMBER STETKAR: I understand.

MR. HERNANDEZ: No, no, what I'm trying to say is --

MEMBER STETKAR: Get it on the record, but yes.

MR. HERNANDEZ: One of the questions that we've asked even though this is a beyond design event, is the manual actions to isolate any possible leakage. That is one of the open items that we have that are in --

MEMBER STETKAR: Yes.

MR. HERNANDEZ: -- 1.4, it's what are the manual actions that can be taken, what are measures can be taken to isolate any leakage throughout the different positions that the fuel assembly can be in, because we've got several gates. So depending on where the fuel assembly is in the path to the cask, you could be blocking one or the other of the gates or of the lifts.

MEMBER STETKAR: Well, and the problem is

I have no idea. Until this morning I thought that perhaps the, whatever they call it, the swivel gate was motor operated and you could operate it remotely. If it's the big guy that has to locally manually operate it, dose rates are going to be pretty high there.

MR. HERNANDEZ: That swivel gate, it is motor operated but it has a manual feature that you can --

MEMBER STETKAR: It is motor operated?

MR. HERNANDEZ: Yes, the swivel gate is a motor operated gate that has a manual feature.

MR. PANDYA: No, actually --

MEMBER STETKAR: At the microphone, this is sort of important.

MR. PANDYA: Yes, sure. No, my impression is that this swivel gate is manually operated.

MEMBER STETKAR: When you say manually I think manually, mechanically. Somebody turning it on.

MEMBER BROWN: You're talking the swivel gate between the --

MEMBER STETKAR: Between the pool sections.

MEMBER BROWN: Okay, not the one that goes up and down for the dry, this is for the movement from over to that facility.

MEMBER STETKAR: I mean the cask loading pool or the transfer pool.

MR. SEGALA: This is John Segala from the staff. We took a trip to the Cattenon plant in France, and their design there had a motor operator and a manual backup. So --

MEMBER STETKAR: We need to understand what it is here because --

MR. SEGALA: -- I'm not sure that we appreciated a difference here.

MEMBER STETKAR: Yes, part of the reason for my question, you know, the luxury we have is we don't necessarily have to stay within the design basis, licensing, single failure stuff. You're right, if you drain down that far you have lost the spent fuel pool cooling systems because they take suction well, well, well above that elevation.

So the question then becomes either isolation or makeup capability, how is it provided, remotely, locally, time to boiling, time to boil off. And if it's local mechanical manual actions, you know, what are the dose rates in those areas for the people doing those local mechanics? So that's all kind of the reason I'm asking these.

(Crosstalk)

MR. HERNANDEZ: Open items that we have out there, you know, is basically describe which equipment do you need, which are safety related, which are backed up by safety related power, what manual actions are you crediting, and time, how much time are you crediting for those? That's one of the open items that we still have up there.

MEMBER STETKAR: Anyway with respect to AREVA, I'd still be interested in those heat up and boil off times even, you know, if you haven't asked them, just for my own sort of edification.

MR. PANDYA: And we'll take an action to confirm that whether those are really manual or motor operated.

MEMBER STETKAR: That would be really useful, because I wrote down manual with a little exclamation point here.

MR. MCINNES: This slide just shows the thermal model that was used for the modeling. The main features of it are just the 2.2 million mesh elements which is comparable or larger than most recent spent fuel pool analytical efforts.

And the model includes the flow pressure loss through the fuel assemblies based on detailed modeling and measured data, and the flow between the individual racks and between the racks and the pool surface.

So that pretty much concludes the Transnuclear part of the presentation.

CHAIR POWERS: I suspect that now is as good a time as any to break for lunch. So why don't we recess until 1:00 for a midday repast.

MEMBER BROWN: I had one question before we do that and it was back on Slide 16. That was your picture of the cask and the bellows picture. It was in the previous thing.

MEMBER STETKAR: They're going to come back to seal leakage if you're going to ask about that.

MEMBER BROWN: Oh, they are?

MEMBER STETKAR: Yes. There's a later --

MEMBER BROWN: Of the cover and as well as the plate that they put on underneath?

MEMBER STETKAR: It's a general topic of seal leakage. I looked ahead. They're going to talk about that --

(Crosstalk)

MEMBER BROWN: Okay, then I'll wait until then. That's fine, I won't forget the question. You may already have it.

MEMBER STETKAR: I have one anyway, so --

MEMBER BROWN: This is an electrical guy that thinks of a mechanical question every now and then.

CHAIR POWERS: We shall exact a penalty if you keep us from lunch anymore, Charlie.

MALE PARTICIPANT: Motion to adjourn.

CHAIR POWERS: All right, we will recess.

(Whereupon, the foregoing matter went off the record at 12:03 p.m. and went back on the record at 1:01 p.m.)

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

1:01 p.m.

CHAIR POWERS: Let's come back into session. And we're continuing our discussion of the

Section 9.1. And Darrell, it's your show.

MR. GARDNER: Very well. We're going keep going with fuel pool cooling and purification system. And George Ifebuzo will be our AREVA guy making the presentation.

MR. IFEBUZO: Good afternoon, my name is George Ifebuzo, the AREVA NP. Again, involved with the fuel pool cooling purification system for three years. And my background is Chemical Engineer.

CHAIR POWERS: All right. Now we're going to get some deep skin here. Where did you get this Chemical Engineering degree?

MR. IFEBUZO: From the University of Massachusetts, at Lowell.

MEMBER STETKAR: A real school, wow.

CHAIR POWERS: Two guys on your side already, wow.

MEMBER STETKAR: People's better now than engineers.

MEMBER BROWN: You're in trouble now, I'll just give you a heads up.

MR. IFEBUZO: All right. I'm here to present an overview of the fuel pool cooling purification system. The system pretty much consists of two separate and independent subsystems. The fuel pool and the fuel pool purification system.

The required safety function of the system is to cool and cover the spend fuel assemblies with water during all storage conditions. What this does is just to remove the decay heat from the spent fuel pool and provide radiation shielding.

The U.S.EPR design conforms to the guidance and requirements provided in SRP 9.1.3 and Reg Guide 1.13 for safety related spent fuel cooling system design. This is lightly different from most operating plants which have the non-safety related fuel pool cooling system design.

The system is also designed to prevent the inadvertent draining of the pool below ten feet above the top of the actual fuel assembly. The first subsystem, the fuel cooling system is designed to remove decay heat from the spent fuel pool. And to maintain the pool at less than 140 degrees Fahrenheit. And this temperature is considering fuel cool-off load with single failing.

Without single fail the temperature is kept at 120 degrees. The system consists of two spent fuel cooling train which are installed on opposite sides of the fuel building. The separation on either side of the building limits physical effects of an internal hazard to just one train.

Each train consists of two pumps in parallel and the heat exchanger. The components are powered by separate electrical divisions of emergency AC power. They are also designed with alternate feed provision. And are backed by emergency generators.

The next subsystem, which is the fuel pool purification system.

MEMBER SKILLMAN: George, please, before you proceed. Back to your previous slide. The location of these pumps relative to internal flooding. Should the seal for the fuel cask have an upset condition? Where are the pumps and their motors located, please?

MR. IFEBUZO: They are located at the lower part of the building. We would have to look at the allowances as part of the previous presentation. And probably address that issue later.

MEMBER SKILLMAN: Thank you, George.

MEMBER STETKAR: George, are there any local power supplies for these things or are they just powered from the buses?

MR. IFEBUZO: No local motor control centers for valves. The fuel pool purification subsystem provides containment isolation of the reactor. Pool purification supply return lines.

It also provides filtration and surface skimming of the reactor pools, the fuel pools and in containment refueling, storage tank. And this removes radioactive material and product impurities.

The system also provides water transfer capabilities between these pool compartments. The purification system, the purification loop consists of two parallel purification pumps. One ion exchanger and two filters.

MEMBER SKILLMAN: George, how is the ion exchange media selected for this application?

MR. IFEBUZO: We use resin materials in the ion exchanger for the purification.

MEMBER SKILLMAN: When you say selection, what do you mean? Is it the same that you would use for the letdown for purification for and cooling? Or is this a different resin?

MR. IFEBUZO: I believe they are the same but I would have to confirm that.

MEMBER SKILLMAN: Yes, I'd like to find out, please. Thank you.

CHAIR POWERS: Is this a cation exchange?

MR. IFEBUZO: Correct.

CHAIR POWERS: So you're not doing the

anion purification at all? How do you keep the chloride out?

MR. IFEBUZO: I will look into that as well.

MEMBER STETKAR: I think it's a standard mixed bed.

MEMBER SKILLMAN: Yes, I think it's one to one mixed bed, is what I suspect it is.

MEMBER STETKAR: He said it's cation

MR. NEWTON: We'll find out.

MR. IFEBUZO: Your questons was how do yu keep the chloride out?

CHAIR POWERS: Yes. How do you keep the chloride out if you're just having a cation ion exchange resin?

MEMBER SCHULTZ: And we were told earlier that chloride was a problem for this system, since it's stainless steel and aluminum.

MR. IFEBUZO: I'll have to get back to you on that.

MEMBER SCHULTZ: George could you elaborate on the third bullet. The water transfer capability between the various sections of the pool.

MR. IFEBUZO: Okay. So we use the purification pumps to transfer water between the pool compartments. We can transfer water from the transit pit to the cast loading pit. We could transfer water from the IWST to any of the reactor building compartments. So the purification pumps in this system provides that capability.

MEMBER SCHULTZ: Thank you.

MEMBER STETKAR: George, I was going to ask this later, but since it looks like you can handle it. The purification loop has bottom suctions from the reactor building pools, the cask loading, what ever you call it. Cask loading pool and the reactor building transfer pool. It doesn't have a bottom suction from the actual spend fuel section of the spent fuel pool.

MR. IFEBUZO: That's right.

MEMBER STETKAR: Is the purification loop normally in operation when you're either bringing fuel from the reactor into the spent pool fuel? Or transferring fuel out through the cask loading pool? And those are the only suctions, those are the bottom suctions from there.

Are those normally aligned and open when you're moving fuel? It's kind of an operational question, but there's a basis for my question. A design basis.

MR. IFEBUZO: I believe most of the purification is done before. However there is a surface skimming done during fuel handling to keep the water clear. But typically purification is done as needed.

MEMBER STETKAR: So are the bottom suctions simply for water transfer? In the transfer pit and the cask loading pit?

MR. IFEBUZO: That's correct. They are for purification and water transfer as well.

MEMBER STETKAR: Water transfer I can understand, it's question of will they be open for purification when they're actually moving the fuel?

MR. IFEBUZO: I will have to look into that.

MEMBER STETKAR: The reason I ask is, they are six inch lines and they're seismicaly qualified up to the first isolation valve. Which is a local manual mechanical, not manual push a button. Mechanical valve. If you get a seismic event when the system is in service and that line is open it's going to be really really difficult for any human being to close that valve. Presuming it's in the compartment that is now filling with water through a broken six inch line.

So there were questions, there were RAI

questions about seismic capability of the fuel pool purification system. And it's not seismically qualified. Is that correct? Except for the stubs that come up to that first manual isolation valve.

That's one of the reasons why I'm kind of interested under what conditions will it actually be in service. And with those valves open.

MR. IFEBUZO: Okay.

MEMBER STETKAR: If you're done taking notes another question. I looked at the flow drawing in the FSAR and there are connections from the fuel pool purification system to the what I call the normal plant. Forgot what it's name is, the normal plant purification system, the CVCS system. The KBE of whatever the heck it's called.

Does the normal purification system include deborating demineralizers, that you can place into service to remove boron from the reactor coolant system?

MR. IFEBUZO: Sorry, can you repeat that question again?

MEMBER STETKAR: Does the normal, let me make sure I get the right name of the --

MR. IFEBUZO: The CVCS system?

MEMBER STETKAR: Yes, the CVCS system,

let's call it that. It's three letter distinction is KBE, but CVCS. Does that system include deborating, demineralizes that you can specifically use to remove boron from the reactor coolant system?

A lot of plants. Well I don't know, I don't want to presume anything. I used to be an operator of a plant and we had demineralizers that we cut in at the end of core life to actually remove boron. You know so we didn't have to just dilute the heck out of the system.

But I don't know whether this design actually has that. The reason I'm asking is there was a question that was raised by the staff about potential removal of boron from the spent fuel pool water.

And the response focused strictly on the amount of pure water makeup to dilute that boron inventory down to whatever nominal concentration it needs to be.

The question came to mind, are there other ways that we can remove boron. So first of all, part A is are there boron removal demineralizes, ion exchangers that this system could be aligned to. Could it be aligned to it and how much boron could I take out? Presuming I've got clean resins in there.

And I just start shooting this stuff through. Until the resins saturate.

I mean you might not be able to do it even if you have them. But that's a measure of capacity of the demineralizers and that sort of thing.

MR. IFEBUZO: Well, that's part of operation before we run the system. We saturate the mixed bed ion exchangers with, we get the boron concentration up to what the pool concentration is to avoid the resins taking out boron from the pool inventory.

There are no other systems that you could connect this system to to actually deplete the boron concentration in there.

MEMBER STETKAR: In the spent fuel pool? The CVCS system doesn't have that capability?

MR. IFEBUZO: The CVCS system has a similar ion exchanger. But we don't use that ion exchanger for purifying the spent fuel pool.

MEMBER STETKAR: Normally you don't. I'm just looking for things that actually can be connected. Well, the primary question, I understand normal demineralizers, ion exchangers and how they are operated. The question is, first of all does the design have explicitly a set of demineralizers or ion exchangers that are for the express purpose of removing boron from the primary coolant system.

I mean if the answer is no, I don't care. If the answer is yes, then even if it's misaligned for some reason to connect those. If they saturate and still can't get these fuel pool boron concentrations down below what's it's minimal is, then I don't care.

MR. IFEBUZO: I would have to look at the CVCS specific design to confirm that.

MEMBER STETKAR: Okay. Thanks.

MR. IFEBUZO: The next system, which is part of the fuel pool purification system is the spent fuel makeup system. Other system provides makeup water without using a spent fuel makeup pump to provide makeup water from the transfer pit or the cast loading pit to the spent fuel pool.

And this pump is backed by emergency diesel power. And the components of the design are Seismic I, Group C. As far as supplemental makeup spent fuel makeup capabilities we have the demineralized water system, which provides normal makeup to compensate for evaporation.

We also have a backup water source from the fire water distribution system. The RWST is also a potential source of water for spent fuel makeup as well. We also have spent fuel pool spray coolant flow which is provided, these are generated back sump pumps. And lastly we have good provided makeup water from external sources as well.

MEMBER STETKAR: Are those manually connected sources be connected outside of the fuel building floor, operating floor? Or are the connections located on the operating floor? They talk about, you know, fire hoses and makeup water flow from an external water source. Are those, I don't' know what that is.

MR. IFEBUZO: Well, the makeup from the fire water distribution system, that connection is right above the spent fuel pool.

MEMBER STETKAR: Somebody's got to go in there and do that?

MR. IFEBUZO: Or makeup from the fire water system we have a dedicated connection right above the spent fuel pool. That actually you could open the valve manually and transfer water to the spent fuel pool.

MEMBER STETKAR: Okay. Thank you.

MR. IFEBUZO: So that concludes my presentation, are there any other questions?

CHAIR POWERS: Do you have any questions for the speaker? Means Dennis is up.

MR. NEWTON: Yes, my name is Dennis Newton, I'm a supervisor for Nuclear Islands system engineering group at AREVA. And I have over 35 years in experience in design, operation and testing of nuclear power plants.

The following slides will address draindown prevention features at the plant. Leak detection features and will provide three hypothetical drain down scenarios.

The US EPR has the following draindown prevention features. Regarding earthquakes all the fluid retaining components of seismic category one. The fuel building and the reactor building, the pool liners and the suport structures. They are all seismic category one.

Including the reactor pressure vessel refueling cavity ring, there's already been some discussion about that. The fuel building and reg building pool drain pipes, I know you'd ask about those. And the drain pipes and their isolation valves are all seismic category one. So essentially you have a fluid boundary that's all seismic category one. So there's nothing in theory break if you have an earthquake event.

Regarding syphon draining, the spent fuel pool, the purification system, the supply and the return pipes are, they're all located at least 20 feet above the fuel. And they all have siphon breakers.

And I think this might have been a question that you had asked earlier. The purification system takes suction from that higher elevation and returns it at higher elevation. And the drain lines at the bottom of the pool at the pit, and the bottom of the transfer pool. They are normally isolated and they are only used if your going to be draining those pits.

MEMBER STETKAR: They're not used to align purification while the pits are in service?

MR. NEWTON: Right, that's correct.

MEMBER STETKAR: Okay. Thanks.

MR. NEWTON: Regarding flexible joints. If we have a flexible joints we usually have two seals and you can monitor for leakage going in between the seals. The examples are the baffles that were discussed earlier in the penetration assembly.

We have The baffles that come down and that is pressurized between the two baffle plates. And you monitor the pressure there to see if you get any leakage. The same thing for the O-ring seal that you have, say at the boundary between the cask and the penetration assembly that pressurizing between there, so you can monitor for leakage.

Regarding gate openings, both gates have a slot valve and a swivel valve. We talked aobut that before, and they're both category one. Regarding the spent fuel cast transfer facility. The penetration assembly that comes down, any piping that goes into that, it's Seismic Class I after the first after the first manual valve.

If we have any valve that are normally open, then there will be two of them. And they're safety related and they are solenoid and they require power to remain open so if they lose power, they close.

Regarding draindown detection features. I guess I mentioned earlier, leakage is monitored between, we have double barriers. Like I mentioned the baffles and the seals.

Level sensors, they are provided in each compartment or each area of the fuel building. And the reactor building pools that can be compartmentalized. For each compartment there's two narrow range, there's one wide range. And there's one local detector.

Now the spent fuel compartment is a little bit different, where that has two wide range and two narrow range and there are both 1E. And all of the detectors, except for the local ones of course are monitored measured in the main control room.

MEMBER SKILLMAN: Dennis, please explain a little more about your first bullet. Leakage monitoring suggests something or some one is one watch. Either an electronic device is keeping track of rate or decay or some parameter. Or somebody is looking at the parameter. What do you mean by leakage monitoring between double leakage barriers?

MR. NEWTON: These examples we were talking about before. We have these baffles. Do you want to explain those?

MR. PANDYA: I'm Nitin Pandya from AREVA NP and about this leakage monitoring there reduces in the spaces being pressurized by compressed air. And this pressure we have been monitoring maybe a pressure transmitter and it will send a signal to the control room. So whenever the pressure reduces the transmitter will give the signal.

MEMBER SKILLMAN: This is a constantly monitored parameter?

MR. PANDYA: Yes, this is a constantly monitored parameter. This pressure monitoring. But it is more important when we are doing the mainly the cast loading process.

MEMBER SKILLMAN: So when you are not loading the cast is this still a monitored pararmeter?

MR. PANDYA: That is a sort of grey area. Again we decided if the plant operator wants to monitor it, as we know these gates remain closed. If we do not do anything like cast loading in the loading, then the gates will remain closed all the time. Then how valuable it is to keep this pressure between the inter gasket monitoring, that I think has to be through the UT and ET.

MR. GARDNER: Let me add too, I think, Mr. Skillman, I think that would be dependant on whether you have water in this pit or not. If the pit were dry there would be no need to monitor for the seal.

MR. PANDYA: So you can decide not to monitor then somebody may decide that we still need to monitor.

MEMBER SKILLMAN: What other double leakage barriers are there besides the bellows?

MR. PANDYA: In the penetration assembly, all are double barrier. Like bellows are double barrier. There is a double seal, then there is a double cover upper and lower cover. Through the penetration and then there's a double gate.

All are double, and also the pipeline is connected with the cask or to the penetration, they have double insolation. So fuels boundary are double.

MEMBER SKILLMAN: Which of these need to be monitored during normal power operation?

MR. PANDYA: During normal power operation, if the cask loading process is not going on. The penetraton of upper and lower cover will remain shut. Both these gates will remain shut. Loading features will remain isolated from the spent fuel pool. It may have water, may not have water. If it has water then some monitoring may come into picture, but otherwise it's not needed.

MEMBER SKILLMAN: It's not needed. Thank you.

MR. PANDYA: It's not needed, yes. It's not a must.

MEMBER STETKAR: Dennis, just to make sure. You mentioned the fuel pool has wide range. I'm assuming wide range goes all the way down to the top of active fuel at least.

MR. NEWTON: I don't know the exact range. Do you know the exact range or the wide range level of the wide range level detectors?

MR. IFEBUZO: We have wide range monitoring in the pools.

MEMBER STETKAR: Well, you know, I worked in a plant, we had what they called wide range monitoring but it was just wider than the narrow one. It wasn't full range.

MEMBER STETKAR: We can check on that.

CHAIR POWERS: You're probably going to get to do it no matter what. Somebody someplace is going to want wide range from the top of the pool to the floor.

MEMBER STETKAR: Certainly at least to the top of the fuel. But to the floor would be even better.

CHAIR POWERS: Well, they're going to want it. Whether it's better or not. Like I say the best level detector I know of for the spent fuel pool are two eyeballs.

MR. NEWTON: I'm sure the pools that they can drain all the way down to the bottom.

CHAIR POWERS: Continue, please.

MR. NEWTON: The drain isolation valves,

we're talking about the drain lines. If it's bigger than two inches there are two manual valves. They're not motor operated, so if they're manual if they're closed, they're closed. And they all have position indicators that are in the control room. So the operators know whether or not those valves are open or closed.

Then the next item is the leakage from the fuel building pool liner, it's collected and it's monitored. So we can detect any leakage through the liner in the pool.

CHAIR POWERS: I was going to ask at the end of your presentation, how in the workd are you going to get this pool to leak tritiated water into the ground water? But you beat me to it.

MR. NEWTON: Yes, I mean the pool's way up, so there's numberous levels of the building that it has to pass down through before it can get there.

CHAIR POWERS: Yes, water's good at passing down. Tell me about this liner leakage business.

MR. NEWTON: Yes. The water that is collected from the leakage it is sent to the nuclear island drain and vent system, so it is collected. It is not allowed to go to the ground.

CHAIR POWERS: What basically, it's not a good idea to let it go to the ground, contrary to the way I was going to phase my question. So between the liner and the concrete we've got some sort of channels there?

MR. NEWTON: Yes, we have channels and they are positioned behind where the wells are in the liner.

CHAIR POWERS: Yes, and they're sloped downwards or something like this?

MR. NEWTON: The final design of it is going to depend on what the liner looks like. But the going in plan is to have a channel behind each of the wells in the liner. And yes it will be sloped so it can drain.

MEMBER STETKAR: Is there some special design feature that can ensure that those lines are open? We had some experience showing that people have a lot of drain lines and when you go in and actually boroscope them they look like not so much drain.

CHAIR POWERS: More like plugs.

MEMBER STETKAR: More like plugs, yes.

MR. NEWTON: Yes, they are going to be designed so they can be flushed.

MEMBER STETKAR: So you will have, the

reason I was asking you in the context of design, not operation was either some sort of active flushing or pneumatic pressurization or something.

MR. NEWTON: Yes, something there to keep boron plugs from being in the channels.

CHAIR POWERS: I guess we have had concerns about corrosion in those areas as well, haven't we?

MEMBER STETKAR: There has been, yes.

MEMBER BROWN: Before you leave that, somebody mentioned a minute ago that this thing has fuel control has two water level indicators and two temperature indicators?

MR. NEWTON: I didn't mention temperature.

MEMBER BROWN: Well, somebody did, somebody was talking about instrumentation. So I went off and look in 9136 and I was trying to find where that was listed and I couldn't see it. It just says you're going to level and temperature, it doesn't say how many.

And I've looked in the drawing and I couldn't see any even listed on the drawing. So I was kind of wondering where the requirements were for those. Like where they go?

MR. NEWTON: I think the drawing that's in the FSAR, it had like a lollipop with something on it.

MR. IFEBUZO: Yes, that's the way we'd indicate it.

MR. NEWTON: But if you look at the system description for the document it gets into much more detail.

MEMBER BROWN: System description, what do you mean, the technical report of some kind, not the FSAR?

MR. NEWTON: Right, not the FSAR.

MEMBER BROWN: Well, it wasn't even referenced. So I mean, there's no reference, at least in that section as to where any other technically document that might be used in terms of developing the design.

In other words what are the ranges of them, what's the configuration? What type of indicator do you desire. There doesn't seem to be, I'd really like to know where that is and have that described.

MEMBER STETKAR: We'll take an action to go look for that.

MEMBER BROWN: Okay.

MR. NEWTON: Obviously we don't have every design detail in the FSAR.

MEMBER BROWN: Oh, I understand that, you don't have any design detail on the protection system and the FSAR's either. You have to go to all these other technical reports.

MEMBER STETKAR: Wrong people, to talk to about that.

MEMBER BROWN: No, I'm just poking at them. It's the same disease and I don't have any problem but at least there the DCD references the other documents and tells you where to go look. Here I was unable, it might be in there but I was unable to find it.

MR. NEWTON: We'll track it down.

MEMBER BROWN: Okay. Thank you.

MR. NEWTON: Mediation. We have three hypothetical draindown scenarios. To give a sort of feel of magnitude for what we have here. These are all beyond basis. Design basis accident is dropping a fuel assembly. We're pretty well protected for that.

The first one is those double seals that we had talked about earlier. It's assuming that both seals fail, and the seals that fail are the ones between the cask and the penetration assembly.

So we assumed both of those failed. The cask loading pit gateway is open to allow the transit of the fuel assembly. And there's a fuel assembly in the pit. Now we don't assume any makeup water, however we can get 400 gpm from the purification system.

Now the purification system takes suction from the IRWST. You probably saw are connection with the CDCS. And the leak that we came up with was a 390 BTM, miraculously it's just below 400 BTM. But we assumed we have both seals failed so it's 360 degrees all the way around.

MEMBER STETKAR: That's simply the orifice flow through that. It's just as if they weren't there.

MR. NEWTON: Right, it's just as if they weren't there. We used a .35 millimeters, which is actually the seal up on the cover. The seals down between the cask and the penetration assembly actually wouldn't be squished, it's metal to metal contact.

And for 390 gpm the water level in the spent fuel pool would decrease about one foot in 30 minutes. So the operator has adequate time to move the fuel assembly out of the cask loading pit and over into the spent fuel pit. And get that swivel gate closed.

CHAIR POWERS: Of course, Dr. Ryan asked

you what happens if he can't get pull it down?

MR. NEWTON: Well, there is the cover plate, that could also be closed. If he can't get the swivel gate closed, there's always the option of getting the slot gate. If you have a crane, lower that into place.

MR. GARDNER: I think his question was if the assembly was physically stuck halfway in the cast. But we're talking about if the assembly were in the pit in transit. Not stuck halfway in or out.

CHAIR POWERS: I see no reason not to have it stuck.

MEMBER RYAN: Not having it stuck is a much better thing than having it stuck.

CHAIR POWERS: If they're going to make them a bad day we might as well make it a really bad day.

MEMBER RYAN: That kind of highlights were we can't do much with it. That's kind of a bad day at the plant so I was curious how you thought about that.

MR. GARDNER: Of course we're showing here that we could just keep it there with water over it.

MR. NEWTON: You mean just keep pumping in makeup water.

MEMBER SCHULTZ: And when you're loading the cast, I misunderstood perhaps, I thought when you were loading the cask you move some assemblies into the cask loading pool.

MR. NEWTON: One at a time, use a manipulating crane, you pick up a fuel assembly, move it into the pit and lower it down into the cask. And we're all straight.

MEMBER SKILLMAN: We're still waiting to hear where that water goes, okay? The internal flowing, we want to know where it goes please.

MR. NEWTON: Water does go into the refueling hall. The flooding analysis assumes a six inch pipe break at penetration. So it might be about 3,000 gpm, that's what the flooding analysis assumes it can accommodate. It all goes into the drains, which goes to the nuclear island drain and vent system.

MEMBER SKILLMAN: Well, at that flow rate your nuclear island drain event system is going to fill up very quickly.

MR. NEWTON: I don't know about the rest of the analysis.

MEMBER SKILLMAN: I'd like to pursue this. Let's really find out what happens if there is a malfunction. Let's take the one that Dr. Ryan points to. You've got a fuel assembly that's halfway in and halfway out. There are normally a quarter of a million of R per hour.

Okay. They're screaming and now you've got a water leak and now you've got a mechanical device that in all candor, quite difficult to approach. This scenario is one I think deserves some reasonable consideration. Because there are some profound safety issues associated with this.

MR. NEWTON: Last bullet, assuming absolutely nothing is done it will take over eight hours, maybe closer to 11 hours for all the water to go down to the top of that weir. So just a feel for the magnitude of how slow it drains down.

MEMBER STETKAR: Through those seals.

MR. NEWTON: Yes. We can go on to the next line. The next scenario, it assumes a crack in two pipes, one in the penetration assembly and one in the drain.

(Off microphone discussion)

MR. NEWTON: Okay. Anyway we assume a crack in two pipes, one pipe is the six inch drain coming off the bottom of the pit. And the other one is a two inch pipe going to the penetration assembly.

It's the pipe that's used for venting, draining the penetration assembly itself.

And the leak rate we've got from those two cracks, the combined leak rate is 75 gpm.

MEMBER STETKAR: That's a crack.

MR. NEWTON: And the rest of the scenario is similar to the first scenario.

MR. GARDNER: Is your crack equivalent to the full six inches?

MR. NEWTON: No. The crack is based on Branch Technical Edition 3-4. For a moderate energy pipe break, pipe fracture.

Okay, the next slide is inadvertent opening of a reactor building pool drain valve. There's an eight inch common header. That's the biggest drain pipe we could find.

And we assume that the isolation valves are open on that, along with, you have to have two other drain lines open that are six inches. And that will drain about 5,000 gpm, and it will go to the IRWST and of course you have your ECCS system that can pump that back in until you're able to do something.

And the pool will drop about seven and a half feet in thirty minutes. If you have a fuel assembly in the transfer pit, if you lay it down horizontally it will provide 12 feet of water over it. And that is my last slide.

CHAIR POWERS: You still didn't give me any tritiated water on the ground. You're just not trying Dennis, that's all there is to it. Any other questions on this area?

MEMBER BROWN: Just one, the spent fuel pool makeup capability, where is that controlled from? Is that a local operation or can it be operated from the main control room?

MR. IFEBUZO: The pumps are started and stopped from the control room but you have to manually open the valves.

MEMBER BROWN: Okay.

MR. IFEBUZO: I mean, not manually, physically you go put your body on it. Just like opening a faucet in your kitchen. Slightly bigger valve.

MEMBER BROWN: Okay. Thank you.

CHAIR POWERS: We're going to do heavy stuff now. We'll move on to heavy load handling and Rick Parler.

(Off microphone discussion)

MR. PARLER: My name is Rick Parler, I'm an advisory engineer with the AREVA NP. With a background in civil. And today I'll be addressing the overhead heavy load handling system. This presentation provides information on the design methods used by AREVA to ensure safe handling of heavy loads.

We begin with a definition, a heavy load is defined as a load the weight of which is greater than the combined weight of a single spent fuel assembly and it's handling tool. And for the U.S.EPR that value is greater than or equal to 1,730 pounds.

The AREVA design meets the NRC guidance specified in NUREG 0612 which discusses the control of heavy loads at nuclear power plants. Also with regard to single failure proof cranes, that guidance provided by NUREG 0554.

The industry standards that are used that implements this guidance are those ASME NOG-1 which provides the rules for construction of overhead and gantry cranes. And ASME NUM-1 which provide the rules for construction of cranes, monorails and hoists of the underhung type.

For handling heavy loads during the final operational phase AREVA will make use of either a Type 1 or a Type 2 crane. The definitions of Type 1 or Type 2 are provided here.

Type 1 is designed to handle a critical load. It's designed to remain in place and support the critical load during and after a seismic event. The crane does not have to be operational after the event. And it also incorporates single failure proof features.

The Type 2 crane is not used to handle a critical load. It's designed to remain in place with or without the load during a seismic event. It need not support the load or remain operational after the event and single failure proof features are not required.

Where single failure proof designs are used the hoists load path components are designed such that any credible failure of a single component will not result in a loss of the capability to stop and hold the critical load.

And the critical load is defined as any load who's uncontrolled movement or release could adversely affect safety related systems required for unit safety. Or could result in potential offsite exposure in excess of established limits.

The U.S.EPR has four single failure proof cranes and those are the Polar crane, the fuel building auxiliary crane. The fuel building upper penetration cover hoist, and the fuel cask biological lid handling hoist.

The Polar crane is used to during outages, it handles items such as the closure head. The upper and lower internals. The stud tensioning machine, cover slabs, things of that nature.

The auxiliary crane in the fuel building is used to handle fuel containers, fuel gates and other miscellaneous loads. And the upper penetration cover hoist and biological lid handling hoist, I believe we have talked about previously, in Section 9.1.4. Those are used with the fuel cask transfer facility.

Those two hoists are stationery hoists, meaning they are dedicated for that one operation, there is no bridging or trolley necessary for those two hoists.

For a Type 1 single fail proof design, the design focuses on those components which are located between the source of the load and the energy holding the load. This would be the attachment point, the hook to the load. The hook and then lower load block, upper block, the geartrain transmission and holding brakes.

And the single failure proof design is

accomplished by the use of duel or redundant components and or by doubling the design factors.

When Type 2 cranes are used to handle heavy loads they'll be used either for lifts or equipment not required to perform a safety function during an outage condition. For example they will make use of stops and air locks to prevent the load from going over safety related equipment. And they will also in some cases be designed, the equipment or components will be evaluated for the effects of a load drop.

So the design and use of the cranes in this manner will provide a safe and reliable heavy load handling capabilities for the U.S.EPR

There is one COL item regarding heavy loads, and that being the applicant that references the U.S.EPR design will provide site specific information on the heavy load handling program.

Which includes a commitment to the procedures for heavy load lifts near irradiated fuel or shut down equipment. And will also provide crane operator training and qualification. Basically the items that are required for compliance with the NUREG 0612.

Do you have any questions?

MEMBER SKILLMAN: Yes, have single failure proof cranes been used in the European designs?

MR. PARLER: Yes.

MEMBER SKILLMAN: And is this design certification design a copy of those designs?

MR. PARLER: As far as the equipment layouts it is. But as far as the method by which the design is performed it will be done to the ASME standards.

MEMBER SKILLMAN: By and large what you're depending on is doubling the factors in order to give design margin?

MR. PARLER: Doubling factors or providing redundant components points.

MEMBER SKILLMAN: Okay. Thank you.

MR. GARDNER: Okay, Dr. Powers that concludes our presentation on Chapter 9.1.

CHAIR POWERS: Do you have any more questions for the applicant? Then I guess we'll move on. Thank you very much.

MR. TESFAYE: Dr. Powers, before the staff presents Section 9.1, would it be possible to anser two of your questions from this morning?

CHAIR POWERS: Absolutely.

MR. TESFAYE: Okay. Those questions are

the CRDM system and equipment qualification acidic environment.

MR. MIERNICKI: I'm Mike Miernicki, a Chapter 3 PM, and with me I have Jason Huang who is with the general mechanics branch. And Jason is the technical reviewer for Section 394. And the question from this morning was with respect to the CRDM testing. Whether the staff had missed the test results, the drop test results or audited the results. So Jason has the audit information with him, he can speak to that.

MR. HUANG: Okay. So on April 9th, 2009 the staff performed an audit to review the prototype testing program. To determine the mechanical adequacy of the CRDM. And during the audit the applicant provided the prototype testing results for the CRDS design.

Which consists of performance, stability and endurance testing. And the performance test results verify the adequacy of the performance of the equipment. In the range of temperature, pressure and full conditions. The stability test result ensured proper functioning is achieved over time. And this also included full height drop tests.

The endurance test results quantified the number of steps during which no appreciable damage possibly altering the mechanical behavior is expected. And these were performed up to nine million steps. And the staff determined the test results were acceptable.

And in the followup we requested that they provide the basis for the 60 year design life. And the applicant responded by providing us the test results from the endurance test, which confirmed the nine million tests.

CHAIR POWERS: Okay. If I recall the question also included the question of did you assess that the test design was sufficient or did you just look at the results of the tests?

MR. MIERNICKI: We looked at their test results for the prototype testing. And we also reviewed their procedures. And audited a number of documents they had, the KOPRA facility had the, during the audit we reviewed the drop times that were recorded during the stability test.

And we also looked at the report for the performance tests and their test specifications and the analysis for the design loadings.

MEMBER SKILLMAN: Let me ask this please. To what extent did you review the most adverse geometry between the upper internals, the control rod guide tubes and the weldments to the upper end fitting?

This is where the rod is fully withdrawn but the internals are off, displaced by 30 thousands of an inch. Where the tip of the rod must now find it's way through a very small displacement. As the rod continues to insert that friction factor begins to impede flight time.

So my question is really about the precision of the test and the accuracy of the flight time given that there could be some displacement between the upper internals and the upper end fitting?

MR. HUANG: Okay. Are you referring to a test that's normally performed on the control rod drives?

MEMBER SKILLMAN: I'm talking about a realistic view of the manufacturing tolerances so that when the upper internals are placed on the fuel assemblies there are certainties of flight times will be achieved.

MR. HUANG: I'll have to get back to you on that.

MEMBER SKILLMAN: I'd like you to do that please.

MR. MIERNICKI: AREVA, can you answer that, if that was part of the testing we.

(Off microphone discussion)

MR. STACK: Let us look into that.

MEMBER SKILLMAN: Thank you.

MR. MIERNICKI: Jason's operating under a disadvantage here because he wasn't a part of that. So it wasn't something we can recollect, we'd have to visit some other people.

MEMBER SKILLMAN: It would be the control rod drive line misalignment study. And this is for the internals and manufacturing tolerances is aggregate intolerance to compromise flight time. And it can only be caught if it's manufactured properly the first time.

MR. MIERNICKI: Any other questions in that area? Okay. Thanks, Jason. Okay, and the second question we'd like to address was related to equipment qualification. It was concerning the nitric acid formation in the containment after large break LOCA and potentially in a high rad environment there might be nitric acid formation.

And whether that was considered by the staff and if not why was it okay not to consider that potential. So Peter Kang from the instrument control, electrical branch is going to address that.

MR. KANG: Yesterday during the 311 environmental qualification presentation that Dr. Powers asked us why is the chemical effects of the nitric acid was not considered. And asked staff why it is acceptable.

Addressing 10 CFR 49, which is environment qualification of electrical equipment. And the FSAR, Section 311 of FSAR requires all components which will be located in a harsh environment, such as inside of containment, should be performed it's function for all anticipated environmental conditions. During and following the design basis event.

Which design basis event is defined as abnormal operations and including post and accident conditions and anticipated operational occurrences and the design base. So that's how we define it. And also basically it's in 5049, rule identify's environmental condition as, temperatures, pressures, humidity and aging of the radiations. And it also includes chemical effects.

So during our staff review of Section 311, our staff had the similar questions. Concerns and asked the questions on the chemical effects. Because in their program chemical effects was all identified as not applicable or none.

So subsequent telephone call with the applicants and they indicated chemical spray was not used before mitigating design basis by event. Therefore the chemical effect was not considered as a environment conditions. Equipment has to be qualified.

So the conversation was on and on and the staff asked what about the core spray? Which is sit on top of containment and AREVA's answer was core spray system was used only, it's not only non class 1E system, it's also used during, only for severe accident cases.

So if it is only used for, it's not used for design basis of event AREVA explained a chemical effect is not considered one of environmental conditions that they should consider for equipment qualifications.

So that chemically in fact it was not considered. So only chemical effects in the 311 was discussed was a containment sump area which requires maintaining pH level of 7.0, which is neutral, or higher by using a trisodium phosphate basket.

So on this basis nitric acid was not considered as an environmental condition that requires to equipment needs to be qualified for environmental qualifications.

CHAIR POWERS: Well, then the question remains, why not? There's going to be nitric acid, it's going to be every place.

MR. KANG: Well, it's basically inside of containment by accidental environment but there was no moisture. Which is the sprays, containment spray is not used so not like any other normal plans.

CHAIR POWERS: DBA is flow down of a pressurized vessel in the containment which takes you up to the design basis pressure and steam. You've got lots and lots of water vapor I presume.

MR. KANG: Okay. So to neutralizing that using a sodium phosphate basket.

CHAIR POWERS: It keeps your sump. But the problem is what about all your electrical equipment, any kind of equipment in the containment that's going to be exposed to this nitric acid vapor that's being created by radiolysis. I believe the staff uses about a megared per hour as their DBA dose rate in the containment.

MR. KANG: But we are talking about that during post accident before and after design basis of accident which could be very --

CHAIR POWERS: You got 30 days.

MR. KANG: Yes, 30 days.

CHAIR POWERS: You got lots of time, so you start off, for the first 24 hours I think it's something like a megared per hour. And then it drops off after a while to about two tenths of a megared per hour.

MR. KANG: Right.

CHAIR POWERS: So you're generating throughout this you've got a G-value for nitric acid formation roughly .21 molecules per hundred electron volts, something like that. So you've got a lot of electron volts going into the atmosphere. You're making nitric acid. And I just suspect that that's not too good for anything electronic.

MR. KANG: So that's the explanation for what we had, we received it from applicant's so that was our basis for chemically effects. In fact they have not considered any chemical effects.

CHAIR POWERS: One of the things that a little bit surprised me is that none of their cable insulations seemed to have polyvinyl chloride in it. And so they get no HCI coming off due to the radiolysis of the cable insulation and the post DBA environment. Is that some area you've looked at?

MR. KANG: Basically like yesterday was discussed the PVC, which is HCI, hydrochloride generation because we are not using PCV cables inside of containment. That element is quite a bit.

CHAIR POWERS: Yes, that's big help if you don't have any.

MR. KANG: Yes, and also Hypalon cables and all that and those silicon EPR silicon based on the cables we aren't expecting too much generation of the hydrogen chloride generations.

CHAIR POWERS: Yes, if you don't have any chloride in there's not going to be any HCO. That you can be fairly confident of.

MR. KANG: Yes.

CHAIR POWERS: We have to be very careful because manufacturers aren't too good about telling you what's actually in those cables. But if you don't have it you don't have. But you do have nitric acid, that's unavoidable because you've got nitrogen in the air. Okay. Thank you.

(Off the record comments)

You ready to go?

MR. TESFAYE: Yes.

CHAIR POWERS: Let's do it to it.

MR. HEARN: My name is Peter Hearn, I'm

the Chapter 9 PM, we'd like to present the presentation for the FSAR the Chapter 9.1 fuel storage and handling. The staff review team consisted from the technical staff of Chris Van Wert, Amrit Patel.

And the reactor systems branch Raul Hernandez and Gordon Curran. From the balance of plan branch. And Jim Xu from the structural engineering branch. The lead PM is Getachew and I'm the Chapter PM.

During the review this next slide shows in each section the number of questions and open items. During the review of 9.1 there were 182 questions asked and 34 open items resulted.

The following 11 slides list the open items, the 34 open items. Number and brief description of the subject matter of the open item. And all told there were 34.

That brings us to 9.1.1 reactor systems and is Amrit Patel to give that presentation.

MR. PATEL: Good afternoon, my name is Amrit Patel. I'm from the office of new reactors and the reactor systems branch. I've been with the branch for three years now. I recently graduated from the NSPDP program. And before that graduated from the University of Florida with degrees in nuclear engineering, a Bachelors and a Masters.

All right. So I'm going to be speaking to Section 9.1.1 which is the criticality safety of new and spent fuel storage. Basically the applicable regulatory requirements are found in 10 CFR 50.68(b)(2) (3) and (4). (b)(2) and (b)(3) cover dry fuel storage requirements. (b)(4) covers requirements in the fuel pool when soluble boron credit is taken both for borated and unborated cases.

So this is basically the high level view of the areas covered by the staff. I want to take time to focus, in this discussion, on the boron credit analysis. Most of the staff review actually due to the complexity that this adds to the analysis it ended up being a concentrated toward burnup credit, so I just wanted to speak mainly toward that. And I also wanted to pull out the criticality code validation, which I'll speak to on the next slide.

So basically there is two parts to this calculation. There is a depletion calculation and a criticality calculation. And the staff is basically focusing on the depletion side on the operating parameters in ensuing that all the operating parameters were conservatively modeled.

In addition to that is the actual profile making sure that a limiting profile was actually used.

CHAIR POWERS: The definition of conservative here is a little confusing, it's tricky.

MR. PATEL: Yes, here we're talking about with respect to reactivity in the fuel pool. So we want to look at parameters, look at soluble boron concentration or fuel moderated temperature. And see how that effects reactivity in this spent fuel pool. So we're looking at those kind of parameters.

CHAIR POWERS: But I mean, in the depletion calculation and the whole profile calculation, it's tricky to define what you mean by conservative.

MR. PATEL: It's not tricky, there's a lot of wiggle room, you can do a lot with it.

CHAIR POWERS: Just defining what is conservative is kind of tricky.

MR. PATEL: Yes, exactly how many, where you put the note edges, right. So the second part is the criticality calculation and we're really focused on the co-evaluation here since we're talking about spent fuel.

And as AREVA noted they're using HTC data which is highly applicable in this scenario when we are modeling spent fuel storage. So overall pretty happy about that. Also I just noted some of the NUREG guidance that we used to help with the burnup credit review.

This is just an overview of the confirmatory calculation performed by the staff. And at this time I just want to focus on the last two bullet points which deals with verification of the burnup and enrichment loading curve. That's part of tech specs actually.

Basically we did two calculations a 1D, a simplified point depletion calculation and then a 2D calculation, a bit more rigorous. And actually both results in terms of comparing the burnup loading curves compared very favorably. So that basically gave us assurance that these calculations are being performed correctly by the applicant.

MEMBER SCHULTZ: So you did a set of basically confirmatory calculations, in their presentation they indicated they used the Scale Suite 2. But they didn't use exactly the same one.

MR. PATEL: Right, this is a newer version actually and they have more advanced capabilities. This side is just one of the open items of interest to the staff. And it's regarding the selection of limiting burnup profiles.

It's not the application in the depletion analysis, but it's really the screening of the limiting burnup profile. So there is some kind of data base or set of profiles that cover all types of fuel assemblies.

And I think the question here from the staff is the screening criteria actually giving us limiting burnup profile. So that's not really clear to the staff so we just want to make sure that that's being done properly.

CHAIR POWERS: So your first bullet up there says what the whole problem is in doing this burnup credit is that everything backwards. The ends are more important than the middle and things like that. It's really tricky, I mean it's hard to get your mind to wrap around that. Interesting, acute problem.

MR. PATEL: That's my final slide so if there are any questions.

MEMBER SCHULTZ: So is the question here associated with the way in which the final profiles were established? That is establishing the proper conservatism associated with it. Once the calculations are done, that's straightforward. You get response and answer.

MR. PATEL: Right.

MEMBER SCHULTZ: But then you've got to series of profiles that you can combine in certain ways and then you need to establish a conservative approach to find the burnup credit.

MR. PATEL: Right, it's not so much the combination, how they're putting the profile together. It's more just the raw selection of the profile. So they have some kind of data base of profiles based on various locations and different points in cycle.

So the question is out of all of these potential profiles are they actually identifying a limiting one for different cases in the spent fuel pool.

MEMBER SCHULTZ: And so that remains an open item now to determine whether it's being done properly.

MR. PATEL: Right.

MEMBER SCHULTZ: And the applicant's providing you additional information related to that determination.

MR. PATEL: Right.

MEMBER SCHULTZ: But in terms of the methodology and the approach you're comfortable with the calculations that are given.

MR. PATEL: Correct.

MEMBER SCHULTZ: The determination of the final credit based upon the cluster of information that has been developed and combined.

CHAIR POWERS: That's one of the things that I think at some future full committee meeting, is just presenting this confirmatory methodology to the full ACRS. Because I think they have not had a briefing in some time about the upgraded scale suite and I'm sure that they haven't been through a burnup credit calculation.

We might want to give that some thought. We can break into the committee's schedule to give a 45 minute precisely on this calculation. Not so much for the EPR as it is for discussing the methodology available for the staff to do these kinds of confirmatory calculations.

We can get together and chat about this at some time. It's not going to happen immediately I know, from looking at the schedule. But at some time it might be useful because this is different than what we're actually used to.

And we do have an update in the scale suite from what any of the members would be used to. So it might be worthwhile to have someone come in and just chat a little bit about it.

MR. TESFAYE: You have also suggested that we present this spent fuel cask loading system to the full committee.

CHAIR POWERS: I think that when we get to that we'll have to spend a little time, both you and the applicant are going to have to spend a little time on this system. Because it's a little bit different than what you might think of.

MR. TESFAYE: Sure.

CHAIR POWERS: Well, when we got to moving that chapter into the full committee, it's not next on our list. But if we do it in May we have to be a little more strategic on how we do that exactly. I haven't thought about it very much.

But one thing we can think about it doing is ask them for a half an hour, or 45 minutes just devoted to that. And then another block of time for the general chapters, which so much more general discussion and not so much in depth.

Just because that system is so different than what they're probably use to and what they anticipate. And the nice thing about that is you've got a lot of visual stuff so they can get their arms around it without a lot of hand waving and things like that.

So we might want to talk about that, I think that's more of a applicant problem than it is a staff problem. Because it's more descriptions that they're aware of what it is.

I mean I don't think, I don't forecast a great number of questions that you haven't already heard. But it strikes me that it's one that they really ought to see because they've really never seen it before, right? And it's more like educating and training the ACRS. And what the staff has available.

And it looks like you have a pretty good command of that calculational method and this could be a nice example of where you've done that. But you'd have to dress it up with a little bit of explanation of what the suite is and a few graphs and things like that.

We'll talk about that, because I'm not sure when we can do it, it's really tough getting on the ACRS schedule right now.

MEMBER SCHULTZ: It would be nice to have an answer to this question that you're working on right now. If you feel that that's a good answer then maybe we ought to talk about it. It would be a good example of the challenges that are being faced. This may be the opportunity to move forward with burnup credit of this type.

CHAIR POWERS: Yes, it's something for us to think about.

MR. TESFAYE: Thank you.

CHAIR POWERS: And Kathy you might find out about that. The handling system and what we can do, and I guess we're targeting May?

(Off microphone comments)

MS. WEAVER: Yes, we'll work on it, and do like you said, possibly use a half hour for it.

CHAIR POWERS: Rather than trying to make it as part of the general block of chapters that we're moving forward just make it a separate item. Is that okay with you guys? You've got a pretty good story put together there. We'll have to tailor it a little bit for the full committee meeting.

MS. WEAVER: So you would want like two hours, half for the chapters and half for the --

CHAIR POWERS: No, I want two hours for the chapters and I want another 45 minutes for just this, I'm going to be greedy. And I think it's just their story, because I think the only thing we're asking to do is just explain that. What does it look like, what is it going to do for you.

What you see is the good things and what you want to spend a lot of time on.

MEMBER SKILLMAN: I'd like to ask Amrit a questions please. I understand the concept of burnup credit, depleted fuel is not as reactive as new fuel.

MR. PATEL: Right.

MEMBER SKILLMAN: But the instant I pull rods on my first full core, if I have a problem in I want in some cases to unload that entire core. And that means that my boron concentration in my spent fuel pool must be appropriate for the 5 weight percent if that's what I've loaded in my batch for my first core.

So can you please lead me through how one might discuss burnup credit when my maximum hold down requirement is when I've had to discharge my first full core or subsequent core with the bulk of my discharge shield assemblies are gently irradiated, but irradiated non the less. But they are not depleted by any amount.

MR. PATEL: Okay. So you're just saying how is burnup credit treated on essentially fresh fuel assemblies?

MEMBER SKILLMAN: Where ever that might be in a fuel cycle, or in the life of the plant.

MR. PATEL: I'm trying to understand a little bit better exactly.

MEMBER SKILLMAN: Say, I'm on cycle four.

MR. PATEL: Okay.

MEMBER SKILLMAN: I've got a third of a brand new core. It's hot as can be, 5 weight percent. I've only run it for 26 days. And I have a reactor cooling system leak where I really choose to defuel because my PRA tells me that is my least risk condition for the plant.

MR. PATEL: Okay.

MEMBER SKILLMAN: So now I'm unloading perhaps the entire core, but there's been burnup credit applied which would suggest that maybe I don't need as much boron in that pool as one might otherwise expect.

MR. PATEL: Right, the boron in the pool is fixed, based on the analysis percented by the applicant. So they define, that's not changed. That's a constant level of boron in the pool. I think to answer your question. I mentioned the burnup in the loading curve, it's part of the technical psecificatons. And that curve tells you the minumum amount of burnup that's required to place a fuel bundle in a region two storage slot.

Alternativly if they could meet that they would have to come up with some other way to off load that fuel. Maybe they would have to put it in the fresh fuel region, in region one.

So there's things that can be done. But the boron in the pool is fixed and you essentially they would turn to the burnup loading curve essentially in tech specs.

MEMBER SKILLMAN: Let me ask one more question please. Will takes credit for burnup require in addition to the core operating limits report that the applicant has to provide at the beginning of each new fuel cycle?

MR. PATEL: So would they have to updatre that, is that what you're saying?

MEMBER SKILLMAN: To relaod you have to have a cooler, that part of the reload. Is taking credit for burnup an add on to that?

MR. PATEL: No, that's not in pool that's actually part of the technical specifications. So the analysis that's presented by the applicant is intended to bounding for all conditions. So all applications of burnup credit should be covered by the base line burnup loading curve in technical specifications.

So the cooler would not be affected by the anything. So the technical specification on the minimal soluble boron requirement and also the burnup loading curve.

MEMBER SKILLMAN: Thank you.

MR. TESFAYE: Ready?

CHAIR POWERS: Yes.

MR. TESFAYE: Thank you.

MR. HEARN: Our next presentation will be on new and spent fuel storage and fuel pool cooling and purification systems. And Raul Hernandez is the presenter.

MR. HERNANDEZ: Hi, my name is Raul Hernandez, I've been with the NRC for over ten years. Most of them I would say has been in the either NRR or NRO. And I've been the reviewer for spent fuel pool and the spent fuel pool coolant system for the EPR, USABWR and AP1000, the DCDs and the COLAs.

I will be presenting the review for the new fuel storage facility and the spent fuel storage facility. The new fuel is a dry storage approximately ten feet deep and with enough capacity for 120 fuel assemblies.

The spent fuel pool is forty seven feet deep, 3 inches, with capacity for 1,247 assemblies. And the single function of the spend fuel pool is to maintain the fuel, store it safe and subcritical under all anticipated operational and accident conditions. And also to limit outside exposure in the event of release of radioactive material.

These are pretty typical designs nothing really too complicated about the new or the spent fuel, with the exceptions of the interactions with the spent fuel cask loading facility.

The fuel building protects the new fuel and spent fuel storage against natural phenomena. And external and internal generated missiles. The spent fuel pool, as mentioned before has sveral sources of makeup water, including seismic class one makeup water that are safety related.

The spent fuel pool liner is assigned with a leak detection system that the applicant described earlier. And it's sized such that it is that we will be able to inspect it and make sure that the leak chase channels are open and are not blocked.

Some of those seismic designs that the staff looked at in order to make sure, to prevent drain down events were that the spent fuel pool walls, liners, the fuel transfer canal and the gates between the spent fuel pool and the spent fuel cask transfer facility are seismic class one.

Section 9.1.2 does not discuss the situation when the spent fuel cask transfer facility is in operation. The relation of drain down prevention when that facility is in operation I'll present that when we talk about Section 9.1.4 in a little bit.

MEMBER SKILLMAN: May I ask you please to go back to 23, slide 23.

MR. HERNANDEZ: Yes.

MEMBER SKILLMAN: The third bullet. Fuel building protects the new fuel storage facility and the spent fuel storage facility against natural phenomena and external missiles. I spent quite a bit of time at a plant where our limiting external missile was a basically a Buick. Coming over the fence as a result of a tornado. I'm serious.

If I interpret that bullet the way I think it is intended to be interpreted the roof will prevent that event from occurring. Is that how I should interpret that?

MR. HERNANDEZ: The roof prevents, not the roof. The spent fuel pool building, the walls of the building protect the spent fuel pool walls which are the safety related components. Which is to maintain inventory in the spent fuel pool.

MEMBER SKILLMAN: I got the walls, now I'm talking about the roof.

MR. HERNANDEZ: No, it wouldn't protect you from something like that. The function here is to maintain water here in the spent fuel pool if something falls in. It doesn't impact the safety or function of maintaining water and protecting your fuel, maintaining cool. Which is the function here.

MEMBER SKILLMAN: So the way it protects me with that external missile is it just catches the Buick and the Buick sinks in the pool?

MR. HERNANDEZ: It protects the walls of the pool so you don't crack or lose inventory.

MEMBER SKILLMAN: But you're not talking aobut a situation where a Buick or a telephone pole comes in and impacts the fuel?

MR. HERNANDEZ: No.

MEMBER SKILLMAN: You're just talking about the water.

MR. HERNANDEZ: Yes.

MR. GARDNER: Darrell Gardener, one comment, this structure is one of the hardened structures for the aircraft impact. So I think the Buick is not going to be a problem.

MEMBER SKILLMAN: Darrell, thanks I was

not trying to be funny, I was serious about my question.

MR. HERNANDEZ: Yes, and I understand but from the EOP stand, from the 9.1.2 review standpoint we are looking only at the inventory, so I didn't want to stretch my review to something that I wasn't sure.

MEMBER SKILLMAN: And I was concerned about the fuel. Darrel's answered that question nicely. Darrel, thank you.

MR. HERNANDEZ: We had two open items, this is the most, one of the most significant ones is that the applicant in Section 9.1.2 states that, and they stated here before, the gates are always closed when the spent fuel cask transfer facility is not in operation.

And the staff is asking the applicant to justify what this no tech special regulatory constraints on the gates to make sure that that is the case.

For Section 9.1.3, which is the spent fuel pool coolant system. The spent fuel pool cooling system is composed of two subsystems. One is a safety related cooling portion of it and the non-safety purification system.

The safety functions of the spent fuel

pool cooling system are to remove the decay heat from the pool, prevent spent fuel pool draindown. Drain below the level required for radiation shielding.

This is different from the 9.1.2 which is maintaining spent fuel pool. Spent fuel pool provides special makeup for normal evaporative loses and seismic category one makeup and isolation of the non safety related portions from the safety related portions.

There is nothing too complicated about this system, we have a an open item in this system. Dealing with the location of the anti-siphon devices. And we're asking the applicant to clarify the elevation of the anti-siphon devices.

MEMBER STETKAR: I've got a question, I stumbled over something as I was reading the SER. I've got a question about why aren't there any tech specs on the fuel pool cooling system since it's a safety related system? And in the SER where it says regards to the RAI 87 in question in 9.1.3-9

The response further stated the fuel pool cooling system is not a structure system or component. This part of the primary success path then which functions or actions are mitigated to design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of the fission product barrier.

Neither the U.S.EPR specific or generic probabilistic risk assessments, PRAs, nor operating experience have shown that the fuel pool cooling system to be significant to public health and safety.

Therefore the applicant concluded that no limiting conditions for operation are applicable. The FPCS reviewed this response and finds that it conforms to NUREG 1431 and standard technical specifications Westinghouse plants.

I just wanted to read that to get it into the record. So you basically concluded that because there isn't a design basis accident for the fuel pool. Because the PRA's didn't show the fuel pool as being risk significant and because there aren't any generic tech specs on fuel pool cooling it's okay not to have tech specs, is that correct?

MR. HERNANDEZ: Yes.

MEMBER STETKAR: Okay. Since I'm a PRA guy I got curious about this because I'm not aware of any PRA's that have actually modeled fuel pool cooling. So I decided to take a look at the EPR. And you know, they don't model it either. So it's not surprising that it's not a contributor to risk. If you don't put it in the PRA it's contribution is precisely zero.

It's not a contributor because it's not modeled. They specifically excluded the plant operating states when that system is operating. Unless I've missed something and believe me, I've looked for it.

So I'm curious about this statement that relies on the U.S.EPR PRA to justify that the risk is small. Because it not only doesn't quantify it it explicitly excludes the only configuration when this system is operating. From their low power and shut down part of their PRA.

So if you use the PRA as justification you're on thin ice.

MR. HERNANDEZ: No, I am not a PRA person, I didn't review of the PRA portion I based my response on the fact that it wasn't part of the design basis event. It was not a typical tech spec that we've seen before. So this would be a unique case and I didn't have the basis for making that.

MEMBER STETKAR: I'm glad to hear you didn't rely on a PRA, I'm curious then from AREVA's standpoint, apparently in your response to the RAI, you cited the PRA as a basis for not showing significant risk. Could you tell me precisely where in the PRA you've quantified the reliability of the fuel pool cooling system?

MR. GARDNER: John, I think we can look into your comment. I think maybe a better answer to that question would have been there's four criteria in 5036, one of those being risk significance. And I think that was the purpose of our answer was to address the fourth criteria and the PRA had not identified any risks significance for the system.

MEMBER STETKAR: If it's not in the PRA it's risk significance is precisely zero. If it's in the PRA, and you can point me to where it is and where it's quantified at 10 to the minus 30th or something like that. I just couldn't find it.

MR. GARDNER: We can go look up a little bit better answer but that was, like I say, the nature of the nature of the response was directed toward that fourth criteria in 5037.

MEMBER STETKAR: Okay. Thanks.

MR. HERNANDEZ: Any other question on the spent fuel pool cooling systems?

CHAIR POWERS: Thank you. I think at this point it would be useful to take a break for, let's be generous, go to 3 o'clock, shall we?

(Whereupon, the foregoing matter went off the record at 2:42 p.m. and went back on the record at 2:59 p.m.)

CHAIR POWERS: Okay. Let's come back into session. Let's see. Raul, we're done with you, right?

MR. HERNANDEZ: Temporarily.

MR. HEARN: Temporarily.

MR. CURRAN: He's coming back.

CHAIR POWERS: You're coming back. Good. We enjoyed your first version, and we'll enjoy your second. But we're going to turn to Gordon now, right?

MR. HEARN: Yes, next slide. So for fuel cool pooling, fuel handling system and overhead heavy loads handling systems, from Gordan Curran, the presenter, and he'll be assisted by Raul Hernandez.

MR. CURRAN: Hi. I'm Gordan Curran and I went to school, well I'm the technical reviewer for the fuel handling system. I've been in the industry for 11 years. And I've been with the NRC for three. I went to School at Washington State University, with a Bachelor's in Mechanical Engineering.

CHAIR POWERS: Washington State in Spokane?

MR. CURRAN: Close, it's just south of it in Pullman.

CHAIR POWERS: Pullman, I'm sorry.

MR. CURRAN: Yes. Nobody's ever heard of it.

CHAIR POWERS: Believe it or not, my mother did teacher training out of Pullman. And for a while I lived across the border in Moscow.

MR. CURRAN: Oh, yes, yes, yes. Very familiar with that. Okay.

CHAIR POWERS: Great place to be from.

MR. CURRAN: Okay. The fuel handling system for AREVA is in basically two parts. You have the fuel handling system, which is the typical fuel handling design, with the spent fuel elevator and fueling machine, the spent fuel handling machine.

And then they have the unique, the cask transfer facility, which contains the spent fuel cask transfer machine and the penetration assembly, which is already been discussed. Some of the stuff might be redundant to what was done --

CHAIR POWERS: That's okay.

MR. CURRAN: -- before. But I'll try to skip through a lot of that. As I said, this unique design hasn't be licensed or used in the U.S. And it's used over in France.

So the staff, not knowing any information about this, we took a MDEP trip over to the Cattenon plant in France, which is in Thionville, which is very close to Pullman in terms of size.

This right here is a configuration, which we've seen this before. It has, you can see the spent fuel transfer machine in orange underneath. And you can see it attached to the penetration at this point with the penetration lid open, which is a little circular thing.

And then you have a cask pit. This rectangular opening at the front of the pit, that's actually the connection from the spent fuel pool to the cask pit. And you can see on the right that it has the spent fuel in the loading pit.

And then it has the double gates that, the double seismic gates, in between the two. One of them's the slide gate and one's the slomo (phonetic) gate, although they look like slide gates in that picture. Three items that --

Well this is a new design, and it's a unique design. So we really didn't have an SRP that was applicable to it. So we used a 9.1.4, which is for the fuel handling. And we reviewed it in accordance with GDC-2 and 61.

I don't intend to go through all the open items. But I'll just go through a couple of key ones and some key challenges that we had. And the key challenges that we had in the review were the natural phenomena protection drain down, and the test program.

Some of the items in the natural phenomenon that we saw that were positive, if we go back to the picture you can see some of it. One is that it operates in the fuel billing, so natural phenomenon are really, you have an airplane that can't crash into it. So it's protected from missiles, except for earthquake.

The transfer machine and the penetration assembly are Seismic 1 components. We'll go back to the picture, and you can see how it runs on rails, how they indicate it.

And then it has side rails in the walls, on the two walls. And it's actually, from when we saw it in France, it's actually a really tight fit in there. And those lateral guides are probably not more than a foot off the walls. And it's stuck in there pretty tight.

I mean, even the penetration, the distance between the top of the machine and the ceiling is pretty, well that's a tight fit too. Actually the penetration assembly's actually recessed into the ceiling just to give you more clearance. And when you lift up the biological lid, it actually recesses, or goes into a recess. So that it's pretty flat on top. What else was I going to say?

MALE PARTICIPANT: Seismic restraints?

MR. CURRAN: Along the wall, thank you, along the rails and the sides, the lateral guides, there's actually seismic restraints. And there are pins that go into them.

And they're like, installed on top of the rails. Well they are in France. The rails, and pins actually go out of the transfer machine into these corbels (phonetic), I think they're called.

Or something like that they call them over there. And keep it from lateral movement. Plus it has the brakes on the bottom of it, which will keep you from moving as well. It's pretty durable.

Let's see. And then the penetration assembly is actually connected to the transfer machine with four irreversible screws. It's really hard to explain this penetration assembly unless you see it or visualize it.

But it actually has four screws that are -- It has the circular penetration through it, but then it has these, I can't explain it. It has these pieces that come out of the penetration.

It's not circular. It's actually like a criss-cross sort of a design. And it has four bolts that go up into each one of these. So when it comes down, it comes down evenly. And it comes down a tight fit. And so it comes with an even force across the connection to the cask.

And then the hoist and the trolleys have some single failure features and interlocks and controls, which they had talked about. And there's no personnel that are allowed in the facility during operation.

There's actually, you have the loading hall, and then you have a door. And it has a valve room, which separates the control room from the valve -- The valve room's in between the control room and the hall.

So there's some good distance there. And they have monitors there that they can visualize everything that goes on in there. And then they have control panels.

CHAIR POWERS: So what happens if I am done with a transfer, I start to withdraw the machine, and something breaks? How do I get in and fix it?

MR. CURRAN: You would --

MR. HERNANDEZ: At that time, you would stop the fuel transfer.

CHAIR POWERS: No, I'm done with that. I'm withdrawing the machine, and it breaks.

MR. CURRAN: What do you mean by withdrawing the machine? Is it disconnect --

CHAIR POWERS: I'm bringing it back out the rails --

MR. CURRAN: -- or pushing back out?

CHAIR POWERS: Yes. And it just stops. Now what do I do?

MR. CURRAN: If it's before the biological lid is put in, so it's between the penetration and moving the biological lid --

CHAIR POWERS: Okay.

MR. CURRAN: There's an open item actually right now. So based on what kind of event would make it necessary for personnel to actually go into the room. And that's an open item at this point.

CHAIR POWERS: Okay. So you guys have thought of everything I can think of. you don't need me.

MR. CURRAN: Because all the questions you're asking, we had at the beginning of this review too.

CHAIR POWERS: So you don't really need me. You guys did it all yourself.

MR. CURRAN: Oh, no, no, no.

MR. HERNANDEZ: It's always good to have a fresh perspective.

CHAIR POWERS: Listen to these guys sucking up here. Nice try, it didn't work.

MR. CURRAN: The open items we have for this is to describe the interlocks, provide the single failure per features. Since this is not ordinarily a single failure per crane, it's pretty much details. You go to NOG-1.

But these are some unique components. The single failure features aren't directly applicable, so we need to know some of that. And then the next one is drain down protection. And Raul's going to do this.

MR. HERNANDEZ: Yes. As we know, this facility connects directly to a spent fuel pool. So drain down is a particularly important issue that we need to address.

And one of the first features that we looked at it, there are fluid retaining components. Make sure they're all, the fluid retaining components were classified as Seismic Class 1. And several of them has a dual boundary, like it was mentioned before.

Another feature that we looked was the fuel drop analysis. If during fuel movement you could drop the fuel assembly at any point. What impact could this have on the facility?

And all the surfaces that could be impacted by dropped fuel are designed to withstand the impact of such without breaking and causing a drain down event. There is a cover plate protecting the buffer plate, which was described before. And it's not shown in any of the drawings.

Now if I could mention that, in addition to the fluid retaining components being Seismic Class 1, also all the supporting components, like the irreversible screws that holds the whole penetration assembly down during a seismic event, the actual trolley itself, it's anchored to the walls.

The brakes are enabled on the wheels of the trolley. We also reviewed to make sure that those loads were evaluated, what the impact on the walls, on the floor, or on the ceiling is going to be. Because it's a low clearance, you know, it's really tight there.

So make sure that all those impacts have been evaluated. Also we can mention that we, they have dual seals on certain places, and leak detection. This leak detection is used during the fuel movement, and also once the lid is closed to make sure it's still leak tight, sealed.

This, the cask loading pit on top of the penetration assembly, can be dry or full of water during the normal operation of the plant. So it's not restricted, it could be either way. That's why it's important that we have a seal, leak detection, on those lids.

It's also good to mention that the two gates separating the spent fuel pool and the spent fuel cask transfer facility are Seismic Class 1. The upper lip is Seismic Class 1. The bottom lip, the flange, the bottom of that is also Seismic Class 1. So it's pretty robust from that point of view.

The staff still has several open items dealing with drain down prevention. And one of them, as mentioned before, is interlocks. The interlocks are real important. We rely on the gates to prevent inadvertent drain down and make sure that it's not open.

So we still have questions about the

controls of the gates. When can they be opened? How this interlocks interact with the gates? And how reliable are they? So there are still several open items dealing with this. Question?

MEMBER SKILLMAN: The information that we received a couple of hours ago is that the maximum gap is .35 millimeters should the O-rings not set properly. And that .35 millimeters yields an approximate 390 gallon a minute leak rate. What attention has the staff given to where those 390 gallons a minute go?

MR. HERNANDEZ: That's still under evaluation.

MEMBER SKILLMAN: When will we hear about that, Raul?

MR. HERNANDEZ: Well we still have open items out. We haven't received responses to all of them.

MEMBER SKILLMAN: And that's one of them?

MR. HERNANDEZ: If I'm not mistaken, yes, that's one of the open items that we still have out.

MEMBER SKILLMAN: If you're not mistaken. Is there, or isn't there plates?

MR. CURRAN: Where the water goes?

MEMBER SKILLMAN: I'm talking internal

flooding. Where does that water go?

MR. HERNANDEZ: Internal flooding that's evaluated in a different section. That is not 9.1.3, 9.1.2. So I need to double check that.

MEMBER SKILLMAN: I'd like to know where that 390 gallons a minute are going. MR. TESFAYE: We'll take a look at the existing open items in Chapter 9, and in Chapter 3, under flooding. And that's not included, we'll come back and update you tomorrow.

MEMBER STETKAR: It's not in Chapter 3. Because in Chapter 3 it discusses wind loadings on the building and stuff like that. Chapter 3 is sort of silent on flooding in the fuel building. Just to, I mean, you can go look at it, but it was --

MR. TESFAYE: No, no. I will take the action to see if an existing RAI covers that. Otherwise we'll probably generate an RAI on this.

MR. HERNANDEZ: The drain down event is stull under evaluation in, we still need to understand this information about the .3 millimeter. This was also just fresh to us. We haven't received that yet.

We know about the 390 gallons. We still have questions about the time to stop the drain down, whether a perimeter is going to be created for that, what operator actions are needed, what's automatic?

We still have a review in this. It's kind of, it's been a complicated review, like we've mentioned before, because of the lack of straightforward guidance on this.

MEMBER SKILLMAN: Okay. Getachew, I heard you say you will take a look. And if there's not an item there, you will place an item there.

MR. TESFAYE: Yes, absolutely.

MEMBER SKILLMAN: Okay. Thank you.

MR. CURRAN: Just to share with you, in France the configuration that they have. They have drains probably 20 drains on the floor. There's quite a bit of them. And then they have the, which they said is a leak tight door, and that goes to the outside. And it's a good size door.

And there's also an entrance way on the side that comes from the control room. And there's a valve room there, and then the control room's on the other side. There's a door there, but I don't know. That's just the configuration that we saw in France.

MEMBER SKILLMAN: Well I'll look forward to your answer. I have this nightmare of a machine that's stuck, operators that in one instant they're up to their ankles, and now they're up to their knees, and now they're up to their hips. And the hydrostatic pressure may prevent them from opening a door.

I lived through a ship that burned at sea. And that was the exact scenario. We couldn't get out, because the doors were flooded. And here is a situation where you could have a very highly irradiated fuel assembly stuck with a leak, water at your hips or higher, trying to figure out, what do we do now? So I think that there are some issues that need to be looked at.

MR. HERNANDEZ: That's why we still have so many open items in this particular issue. And we are participating with the applicant, in some back and forth conversations trying to understand the particular design.

MEMBER SKILLMAN: Thank. you.

MR. CURRAN: Okay. The third item that I had was the test program. And this is sort of complicated. The only way that they have to get, they don't have a heavy load --

MEMBER STETKAR: Gordon, before you do this. Something just popped up. And it's not, I mean, it's generally fuel handled. I couldn't find a drawing, and I looked but I couldn't find one, of the fuel transfer tube, from the containment to the fuel pool. Does that, and I meant to ask AREVA and I forgot. Does that have a drain line from it?

MR. CURRAN: What do you mean?

MEMBER STETKAR: They usually do, but --

MR. CURRAN: You'd have to ask them. I'm not sure.

MR. PANDYA: No, actually, no.

MEMBER STETKAR: There's no drain line?

MR. PANDYA: No, that's correct. I'm Nitin Pandaya from AREVA. The transfer tube does not have any drain pipes.

MEMBER STETKAR: No drain? Okay.

MR. PANDYA: No. No drain in this facility.

MEMBER STETKAR: You just drain that when you drain, it's at the bottom of the cavity?

MR. PANDYA: Yes.

MEMBER STETKAR: I mean, it drains when you drain the --

MR. PANDYA: Absolutely.

MEMBER STETKAR: -- cavity? Okay. Fine. Thanks.

MR. PANDYA: Okay.

MR. CURRAN: That's Seismic Class 1 --

MEMBER STETKAR: Yes. I know. I thought

--

MR. CURRAN: -- with the gates also Seismic Class 1.

MEMBER STETKAR: I've seen a different design that had a fairly decent size drain line from it. Thanks.

MR. CURRAN: Sure. The test program, the EPR, the only way they have to get fuel out of the pool would be through this opening. They don't have a heavy load handling crane that's capable of lifting casks.

So the intial test program is related to proof of capability that they could actually remove fuel when the plant starts up. The applicant needs to define testing that needs to be done prior to start up and prior to use, since the use might be ten years down the road.

They had proposed having the initial test program at first time of use. But what that does is, you have no proof that they can actually remove fuel at start up. So we went back and we asked them to provide us the testing that that is done prior to start up and prior to use.

This COL item is related more to when a cask is available. Currently the design, well they're restricted from what they can actually load to those casks based on the size of the penetration.

So the cask has to be a certified design and available, and can connect to this facility before we will give them a license. So they gave us, or they proposed the COL item that they'll provide the cask prior to use.

But then they, again, they don't have any proof that they can connect the certified cask to the facility to offload fuel at plant start up. So they need to come up with a COL item, or some sort of proof, so that we know at start up that they can connect a U.S. certified designed cask to this, and remove fuel. That's what it comes down to.

MEMBER RYAN: So you're really saying, they don't start up without it?

MR. CURRAN: Yes.

MR. TESFAYE: They can't load fuel --

MR. CURRAN: We're talking about the cask --

MEMBER RYAN: They can't load fuel, right.

MR. TESFAYE: They can't load fuel.

MR. HERNANDEZ: We're trying to make sure that it's the same as for any other site.

MEMBER RYAN: We just want to be clear.

MR. HERNANDEZ: Can use an approved design to offload fuel, they should demonstrate a similar capability.

MR. CURRAN: Now the cask itself doesn't need to be on site at start up. You just, if you show the capability that you can --

MEMBER STETKAR: You have a crane. In other designs you have to have a crane that can --

MR. CURRAN: Exactly.

MEMBER STETKAR: -- lift the cask. And you have to have a place to put it, and all that kind of stuff.

MR. HERNANDEZ: The challenge here is that it is not clear that a cask exists that can connect with that particular, well there is no cask approved in the U.S. that can physically connect with that facility. So that's the purpose of the COL action items, to make sure that one exists at the time of fuel load.

MEMBER RYAN: Thank you.

MEMBER SKILLMAN: Is there a back up? If that option is not available, is there another way to discharge irradiated fuel safely?

MR. CURRAN: That hasn't been discussed. But my personal opinion, no.

MEMBER SKILLMAN: So the only way out is through a hole in the bottom of the pit?

MR. CURRAN: Unless they can come up with some contraption, a smaller cask or, that would be within their fuel building crane capacity --

MR. HERNANDEZ: No other method has been proposed for the staff to review.

MR. CURRAN: They can't put it in the top. They don't know the, their crane doesn't have the --

MEMBER STETKAR: The crane isn't, the fuel building crane dosen't have the capacity to --

MR. CURRAN: Exactly.

MEMBER STETKAR: Oh, is that right?

MR. CURRAN: That's why I say they could have some smaller cask if they make it. I don't know. But switch it out one fuel element or something like that, that would be within the capacity. But I don't know the details, if you could actually do that.

MR. HERNANDEZ: No alternative have been proposed for the staff to review. So we don't know.

MR. CURRAN: Thank you.

MEMBER STETKAR: This also sounds like, well I mean, we'll see how it plays out.

MR. CURRAN: Okay. And then operating procedures and training, they need to commit to prior to plant start up. Because if they train them when they get this cask, 15 years down the road, then they haven't shown that they can operate this and offload it at the time of start up.

And also ITAAC. ITAAC have not been provided for the fuel transfer, or the cask handling facility. So they need to provide that as well. And that's an open item. Those are all open items.

In addition, we have numerous, or open, items on the structural design of the facility. We have this one. And there's maybe a handful more.

They haven't provided responses back to the strucual capability, and how structure will withstand the loads of this design. And that is all I have. Any questions?

CHAIR POWERS: Well that's enough. The last one was a real zinger. We end with a bang, sir.

MR. HEARN: The staff finds that the 182 questions and 34 remaining open items to the use of public readings, and all this in conference rooms, AREVA and the staff have a general common understanding of these requirements that must be satisfied.

The staff includes the resolution that the 34 open items is manageable within the planned schedule. Upon resolving the open items, the Chapter 9, U.S. EPR/SAR will provide sufficient information to assist the COL applicant in constructing U.S. EPR that satisfies the requirement of 10 CFR, Part 52.

MEMBER SKILLMAN: What is the connection between your second sentence, 42 remaining open items, and about the fifth sentence --

MR. HEARN: That's a typo. It should be 34.

MEMBER SKILLMAN: Yes, sir. Thank you.

MR. TESFAYE: I thought I caught that.

CHAIR POWERS: Any other questions to pose?

MEMBER RYAN: No, sir.

CHAIR POWERS: No?

MEMBER BROWN: You really don't want me to. No, I don't have any.

CHAIR POWERS: Everybody's happy? I think we're done for the day.

MR. GARDNER: Dr. Powers, we're prepared to present on Chapter 4, if you're prepared to look. I have it right here.

CHAIR POWERS: I think we're not. I think we'll start again tomorrow. I think you've saturated us. So let's recess for the day and start again tomorrow.

(Whereupon, the meeting in the above-entitled matter was adjourned at 3:25 p.m.)

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
U.S. EPR Subcommittee

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Thursday, February 23, 2012

Work Order No.: NRC-1468 Pages 1-105

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

U.S. EPR SUBCOMMITTEE

+ + + + +

THURSDAY

FEBRUARY 23, 2012

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Dana A. Powers, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

DANA A. POWERS, Chairman

J. SAM ARMIJO, Member

CHARLES H. BROWN, JR., Member

MICHAEL T. RYAN, Member

STEPHEN P. SCHULTZ, Member

JOHN STETKAR, Member

GORDON R. SKILLMAN, Member

NRC STAFF PRESENT:

KATHY WEAVER, Designated Federal Official

MANAS CHAKRAVORTY, NRO

TANYA FORD, NRO

ANNE-MARIE GRADY, NRO

TERRY JACKSON, NRO

DAVID JAFFE, NRO

ANDREA KEIM, NRO

DANIEL MILLS, NRO

GETACHEW TESFAYE, NRO

ALSO PRESENT:

JOHN CONCKLIN, AREVA NP

DAVID FOSTER, NUMARC

DARRELL GARDNER, AREVA NP

WALLACE PONDER, AREVA NP

TIM STACK, AREVA NP

CHARLES W. TALLY, AREVA NP

T-A-B-L-E O-F C-O-N-T-E-N-T-S

P R O C E E D I N G S

8:30 a.m.

CHAIR POWERS: Meeting will now come to order. This is the third day of our three day meeting of the Advisory Committee on Reactor Safeguards, U.S. EPR Subcommittee. My notes say it's the last day of that Subcommittee, but I assure you it is not.

I'm Dana Powers, Chairman of the Subcommittee. We have in attendance at the meeting the Chairman of the ACRS, Mr. Armijo. Mr. Armijo, do you have any opening comments you would care to bless the Committee with.

MEMBER ARMIJO: Just go ahead.

MEMBER STETKAR: Carry on.

CHAIR POWERS: Carry on.

We also have in attendance ACRS Members Steve Schultz, Dick Skillman, John Stetkar, Mike Ryan and the ever-esteemable Charles H. Brown, Jr.

MEMBER BROWN: You're maximizing the entertainment value that I bring to this table.

CHAIR POWERS: I could not even approach the entertainment value you bring to this table.

All participants at the meeting should first identify themselves and speak with sufficient clarity and volume so they may be readily heard.

We request that participants on the bridge line identify themselves when they speak and keep their telephone on mute during times when they are just listening.

Portions of this meeting may need to be closed to the public to protect the proprietary interests. I'm asking the NRC staff and the applicant to identify the need for closing the meeting before we enter such discussions and to verify that only people with required clearance and need to know are present.

We are embarking today on initial test program and ITAAC in the SER. That's Chapter 14 called Verification Programs.

Do any of the members have opening comments they would care to make on this topic?

We may also do some catchup on items from earlier in the week.

If we have no opening comments, then I will call on Getachew Tesfaye to give us an opening comment.

MR. TESFAYE: Thank you, Mr. Chairman.

It's been a little over two years since we started Phase III Presentation to the Subcommittee, and today's our last day --

CHAIR POWERS: Time flies when you're

having fun, doesn't it?

MR. TESFAYE: Yes.

CHAIR POWERS: I'm having fun, maybe you're not.

MR. TESFAYE: But the Subcommittee is not done yet. When we close open items in Phase IV, and there's Phase V of course. But we really appreciate the flexibility you give us to bring these chapters sometimes in sections, and that's been extremely helpful.

CHAIR POWERS: I was extremely suspicious of doing it this way, but I have to say, and I think it's all to the good work everybody has done, both staff and applicant, I think it's worked out just fine. I have not had any troubles with the somewhat disjointed nature or the material. But it only works out because you guys do such a great job.

MR. TESFAYE: Thank you.

CHAIR POWERS: And if you didn't, then it would just be chaos, I'm afraid. So we have to be very careful about doing this piecemeal sort of thing.

MR. TESFAYE: Yes. We're done now. Hopefully, Phase V will be a lot smoother --

CHAIR POWERS: I think so.

MR. TESFAYE: -- and not in piecemeal.

CHAIR POWERS: I think so. I think that's true. And, of course, the general philosophy of trying to iron out the contentious points to the best you can before you come to the Committee, that's the only way this works. And so I really appreciate it. I mean, all concerned have been involved in that and it's a testimony to you guys that it worked at all.

MR. TESFAYE: Okay. And in addition to closing out some of the questions you raised this week, I think we're going to bring up the Chapter 7 that we presented back in November. We're going to have some discussion.

CHAIR POWERS: Yes. We'll chat about that and see what we want to do on that. My predilection right now right now is that if we can't resolve it, just leave it as an open item --

MR. TESFAYE: It is. That's what we intend to do.

CHAIR POWERS: -- and move on, not hang things up on that.

MR. TESFAYE: Yes. We've discussed the content of that RAI that we leave as an open item in Phase IV. So --

CHAIR POWERS: Yes, I mean I think that's the way to do it is just let's keep the dynamic going and not get hung up on that. And, hopefully, it will be resolved in Phase IV and we can pursue it at the maximum of our endurance.

MR. TESFAYE: Thank you.

CHAIR POWERS: Darrell, it's your show.

MR. GARDNER: Very good.

Of course, I thought Getachew's comments we're certainly excited to reach this milestone in this process. It's been a long productive road, I think we've been pretty successful.

Our presentation today on Chapter 14 will provide an overview of the verification programs, including the initial testing program and AREVA's approach and methodology for developing inspection tests analyses and acceptance criteria for ITAAC.

I've provided a specific presentation this morning on Section 14.1 since that's an introductory discussion. Now the presentation materials for the test program on ITAAC are at an overview level as it was not practical to provide specific presentations for every test description or for every ITAAC that's within the Design Certification and associated material. However, we are prepared to address Members' questions and comments on any portions of that material.

Today's presentation will be provided by Charles Tally with additional technical support from John Concklin and Wallace Ponder.

I would ask the Subcommittee's patience, however. We have one item from yesterday Mr. Stack would like to address regarding the CRDMs.

MR. STACK: Thank you, Darrell. This is Tim Stack from AREVA.

We had a question yesterday talking about the CRDM testing with regards to misalignment. And back in April of 2009 AREVA entered an RAI, it was RAI 95, it was question 03.09.04-1 bravo and foxtrot that was looking at CRDM testing. As part of that test program we looked at what degree of performance should the CRDMs be during earthquake conditions, in particular where we looked at static deflections of the top of the pressure housing in the CRDM as much as 100 millimeters and we looked at oscillating deflections in midpoints of the pressure housings of about upwards to 15 millimeters. And we looked at the drop times. Those tests showed that we had basically a negligible impact on the drop times which are really simulating misalignment and the effects on the drop times.

What I would ask is if there are further questions on that topic, we would like to submit that as our response to that at this point. If Mr. Skillman would like to look at that and see if that satisfies his need, that would be very good.

MEMBER SKILLMAN: Tim, thank you very much.

That response satisfied my concern. I recognized when Tim introduced this information to me yesterday, this had been looked at by the Committee previously, and I have no further questions. And I thank you for following up. I'm satisfied that you've answered my questions.

Thank you.

MR. GARDNER: Okay. With that, then I will turn it over to Mr. Tally.

MR. TALLY: Good morning. My name is Charles Tally. And my official actual job title is Manager of Engineering Integration. I am the Regional Deputy for Project Integration on a global basis for AREVA.

After some time in the nuclear Navy I joined B&W back in 1976 in time to actually participate in some of the start-up testing that was still going on at some of the B&W plants.

So, I've been in engineering my whole

career, and I'm pleased to be here to talk about Chapter 14.

John Concklin to my right is my subject matter expert for ITAAC and Wallace Ponder for the start-up and test program. With that, we'll just take the plunge.

The Table of Contents for Chapter 14 is basically three subsections. As Darrell mentioned, 14.1 is essentially just a brief introduction to what's in 14.2 and 14.3. Not much to comment on there.

So, we get into 14.2, the initial test program. Our test program follows Reg. Guide 1.68 Rev 3 for scope and the specifics of implementation. It includes testing of unique EPR design features, transient performance to be able to demonstrate that the plant can meet its performance criteria as well as operate within the safety limits. And it's noted here that the actual conduct of the test program will be the responsibility of the COL applicant.

We applied the standard definitions for the initial test program in regard to the phasing of this, in regard to construction, pre-operational testing and the start-up testing. There are no exceptions here. The only thing that we wanted to point out that is an exception, there is one, has to do with the calibration of instrumentation which traditionally with all analog systems took place in the construction phase after that equipment was completely installed. Given the DCS complexities, it will most likely be later in the overall construction program process when the complete systems will be available to do complete string calibrations for these systems. So, this is a detail that will be worked out I'm certain, I'm sure by the COL applicant, but we recognize that there is this, I'll say nontraditional need that's been identified by a contemporary plant.

MEMBER SKILLMAN: Charles, is this the way the ITAAC is satisfied in the European plants?

MR. TALLY: It this the way --

MEMBER STETKAR: I think Europeans don't have ITAAC.

MEMBER SKILLMAN: Well, how do they test? Do they --

MR. TALLY: Well actually, OL3 right now, they're very late in their construction. Essentially all physical construction is done and yet -- and the last thing that's actually going to be installed in the plant in an integrated way is the I&C system.

They've had some difficulties in their

engineering and pretesting of that I&C system that had contributed to that. But I think still the lesson is there that the DCS has got to be intact in the plant before you can start doing some of these overall integrated checkouts of the I&C system.

MEMBER STETKAR: But, Charles, a more relevant example would be Britain where they are doing something akin to the Design Certification process for the EPR. How is the whole notion of pre-operational testing calibration satisfied in that process? I'm not as familiar with -- I'm familiar with the general process, but not with the details. Are there something in the British licensing that are akin to ITAAC coming out of their -- you know, the equivalent of their certification process; it's not quite as formal as what we're doing here.

MR. TALLY: Can you answer that question, gentlemen?

MR. CONCKLIN: I don't know how to answer that question.

MEMBER STETKAR: Because, I know France and Finland don't quite have that same framework. But Britain kind of does.

MR. TALLY: But I'll be honest with you, for the UK EPR I'd be surprised if they're far enough along to actually have considered that. I mean, they might have knowledge --

MEMBER STETKAR: Well, they're pretty far along in whatever they call it, the --

MR. TESFAYE: GDA.

MEMBER STETKAR: GDA. Thanks. They're pretty far along in that process I thought.

MR. GARDNER: We'll look into that if you would like?

MEMBER STETKAR: You know, if you answer Dick's question, you know generic Europe isn't good. You know, your example from Finland probably isn't good.

MR. GARDNER: Right.

MEMBER STETKAR: But UK kind of general process parallels ours to some extent.

MR. GARDNER: And would the question be in relation to this issue we're identifying here where the plan would be to defer that instrumentation calibration until the pre-op phase versus the traditional construction phase?

MEMBER SKILLMAN: My question was whether or not there's experience that might cause us to rethink how this sequence is undertaken.

MR. GARDNER: Yes.

MEMBER SKILLMAN: And so I'm kind of the mind that if there's a lesson out there that we've learned that makes the plant safer, let's copy that, let's duplicate it.

MR. GARDNER: Yes.

MEMBER SKILLMAN: I understand the logic from the digital perspective, but I was just curious whether or not there is some information that we could say "Hey, we see how they're doing it over in this country or that county, and that makes sense, and that's the basis for our being resolved to do it that way on the EPR in the first COL in this country. So, I don't have a further action, but that was helpful.

MEMBER BROWN: Now I've got one other question. I mean, I find it -- I mean, I did in fact work in systems like this and never had -- and just assuming analog and digital for calibration, you're calibrating instruments is about zero. So, what I'm gathering out of your comments is that the system is so complex in Finland that they can't get it to work.

MR. TALLY: Well, no, I didn't mean to imply that. It's just that transmitters and --

MEMBER BROWN: Well, let me -- transmitters feed analog to digital converters and those digital converters then feed the entire DCS system. And you can't do system checkouts at all once you complete a construction of a system or whatever, unless you've got some type of instrumentation.

MR. TALLY: Right.

MEMBER BROWN: And I don't know where -- I'm just not familiar enough with the commercial to know where you do that system checkouts, whether it's in the construction phase or in the pre-operational phase. Seems to me it would be in the construction phase I would think, at least the initial calibration and setups to make sure water is flowing through pipes and valves come on, and indications you have pressure and temperature and other types of indications available so that your operations of those systems can then be monitored and then tested.

And so, but attributing it to the difficulty of the digital to analog interface doesn't bear any relevance to what's going on

MR. GARDNER: Can I give it a shot?

MEMBER BROWN: You can give it a shot. You're already going to keep digging.

MR. GARDNER: I think that initially what we understand is initial construction testing where there's construction inspections on the installation of equipment is not any different, but some I'll say calibrations and the literal definition that used for digital I&C systems, they need the system intact to hook up these test computers that work from the -- they go back out through the loops. So that total loop calibration that needs to be done would be done when the systems are intact.

So there's pieces that I would agree, that can be done along the way that would still be done, but--

MEMBER BROWN: I understand the integrated. I mean, I understand getting everything like that. But I mean you're hooking up a detector and putting your pressure detector and putting your test-- you know, pointing them up and pointing them down to get them to go throughout the range making sure that output goes off to a digital -- an analog or digital converter and then making sure you have the appropriate outputs out of that that it feeds the equipment. I'm trying to remember after then a few months, a couple of months since I've looked at your alls total bus layout, which we had considerable discussions on back in November.

Analog, if you go with an analog system, you still got to get the outputs off to the instrumentation so you can see it. So there's wires, a bus, whatever it is. It's be what it'll be, but I'd get a little bit disturbed when people start saying "Gee, because it's digital we can't do it." And it's really not because it's digital, it's because you've designed a system that doesn't allow you to do it because of the way you've constructed it to get your information out to the rest of your system. So, it's not because it's digital. It's because of the design of the system.

MR. TALLY: Well, I think --

MEMBER BROWN: Make it more complex. If you can make it less complex, and then you don't have that problem. That's a little bit of a message, subliminal maybe, but still a message.

MR. TALLY: To answer your question, I believe that we view what's going to happen in construction the same way you do. It's just that the integrated system operation that requires a lot of instrumentation which is required in pre-operational testing for the actual operation of this system, really can't be done until the overall integrated system is all there. And that's when the final check out of a lot of those systems will take place.

MEMBER BROWN: Okay.

MR. TALLY: We don't operate the systems

actually in the construction phase. I mean, that flushing and draining and flowing, that kind of stuff.

MEMBER BROWN: I understand that. I understand. I just was looking for a little bit of an answer and you gave me that part, you all did. Okay.

MR. TALLY: Any other questions?

Okay. So in the pre-operational test phase of this overall evolution we'll be demonstrating that we have functionality of the SSCs prior to fuel load. We'll be exercising the technical specifications and surveillance procedures to ensure that those are all appropriate and work.

We'll be exercising the EOPS and giving the operators critical experience necessary so that when the plant actually goes into commercial service, they'll be familiar with how the plant responds and that kind of thing.

We've just included this just to give a feel for the scope. This is how we have for the EPR grouped systems in the plant. The FSAR is laid out this way.

We'll just note that pre-op testing includes hot functional tests near the bottom of this list. And just maybe are noteworthy that there are 173 individual test abstracts that are included in the

FSAR in Section 14.2 that cover all of this.

The start up objectives in the next phase, actually after fuel load, are:

To establish that we can safely load fuel and establish initial criticality;

Perform with our physics testing, and;

Go through our normal power ascension and along the way complete a wide variety of operational and transient tests that you would never be able to demonstrate without having the reactor power.

Testing scope. There's nothing here that's atypical for what you might see in any other PWR. Just noted here that in our FSAR we got 39 tests that describe abstracts for various and sundry tests that occur along this trajectory.

We've included this overhead. It's a somewhat of an anomaly in way to call these all unique because several of these features in EPR are only evolutionary in regard to how they're applied in our particular design. They're not necessarily fundamentally unique to the EPR in the concept for functionality or the general organization of it.

The thing that may be somewhat unique in regard to how the plant has been designed is the partial trip feature which is noted as the last item on this list, which is an important feature in order to demonstrate all the maneuverability in transient upset robustness that we've tried to design into the EPR.

Slide 10 shows a representative list of the events that will be specifically tested during the ITP. Certainly not comprehensive, but representative.

There is some information in your slide deck that basically just highlights what the primary objective of each of these tests are. I don't think there's anything here that, again, is atypical of a typical PWR start-up or what you would expect to see in the scope. And there's nothing that is peculiar in regard to the EPR other than the size of the plant that we would draw attention to.

The last item is the one that we thought might be worth just discussing briefly, the island mode of operation. So, we'll just go to that, if that would be acceptable.

MEMBER STETKAR: Charles, before you do that, I'm sorry.

MR. TALLY: Yes.

MEMBER STETKAR: I'm kind of in a fog here a little bit. I'd like to say I read every single test procedure in 14, but I don't like to lie, so I didn't.

Back on the previous slide, No. 9, where you talk about the RCP standstill --

MR. TALLY: Seal.

MEMBER STETKAR: Standstill seal test, could you summarize what you're going to do with that? Are you actually going to turn off all cooling and let the system sit there hot and pressurized and verify no leakage from the standstill seal?

MR. TALLY: That is correct. It was made to be tested.

Wallace, can you answer specific questions about the technical parameters?

MR. PONDER: I'm not sure how long, but we're going to do it during hot functional.

MEMBER STETKAR: Sure, obviously.

MR. PONDER: We go down and make sure that the RCPs have stopped.

MEMBER STETKAR: Yes.

MR. PONDER: And then we close the seal and open drains and verify that we're not getting backflow through the seal.

MEMBER STETKAR: Okay. That's sort of initially, but you know the purpose of the thing is to have no leakage under no cooling at temperature and pressure for some period of time. So, I was curious whether you're just going to verify that you got no leakage for, you know 30 seconds and that was success or whether you were going to let it sit there and cook for 24 hours or something like that for a functional test of the design of the piece of equipment.

MR. PONDER: I'll have to look it up. It's Test 161.

MEMBER STETKAR: Okay.

MR. PONDER: And I'll see how long we leave it.

MEMBER STETKAR: In the interest of time, why don't you go on with the -- if you can find it, that would be good. I'll see if I can find -- is it summarzied in 14.2?

MR. PONDER: The test abstracts.

MEMBER STETKAR: Test abstract.

MR. PONDER: We'll come back to that.

MEMBER STETKAR: Yes, come back to it, and we'll go on. Because the loss of offsite power is interesting.

MR. TALLY: So Test 227 is the loss of offsite power with auxiliary load supplied in the island mode. And the test objective is noted here. Essentially the way this test is executed is that it deliberately opened the switchyard output breakers which normally would supply to your incoming or outgoing grid lines and demonstrate that the electrical transient can be sustained on the electrical buses within the plant to satisfactorily respond, and then that the plant can run back from what essentially is going to be probably a 90 percent load rejection maintaining the RCS within parameters, pressure and temperature so that it doesn't trip. Pressure rod drop effectively will reduce the power to allow the power to then be run on back to about 20 to 25 percent.

So, it's a very dynamic event, a lot of interest in it. We're fully anticipating that this test is going to be run at OL3 and Flamanville, and Taishan. So, before the first U.S. plant starts up there should be a lot of experience with this to help iron out any issues if there are any.

Now, this does require a high degree of tuning, and not only tuning for the NSSS support auxiliaries and all that, but also that the electrical system and all the relaying and selective tripping functions be set up properly so that you don't lose buses that you're not supposed to lose and wind up with a more serious event.

MEMBER SKILLMAN: Charles, does that last bullet suggest that the main steam safety valves do not actuate?

MR. CONCKLIN: That's the plan.

MEMBER SKILLMAN: That's the plan?

CHAIR POWERS: You raise an interesting--

MEMBER STETKAR: That's turbine bypass, so it's kind of important on this.

CHAIR POWERS: You raise an interesting question of how many of the tests that you anticipate doing, what also have been done at the other EPRs which are slightly different, but close enough for this purpose as a prior to when you anticipate without knowing exactly the conduct of the test in the United States.

MR. TALLY: Are you asking a question?

CHAIR POWERS: Yes. I was asking how many of them?

MR. TALLY: How many of them?

CHAIR POWERS: I mean, are other people doing the whole panoply or are them some subset of them, or --

MR. TALLY: Our European EPR people have told us that the plans are for this test to be run at all three of those other sites.

CHAIR POWERS: This particular one? How about all the others?

MR. TALLY: Yes. I don't know about -- it's hard to say.

And the other thing I think is noteworthy, is this will probably be the last test that will be run. And, you know you saw the initial list that I put up. There are a lot of very dynamic events there including load rejections, separations from the grid you know before we actually get into this. So, typically in a plant start-up you wind up doing tuning and adjustments to get things dialed in. Hopefully by the time we get to this test things will be solid enough that we will be able to execute it successfully.

CHAIR POWERS: That crosses my mind that in the aftermath of Fukushima there's going to be lots of things discussed --

MR. TALLY: Yes.

CHAIR POWERS: -- about the capabilities that they want the plants to have, probably exceeding the design basis per se. And I'm wondering in thinking about your test program if you've tried to anticipate what the Commission might think plants should be able to do and factor those into your test program?

MR. TALLY: The answer to that is not for the EPR. AREVA does have an active effort in progress in regard to what's going to be imposed on the operating fleet. I think things like that on mode of operation may be viewed as more critical going forward to preserve the overall grid, you know in the event of a large conflagration. But we haven't deliberately tried to factor into this test program yet anything that may come out of --

CHAIR POWERS: Well, it's been speculative at this point, to be sure, and whatnot. But it may not be ignorable at this point either.

MR. GARDNER: I'd just say we're developing those plans now with discussions with the staff, some beginning next week. So the key word is not yet.

CHAIR POWERS: Yes. I'm, glad to hear that. Because, I mean I can't give you any advice. But I know they're talking about all kinds of things they want plants to be able to do, and in fact plants ought to be able to do. But, who knows?

MR. GARDNER: Yes.

MR. TALLY: Yes. Well, you know if you have a serious external event that takes out your switchyard, you know you're not going to be able to operate like this anyway.

CHAIR POWERS: Yes.

MR. TALLY: So, I mean, it'll just be dependent on what kind of an external event you actually have that limits operations.

CHAIR POWERS: Yes. One of the problems that people get very focused on particular external events, and the fact is that particular external event probably will never occur. It will be some different external event with different characteristics that we are unable to anticipate.

MR. TALLY: Right.

Well, if there are no other questions, we'll go on to Slide 17.

The COL applicant is the one that's responsible for the implementation of the ITP. According to the SER, we will have a role in that, the vendor will have a role in that in regard to the test panel, that we'll be reviewing the test procedures and the results of those. But within the scope of that they will be required to provide the organizational structures, the requirements, qualifications, detail of the test program schedule and evaluate and proscribe how tests will be approved, results will be evaluated, et cetera.

And with that, that's the conclusion of the review of the initial test program. Any other questions before we --

MEMBER SKILLMAN: Any chance you've found an answer to 161, please?

MR. PONDER: I did not include a time limit. I said "within design limits." Let's see, the RCPs can be secured one at a time at hot zero power conditions and the RCP sealed package including the stand still seal can be verified to limit RCS within-- leakage within design limits.

MEMBER SKILLMAN: Thank you. Thanks.

MEMBER BROWN: Okay. I have one follow-on question since you're going through the lists of tests. We've had considerable discussion under the I&C rule in terms of the importance of the watchdog timer to ensuring that if the break processors lock up in any division, that in fact it generates a reactor trip signal as it articulated to supposedly do in the SER and its associated documents. Is there a test that's part of this pre-operational test program that confirms that it ensures that the watchdog timer actually experiences a timeout -- I don't know how you do it. I'm not a designer. But to make sure that it does get executed and that it does result in an appropriate trip of its associated reactive trip device in, you know two out of four chain of operations?

I'd like to say I tried to find that. I got the note to go look for that. I just now thought of it.

MR. TALLY: I don't know. Do we have that level of detail that's in here?

MR. PONDER: It's a fair amount, but I'd have to --

MR. GARDNER: Maybe we can ask and give him an opportunity --

MEMBER BROWN: No. It don't need to be answered now. It can even be answered later in terms of our subsequent discussions relative to the performance and the further clarifications of the operations of the watchdog timer. It's just that it is a critical key and since it operates on a division-by-division basis, you know they're supposed to be totally separated from each other, but it would be good to verify it. So I'd like to at some point later, we don't have to deal with it right now. But somehow list now to ask that question later as part of our overall discussion as a resolve to where we go with the watchdog timer discussions and clarifications and get a picture of what they look like.

MR. GARDNER: Okay.

MEMBER SKILLMAN: I would like to ask Wallace about the pressurizer surge line test for thermal stratification and it connected design elements.

MR. PONDER: Yes.

MEMBER SKILLMAN: Could you give us just a glance of what this test really does?

MR. PONDER: What we're trying to do is verify that it has a continuous slug and we know there'll be some cycling. But what we're really worried about is a high number of cycles with something phenonomenal like thermal strapping; we should not have that.

MEMBER SKILLMAN: So the design limits in this context are the fatigue limits on the --

MR. PONDER: The fatigue --

MEMBER SKILLMAN: -- sections of the metal or the T -- or the connection to the pressurizer, that type thing?

MR. PONDER: That's correct.

MEMBER SKILLMAN: So it's really connected to the fatigue limits for the ASME code analysis?

MR. PONDER: Yes.

MEMBER SKILLMAN: So this then becomes an cycle counting?

MR. PONDER: Cycle -- we want to make sure that we're only acquiring counts when the system is started up and shutdown, that we're not acquiring counts in steady states.

MEMBER SKILLMAN: Okay. Thank you. Thank you.

MR. TALLY: Anything else on ITP? All right.

The outline of the material that we're going to go through for Chapter 14.3 in regard to Certified Design Material ITAAC is on this overhead. We'll walk through this subchapter section at a time.

Section 14.3 Tier 2 provides the selection criteria and the methods that ar used to develop the Tier 1 material. There are two types. The Certified Design Material, which is essentially brief system description type requirements. And it's noteworthy to point out that the Tier 1 material is always dry from Tier 2 material. That there's no new information that's developed from Tier 1.

There are five chapters that are described in the FSAR for what's in Tier 1. They're outlined here. We're going to go through these one at a time.

We need to point out that the Design Certification provides interface requirements to the COLA and the COLA provides the ITAAC for emergency planning and the site-specific portions of a facility that will be licensed by the applicant, the COL applicant.

This provides kind of a pictorial of how ITAAC are developed for the COLA applicant. You'll note here in the middle of the page that the FSAR develops DC ITAAC that have to be satisfied by the COL applicant. At the same time, the DC effort identifies interface requirements for systems that are incompletely described in the Design Certification package. In other words, we may have requirements for something like that. Essentially service water: There's a large part of that system that may be embedded in the scope of the DC, but when we go out to something that's site-specific and the COL applicant has got to satisfy those interface requirements. So these feed into the COL ITAAC COLA action, so to speak, as well.

And then in addition to that any site-specific systems where there are significant design features that inherently bear on safety have also got to be identified in the same way we would for the DC-- the COLA applicant has got to do for his scope. That is the last piece that feeds into the COLA ITAAC collection that ultimately then will have to be closed out by the COLA applicant who is constructing the plant.

The introduction of Tier 2 Section 14.3.1 basically provides the backdrop infrastructure for the definition of the rest of the material that's discussed in 14.3 You actually get into the meat and potatoes when we get into the second section of this chapter, which is the system-based design descriptions in ITAAC. This is where you'll find the bulk of the ITAAC that are derived for the plant. As noted here again, this is all coming from Tier 2 material and is the basis for the Certified Design phase as well as the content and format for the actual ITAAC themselves.

We included here just a listing of, again, the grouping the way it appears in EPR FSAR for the overall structure of what you would find in the ITAAC. If you pull out the actual ITAAC, they're organized and grouped in this fashion.

Do now we want to talk just briefly about the selection process for what lines up being included in ITAAC. In other words, how did we get to this significant body of work that we call our ITAAC?

There are two fundamental processes. This is consistent with what's defined in the SRP for 14.3. Essentially, we go through an assessments of SSCs to determine what has some safety significance and at the same time in parallel go through a series of evaluations of analytical pieces of work that support the overall plant design to identify any key design parameters that are noteworthy and should be addressed with ITAAC. These two collectively are then rolled into the Tier 1 commitment and we have ITAAC developed for them. We'll have some examples here just shortly in regard to what these look like.

So these SSCs are reviewed based on their classification, safety classification and function. And the thing that's important to find out here is that in ITAAC we're not verifying a function, we're verifying a design feature that supports that function. So, you know the ITAAC tend to be extremely specific with regard to a measurable measurement that needs to be demonstrated at the time that the plant is actually constructed.

An example here is shown on the second bullet where we would have an ITAAC that would demonstrate or confirm the existence of piping and other equipment that's necessary to be able to provide a safety function in this particular case.

Note that on the third bullet that there would not be an ITAAC for a lot of the ancillary equipment that you would find typically in a fluid system that would be there for, you know the normal operation, maintenance and that sort of thing. So the key here is what's really essential to demonstrating that the function will be able to be provided that is critical. The functions are defined in the CDM.

The analyses that are reviewed are consistent also with the guidance in the SRP. We've put them up here. You can see what had to be culled through to determine what was noteworthy here that needed to find its way into ITAAC. And, of course, this has been a very interactive process for the staff reviewers who sometimes have had differing views in regard to not only this portion, but some of the other systems, SSCs, in regard to what really ought to be included and what was the appropriate way to phrase or status what the ITAAC will be. It's been a little bit of a -- it's been a lot of a learning process, very -- very interactive.

CHAIR POWERS: It will continue to be

interactive.

MR. TALLY: That's right.

So in other words, to summarize here again, the SSC features that are provided to meet various functional requirements are discussed in the Tier 2 material. There's nothing in Tier 1 that points to in a direct reference way, Tier 2. So Tier 1 is self-contained.

Here's another example both for our system and structure. If you looking at the functional requirement, you would say, for instance, that the LHSI provides core cooling for large-break loss of coolant accident. But rather than find something that includes that functional statement in ITAAC, what you would find is that there exists LHS piping runs from the IRWST to the reactor coolant system of the IRWST necessary pump and heat exchanger that would provide that function. So these are discrete: You can go touch, feel, confirm that this equipment is there.

At the same time the analytical reviews, for instance in this case Chapter 15, would say that in order for this function to actually be satisfied, you've got to be able to deliver fluid from this system at a certain minimum flow rate. So you will find also in ITAAC something like the third bullet there under the systems example that would confirm that the system would deliver that flow under those conditions that would exist for the event.

So there is a performance-based ITAAC and then there's a physical features-based ITAAC that in concert demonstrate that you would be able to satisfy the overall function.

The structural example is perhaps a little bit simpler, you know where to provide some inherent features such as radiation protection or flooding, or whatever, you may have a wall that's got certain dimensional to it that you would confirm after construction is there with that minimal wall thickness. So there are quite a few ITAAC that are in our submittal that go along those lines as well.

The system design description that's included in Chapter 2 is what we refer to as a Certified Design Material. The only thing we wanted to highlight here is the recognition that the Certified Design Material is in effect for the life of the plant, and whereas as we'll point out here shortly, you know at the conclusion or close-out of the ITAAC those features then become controllable by the licensee through other processes.

MEMBER SKILLMAN: Charles, you made the

distinction on Slide 31 that the design material in Tier 2. Isn't it accurate to communicate that both Tier 1 and Tier 2 are certified, but Tier 2 material requires a departure that's been evaluated by the staff at the plant, whereas Tier 1 is really a license change and requires regulatory action?

It's all certified, but the difference between Tier 1 and Tier 2 is Tier 2 can be changed by the licensee with a 50.59-like process, whereas Tier 1 is an actual license amendment?

MR. CONCKLIN: This is really just quoting words out of the SRP where they use the term "Certified Design Material." It's not meant to infer what's the totality of the Design Certification.

MEMBER SKILLMAN: Okay.

MR. CONCKLIN: So the Certified Design Material, the point of that is that's in effect for the life of the facility and the other stuff can be changed, as you say. That is correct.

MEMBER SKILLMAN: I agree with that. Perhaps I jumped in haste. What I was trying to do was to discern why you choose the word "Tier 2" in referring to the first bullet. I think all the material is certified, but Tier 1 can be changed with one process, Tier 2 can be changed with a different process. Departures are required.

MR. CONCKLIN: We would agree.

MEMBER SKILLMAN: Thank you. Okay. Thank you.

MR. TESFAYE: That's correct.

MEMBER SKILLMAN: Okay.

MR. TALLY: Slide 32 basically is just to highlight that, you know ITAAC are consistent with what's in the Certified Design Material. And as I mentioned earlier, the Certified Design Material, if you're not familiar with it is essentially a system description by system that actually includes functional requirements.

The ITAAC must be satisfied with closure justification. This process, which will be interesting for the COL applicant, I'm sure. And as noted here, the third bullet, you know the ITAAC expire after the closure process has been completed.

Slide 33 is just another review of the format and content of ITAAC. We comply with this. No issues here.

Now we get into Chapter 3. This is the nonsystem-based design description of ITAAC. The SRP provides a suggested list of topics. These tend to be, what do you call them, transfers types of issues in a plant. They don't necessarily line up with a single system very cleanly. And as you can see from this list, you know the Reliability Assurance Program and the factors and things like that are in fact transfers with regard to their scope.

While AREVA was going through this overall evaluation and developing our Tier 1 material we also added topics from the list that you can see that's included here in the realm of security: Containment isolation, plant cable and et cetera.

The Certified Design Material in ITAAC or Chapter 3 follow the same approach as the system-based CBM in ITAAC or Chapter 2.

Chapter 4 actually gets into these interface requirements that we discussed earlier in regard to what the COL applicant is going to have to address. It's incumbent upon the Design Certification provider to identify these interface requirements. I don't know that there's any more that needs to be said about this.

And the last chapter has to do with site parameters. These are essentially site parameters that were assumed in the Design Certification that the COLA applicant has then got to confirm, he satisfies for his particular site that he's going to be licensing.

The last section has to do with the nine acceptance criteria. Here again, we've used a site interpretation definition of DAC that's in the SRP. I don't think there's anything unusual here to comment on either. Closure processes for DAC are noted at the bottom of this overhead.

Here again, this will be the COLA applicant that will be dealing with these.

The last overhead, the next overhead, just points out that for the U.S. EPR we're only applying DAC in two areas for piping design and human factors engineering.

And that concludes the overview of the 14.3, the Certified Design Material in ITAAC.

MR. GARDNER: Dr. Powers, if there are no questions, then we'll turn it over to the staff for their portion of the presentation.

CHAIR POWERS: Do we have any other questions in this area?

Thank you very much. You're done.

MR. GARDNER: Thank you.

CHAIR POWERS: Tanya.

MR. TESFAYE: And we are ready. Dave Jaffe, who is the Chapter PM for Chapter 14 will lead this discussion.

CHAIR POWERS: Okay.

MR. JAFFE: Good morning. My name is Dave Jaffe. It's an honor to be here this morning with the Subcommittee to discuss the staff's evaluation of Chapter 14.

I received my Bachelor of Science degree from Clarkson University and my Master's in Engineering Science from Rensselaer Polytechnic while dinosaurs roamed the earth.

MEMBER STETKAR: But from real schools that turned out real engineers.

MR. JAFFE: Absolutely.

I am in my 35th year with the NRC staff, and I have ten years experience elsewhere in the industry, mostly in licensing project management.

Currently I'm assigned in Licensing Branch 1 in DNRL. And I'm lead for Chapter 14 review.

Next slide, please.

The subject material in Chapter 14 is, of course as AREVA's pointed out, is divided between the initial plant test program in 14.2 and then ITAAC in 14.3.

14.2 is a fairly cohesive evaluation under the purview of the Quality Assurance Branch. And Andrea Keim will present items that we hope are of interest to the Subcommittee in 14.2.

14.3 is a number of inputs from virtually every branch across the design spectrum that are involved with ITAAC. So 14.3 is rather an assemblage of other inputs. And the names below Andrea Keim are the various disciplines.

Next slide, please.

Getachew Tesfaye, as you know, is the Lead Project Manager for the U.S. EPR --

MR. TESFAYE: You're capturing that.

MR. JAFFE: Yes. Yes, he seems to kind of show up from time-to-time. I don't understand why, but he's here. Okay.

Tanya Ford is Co-Project Manager with me on Chapter 14. And for the purposes of this presentation and of the staff's review, Tanya had -- excuse me. I had 14.2, Tanya had 14.3 as Project Managers.

Next slide, please.

We provided some statistics here for you as to the number of questions and status of OIs. I'm sure you've seen this before.

Next slide, please.

And again. Next slide.

Okay. We had a total of 33 open items, and of course not all of these are of equal import. And we don't want to bring you things that you would not find interesting.

However, next slide. We did corral a number of items that we'd like you to hear about. Andrea Keim will present information about open items in 14.2. Tanya Ford is going to present information in 14.3.1 which normally is not much of a topic for us,b ut there are some important crosscutting issues here including inspectability that we think you should listen to.

Manas Chakravorty will talk a little bit about open items in structural and systems engineering. And Daniel Mills will talk about issues in I&C.

We have experts in the other areas that are available to you should you be interested to hear about these other areas of review.

Tanya Ford will now -- oh, I'm sorry. Andrea Keim, please.

MR. KEIM: Hi. Thanks for having me.

My name is Andrea Keim. I received a Bachelor's and Master's degree from Stevens Institute of Technology in Materials and Metallurgical Engineering.

CHAIR POWERS: We got some new engineers.

MR. KEIM: I've been here with the Agency for about 16 years. Currently, I'm working in the Quality Assurance Branch in NRO. My boss is Karrie Kavanaugh.

I appreciate this opportunity to brief the ACRS Subcommittee on the status of the review for Chapter 14.2 of the initial plant test program on the EPR design.

This has been a multi-year review involving a broad number of staff and multiple disciplines. So we also had a lot of people; I've had I think 14 different reviewers provide me some small input or review and checklists -- not checklist, scratch checklist. And checking and verifying the data in their chapter reviews to confirm what is in the initial plant test program.

So, approximately 18 staff personnel have provided the 163 RAIs. At this time we have six open items that are currently being reviewed by the staff, and we have the information that is provided by their applicant that are being resolved, hopefully shortly. As they finish the chapters, we'll be able to close out the open items on those six.

There's one open item that we are still

waiting for a response from the applicant, and that is on Question 14.2; that's the one that's showing on the screen. And it's related to the radiation monitoring system. The staff noticed some inconsistencies and asked for some clarification. These systems are important for ensuring proper operation of automatic control functions upon detection of higher radioactivity levels.

Once the staff reviews the applicant's response, the staff should be able to close out this item.

At this time there aren't really any high level outstanding issues that are being discussed for 14.2 beyond the level of details and some inconsistencies between the chapters and the test abstract acceptance criteria that are being resolved through the RAI process.

So if there's no questions, I can hand this over to Tanya Ford.

MEMBER STETKAR: If there's no questions. Unfortunately, there is one. I want to follow-up a little bit with you regarding my question to the applicant about the success criteria for Test 161. And I couldn't find any questions regarding that test, so apparently you were happy with at least the summary information in the FSAR. But I point you to SER section 9.3.4.4.1. And in that section of the SER there's a discussion regarding the performance of the standstill seals. And without quoting a whole lot of text, it basically says -- this is discussing station blackout, loss of all seal coolant.

"Approximately ten minutes into the SBO event the RCS pump seals fail which adds about 100 gallons per minute RCS leakage rate to the to the initial leakage rate. Around 15 minutes into the event standstill seal system reduces the leakage rate to two gpm for the duration of the eight hour coping period. When the RCS leakage rate is integrated over the eight hour coping period, the total leakage is approximately 7,510 gallons, approximately."

And that, you know was the basis for resolving the RAI. In my mind that's acceptance criteria for the performance of the standstill seals; namely a leakage rate and an integrated leakage over an eight hour coping period at high pressure with the no cooling. And I was curious whether or not indeed their test will verify this?

And I'm particularly interested, Fukushima aside, this standstill seal package as I understand it has not yet been installed in any other operating plant. It is indeed a new design for, in particular, the U.S. EPR. So we don't have any operating experience. We don't have any other test experience on this particular type of seal. So, I was curious why you haven't followed up on that test.

MR. KEIM: It sounds like something we should follow-up to make sure that we get consistency between the chapters --

MEMBER STETKAR: Yes. I mean all they said when I asked them is that it would meet the acceptance criteria, but I wasn't quite sure in their mind what that meant. And in my mind, this is an excerpt from the SER. It's not from the FSAR; I couldn't find these words in the FSAR. But there appears to be some closure that needs to be made regarding what indeed are the functional performance acceptance criteria for those seals and how that will be verified through the start-up functional testing part.

MR. KEIM: So that may need -- in 14.2 from the test abstract back to the --

MEMBER STETKAR: Yes. I didn't know whether you had any discussions. Granted, the test abstracts or test abstracts, but --

MR. JAFFE: I took a quick look at 161, and I didn't find any hold times.

MEMBER STETKAR: There aren't any, and in fact quite honestly when I was skimming through things I didn't even link 161 as related to kind of performance testing of the standstill seals.

MR. JAFFE: There's probably a level of detail, you know that's --

MEMBER STETKAR: And at this stage I don't know how much detail you go into those types of issues, typically. But --

MR. KEIM: Sometimes the more the better, sometimes the less the better. So you give it a little bit of possibility --

MEMBER STETKAR: It's sometimes easier to get the discussion, you know on the table already.

So, that's the only I had whether you had any discussions relating to that issue.

MR. KEIM: We can take that back and maybe look into maybe adding another RAI --

MR. JAFFE: Yes.

MR. KEIM: -- to try and get a little more detail.

MR. TESFAYE: We'll get back to, maybe today, and see what we have.

MEMBER STETKAR: Probably not today. I won't be here this afternoon. So that might give you some wiggle room.

MR. TESFAYE: Oh, okay.

MR. JAFFE: We'll take it, in any event. Thank you.

MEMBER STETKAR: Thanks.

You're here.

MR. STACK: This is Tim Stack again from AREVA.

And when we talk about the initial test program, one of the other things to keep in mind is separately from that there's a qualification test program for the equipment that typically will do an eight hour run on the standstill seal for whatever the required duration is; eight hours, or whatever the number turns out to be. And similarly, like on the watchdog timers you do a functional test and demonstrate the functional testing before you ship it from the factory that, you know when the watchdog timer times out, it flips the reactor.

So everything that you have in the initial test program isn't necessarily tests. There are many tests that are performed in qualification just like we talked about in the CRMs earlier. So you need to keep it in mind that the tests will be done, they may not all appear in the ITP.

MEMBER STETKAR: Yes, I understand that, Tim. The reason I brought it up was we kind of raised this issue when we were going through our -- I don't remember whether it was Chapter 5 or Chapter 9. I have notes in both of those chapters here to myself. And all my notes say is you were going to get back to us on what sort of acceptance testing you were going to do. So --

MR. STACK: And we drafted a response.

MEMBER BROWN: Let me make one comment relative to your last -- if you read the DCD and the rest of the documents, it doesn't really tell you where the reactor trip devices themselves are located. Are they part of the cabinet itself, are they located closer to actual actuators that they have to control?

The other thing is you obviously tested in the qualification test program, but at some point you got to make sure it does something in the plant. In other words, are the wires hooked up? Are they hooked up to the right place? So you got to have something that verifies your overall as opposed to just an inspection.

And the only reason I say that I've seen people do inspections. Somebody put the wrong wire marker on. All of a sudden the wire doesn't go from point A to point B, it goes from point A to point D and you do not get the desired end result. So, a final integrated test which shows that you actually -- it gets your end result in my mind is an important aspect of that pre-operational test program.

So, I just wanted to provide that as an amplification on your comment. I understand the qualification part. They'll obviously see -- no, I'm not going to say that. Theoretically, that should be tested.

MR. STACK: Okay. Thank you.

MEMBER BROWN: All right.

MR. JAFFE: All right. Good.

Tanya?

MS. FORD: All right. Good morning.

My name is Tanya Ford. I am Project Manager and I assisted Mr. Jaffe in coordinating the staff's review for Chapter 14 of the U.S. EPR Design Certification application.

This morning I'd like to discuss some of the generic concerns identified by the staff for Chapter 14 which were issued to the applicant in RAIs.

Sorry, I have to get use to working my slides and reading.

In RAI 182 Question 14.3-10 the staff

raised various concerns regarding ITAAC including inconsistencies with ITAAC wording in interpretations, technical adequacy of ITAAC. definitions used in ITAAC wording and ITAAC inspectability issues.

One example of these generic concerns was the applicant's definition of the term "as-built." The staff has worked with NEI and endorses the definition as-built in NEI document 08-01 Revision 4. This document establishes guidance on the accepted definition of the term of the term as-built and how to interpret this term when it is used in ITAAC. The applicant has since adopted the NEI 08-01 Revision 4 definition and the staff considers this generic issue to be resolved. However, after reviewing the applicant's complete response to RAI 182, the staff determined that the response was insufficient in addressing all of the staff's generic concerns, and therefore the staff issued follow-up RAI 469 Question 14.03-16 to address the remaining concerns that have not been resolved.

So as a follow-up, RAI 469 contained some of the same generic issues including specificity in ITAAC wording, improper use and omission of as-built terminology in ITAAC, and ITAAC inspectability issues.

As noted, the staff is still in the

process of reviewing the applicant's response to RAI 469 and has already provided the applicant some feedback regarding its response. Some quick examples of feedback that has already been provided to the applicant include:

Lack of specificity. So for example, in the SER there are several instances where the ITAAC requirement simply states that an analysis be performed. The staff's issue was that there is no specificity as to whether this analysis is to be based on the design phase or after construction. So, by saying analysis only and not providing this specificity at either the design phase or after construction, this leaves ambiguity in when the analysis is to be performed. So the staff has informed AREVA that this level of detail needs to be included and so that they should look throughout the ITAAC and provide this specificity wherever an analysis is required to be performed.

Another example is the lack of inspections of analysis. So the staff noted that in several cases there are analyses that are required to be based on the as-built conditions. There also needs to be an inspection associated with this ITAAC to verify that the work was completed according to the applicable specifications of the analysis. So therefore, the staff informed AREVA to take a look at all of its ITAAC to determine where there is a need to add an appropriate inspection to correspond with the ITAAC analysis.

Quickly, next slide.

An issue with ASME code related ITAAC. The staff just identified that all ASME code related ITAAC should be consistent throughout all of the ITAAC sections. So this means if an ASME code related ITAAC appears in different ITAAC chapters, the wording should be consistent in each reference throughout ITAAC to avoid confusion.

With omission of as-built terminology, the staff noticed that in several instances the term "as-built" was removed from ITAAC wording when in some instances it should not have been. So the staff noted that if the requirement is to be performed after construction has been completed, then this terminology should be added back into the ITAAC wording to provide this level of specificity.

And one last example, next slide, is for severe accident ITAAC. The staff has requested that the applicant add ITAAC for specific nonsafety-related equipment. AREVA quotes from SRP Section 14.3 that only the existence of the feature needs to be verified by ITAAC. This argument relates to the SRP Section 14.3 guidance that the level of design detail need only be commensurate with the significance of safety functions. However, the SRP also suggests that a graded approach be used, specifically how to address specific nonsafety-related criteria for inclusion in Tier 1 such as severe accident, ATWS and fire protection.

The staff believes that additional severe accident ITAAC need to be included or selected safety significant, but nonsafety-related equipment. An example of this would be the hydrogen monitoring system which measures the hydrogen concentration in containment during and after the accident.

And the staff was also issued a specific RAI on severe accident ITAAC in Section 14.3.11

CHAIR POWERS: This particular item would seem to relate closely to my question I posed earlier. We can anticipate that there may be additional requirements stemming from the post-Fukushima fallout. Are you keeping your finger on the pulse there to understand what those might be as they relate to this application?

MS. FORD: Yes, the staff is. And we have

Anne-Marie Grady who is actually the second core reviewer for Section 14.3.11. And I believe that is where the additional RAI stemmed from. So they brought it out of RAI 469, which was generic, and made a specific severe accident ITAAC. I don't know, Anne-Marie, did you need to add anything to that? Okay.

CHAIR POWERS: Give us any insight on what's going to be required?

MS. FORD: Yes, I don't think that we have that information ready yet.

MEMBER STETKAR: Tanya, you've characterized this on the slide as severe accident ITAAC because severe accidents have a connotation that may be different to different people. Is this really restricted to severe accidents? The examples that you've listed here, I know what ATWS, I know what fire protection, I know what station blackout is, I know what hydrogen monitoring is. But does it expand more broadly into that list of risk significant systems that are on the D-RAP list, which may not necessarily be severe accident-related. They may be core damage prevention, if you will, or is the concern strictly related to what I understand as severe accident issues?

MS. FORD: Let me ask Anne-Marie to

address that.

MEMBER STETKAR: I'm just trying to understand the scope of this RAI in terms of --

MS. FORD: Right.

MEMBER STETKAR: -- how it reaches out into nonsafety-related things throughout.

MS. FORD: Exactly.

MS. GRADY: Yes. This is Anne-Marie Grady from the Containment Systems Branch.

And I can't speak to the D-RAP list at all. But there are pieces of equipment that are in our view safety significant, individually identified. And because they're not safety-related, they have been for that reason only not included in the ITAAC. And we have on a case-by-case basis identified certain equipment we think is safety significant and should be ITAAC'd. It's not a generic ITAAC with all -- it couldn't require the severe accident case-by-case basis.

And ITACC'd -- the open item, the RAI that I wrote related to the hydrogen monitoring system for high range monitors for hydrogen.

MEMBER STETKAR: Thank you. That helps, but I guess in my mind it's a bit troubling because you used the term systems that you think should be on this list. And I guess it raises a question in my mind as far as the type of process that you use to draw those conclusions about why specific things are on your list and why specific things are not on your list when, indeed, there is a process that's been applied in this plant as part of the Design Certification to create a list of things at least from -- it's partly risk-informed, but it's also this expert panel, you know reviewing the whole plant in the context of things that could be important. That list happens to include the hydrogen monitoring system, but it also includes other things.

So, I was curious about, you know how you make your determination of what you think should be on this list and why you're asking questions about those specific things and whether there's a kind of consistent process here.

MS. FORD: Right.

MEMBER STETKAR: And I guess it's troubling if you hear the people saying, you know you're asking these questions but you're not familiar with the D-RAP list, because I thought that that was one of the purposes of that whole Reliability Assurance Program was to identify nonsafety-related things that are related to safety and risk.

MS. FORD: Well, I think that this will be an item that we'll take back and --

MEMBER STETKAR: I'm not necessarily inferring, by the way, that --

MS. FORD: Right. Exactly.

MEMBER STETKAR: -- everything on the D-RAP list ought to be.

MS. FORD: Exactly.

MEMBER STETKAR: It bears to the applicant. I'm just basically asking a question about what sort of process did the staff use --

MS. FORD: Right.

MEMBER STETKAR: -- to focus in on things under this particular RAI.

MS. FORD: And that will be the exact things that we would get back to you.

MEMBER STETKAR: Thanks.

MS. FORD: Yes.

These are just some of the staff's generic concerns and issues that still need to be resolved. So, as you can see, RAI 469 Question 14.03-16 is still being tracked as an open item to resolve the staff's remaining ITAAC concerns.

At this time, this concludes my discussion regarding the staff generic ITAAC concerns. And I will take that one item back with me to get back to you with a more complete answer about the process.

MEMBER STETKAR: Yes. I mean, I'd like to understand a little bit more about why specific items are of concern.

MS. FORD: Yes. No problem. Yes. Thank you.

MR. JAFFE: I'd like to introduce Manas Chakravorty and Dave Foster.

I apologize that we don't have proper name signs for them. Can you see their names properly?

MR. CHAKRAVORTY: Good morning. My name is Manas Chakravorty, and I'm in the Structural Engineering Branch of NRO. And I have been in the nuclear industry for more than probably 35/40 years. Since I actually graduated. And I was in the optic engineer company first and then went to utility, then into operating and operated the plants and then eventually came back to being a regulator.

And with me I have also got David Foster. We also worked way back then, 30 years back designing Beaver Valley containment structure.

MR. FOSTER: We've known each other a long time.

MEMBER STETKAR: You guys responsible for the --

MR. CHAKRAVORTY: No, no, no. The structural design.

Let me give you a little bit brief overview of what we did in 14.3.2 on our structural ITAACs. Using building structures of the new checklist that is in the SRP our structure we've included TL1 system-based design descriptions of ITAAC Section 2.1. On structures giving these specific features we used the ITAAC tables for verification.

Our primary focus was on the verification of the Design Basis loads, key building dimensions, cubicle pressurization and protections from internal and external hazards and internal flood, containment pressure testing and also seismic interaction effects.

So based on that we looked at those ITAACs that are provided in those sections and also reviewed the Certified Design information section that is in the Tier 1 2.1. And verified that the attributes, that the features that is necessary in the ITAAC list is appropriately represented.

Now we did have about -- I don't know what is the total number of RAIs, but correctly we had nine RAIs which are open, we're getting responses and being resolved. As an example, a number of the times that we listed two of the RAIs here on the slide and on the number 14 Slide, RAI 386, 14.3.02-45. It really involves verification of features for internal missile barriers. So we requested the applicant that they identify these missile barriers areas including those inside the reactor building because we were not sure whether everything in the reactor building has been looked at.

And also the three dimensions, that issue should be there.

Now the applicant did provide some information in ITAACs for fire and internal flood protection, but they didn't provide anything for missile barriers. So we still do have that RAI open and we'll be reviewing it.

The other issue is the basis for treating U.S. EPR containment structures as a non-prototype during a structural integrity test. When we looked at the RAI they didn't have any requirements for strained measurements, which is normally required for a prototype structure integrity test as per ASME Division 2, I think Article 6,000. When we asked that question to the applicant, applicant indicated that it is non-prototype containment. So we asked that that's good, but we need some information on that non-prototype for us to compare and make an evaluation that it is okay to be a prototype or non-prototype containment. So those are the kind of things that we have looked at, and this is what is presented.

Now, you have any questions, any other issues, you know I'm happy to respond. We have Dr. Foster here and he has looked at it in great detail.

MEMBER SKILLMAN: How would you resolve this if the EPR design is prototypical, but the requirement is that you test to a prototype and this is not a prototype, how do you resolve this?

MR. CHAKRAVORTY: Well, prototype is the first time that you do it. And they do have to have test data, okay. In other words, they have to have the kind of containment that they have tested before, you know as well as the reinforced concrete, was it a pre-stressed concrete, you know what kind of dimensions it had. And we need to verify those numbers -- you know information for us, you know to determine whether they are were tested properly.

And like, we have a 62 psig pressure, you know what pressure it was tested. So we have to have all this information before we could decide that it is a non-prototype containment in U.S. EPR. We don't know. We don't have the information.

MEMBER STETKAR: But have they identify the referenced containment that they're --

MR. CHAKRAVORTY: Not yet. We haven't seen it.

MEMBER SKILLMAN: Okay.

MR. CHAKRAVORTY: But we just asked the question. So we're expecting some information.

MEMBER SKILLMAN: Thank you.

MR. CHAKRAVORTY: Thank you very much.

MR. JAFFE: I'd like to introduce Mr. Daniel Mills from the I&C Branch who will discuss the I&C effort.

MR. MILLS: Good morning. I'm Daniel Mills. I work for Terry Jackson in Instrumentation and Controls and Electrical Engineering Branch in DE.

I've been with the NRC for about 4½ years.

I am a recent graduate from the Nuclear Safety Professional Development Program.

I graduated from Ohio State University with a Bachelor's degree and a Master's degree in Mechanical Engineering and a Master's degree in Nuclear Engineering with a research focus on instrumentation and control systems.

Our review, the staff's review consistent with the Standard Review Plan 14.3.5 Instrumentation and Control ITAAC proceeded in parallel with the review of Chapter 7. So, you may have noted that we have several pointers to sections of Chapter 7 where we have some discussion of evaluation of the ITAACs.

I'm going to go ahead and go through the four. I guess a correction to one of the previous slides, we actually have four open items for 14.3.5.9, not five as was shown. And these four as shown on this slide starting with RAI 506 Question 14.3.5.27, this deals with design description and ITAAC verification items dealing with the safety information and control system safety functions.

Question 14.3.5.30 deals with ITAAC verification of safety functions of the priority and actuator control system.

Question 14.3.5.39 deals with -- there are several systems where ITAAC items verifying single failure protection were not included. And this question requests that the applicant address that.

And Question 14.3.5.41 deals with the self-test functionality of the safety automation system.

And I'm happy to take any questions if you have them.

CHAIR POWERS: I guess, especially in this area, it's not clear to me how one decides when you have to test something after it's installed and when it's adequate to test it as the equipment qualification aspect. How is that decision made?

MR. MILLS: Decision made as to whether to include functional testing versus -- meaning initial test program type versus --

MEMBER BROWN: Factor acceptance test.

MR. MILLS: -- factor acceptance testing?

MEMBER BROWN: At least, I think that's what he's referring to --

CHAIR POWERS: Yes.

MEMBER BROWN: You got a factor acceptance test qualification program and then you have whatever is done subsequent to delivery of that equipment after it's completed its factor acceptance test.

CHAIR POWERS: And we've already said the delaying a lot of this because we need the entire integrated systems. So I assume the entire integrated system must have some impact on this. I mean --

MEMBER BROWN: Well I try to pull on that a little bit. I think part of it is that the way their integrated system operates its not discrete sets of wires going from each and every thing. There's an integrated bus, a distributed bus system that sends information around and you have to have that entire -- correct me if I'm wrong. But you have to have that entire integrated bus system set up and tested to see if all the data's getting on it and it's going where it's supposed to go.. Because all you've got is a bunch of boxes and then you've got fiber optic buses and then run -- or transmitting data through all the distributed systems.

CHAIR POWERS: I think I understand that, and that's what leads to the question to use --

MEMBER BROWN: I'm not disagreeing.

CHAIR POWERS: I mean, how good is it? Suppose that the box has been tested up one side and down the other, but if I don't have it pinned to the whole thing, how will I know that it works?

MR. MILLS: Well, obviously the idea with this is to get to the same place, to have insurance that the systems are going to function in combination.

I'm not sure how to address your question. I think I'd have to give it some --

CHAIR POWERS: I don't even know how to pose the question very well, so --

MR. MILLS: Let me throw it to Terry.

MR. JACKSON: This is Terry Jackson. I'm

Chief of the I&C Branch in the review.

There's a series of tests and so forth that are performed on the I&C systems and they start off, basically, as a unit test and start off with individual small functions and enter at the factor of negatives all the way up to factor acceptance testing where the whole I&C system is integrated and tested at the factory.

Then it's shipped to the site and installed at the site and there's a site acceptance test that's performed when it's performed at the site. So that ensures that it's not going to be the same full scope as to factor acceptance test as we understand, but it will be sufficient tests to verify that the system has been integrated into the plant appropriately. But then there's other tests too that are associated with some of the mechanical systems. Just for example, like I think that's reason why it's taken a little bit longer to get it a response on the questions for these safety information control system and the party actuator control system because a lot of those tests are associated with mechanical systems and so not necessarily specific I&C tests but it's the integrated test with I&C and the mechanical system.

CHAIR POWERS: So that the values the

criterion is interfaced with a mechanical system and then you test -- what I'm trying to understand is there is a fairly comprehensive what we will call at the factory test; where it takes place is not important here. And then there is some more limited testing once it's installed. And what I'm trying to understand is how do I decide what tests not to do once it's installed.

MR. JACKSON: Our expectations that the tests, that the integrated tests would test the interface. The interfacing requirements. So, for example the I&C system is going to have system requirements that come down from the plant, mechanical system or nuclear system. And so those requirements should be tested in those integrated tests.

There are other more detailed level requirements for the I&C system itself that would probably be tested at the factory but not necessarily at the plant.

MEMBER BROWN: Terry, let me ask the question a little bit, slightly differently. If you look at that -- during the I&C presentation which I'll check there was this overall big top level block diagram with PIC, SIC, SETS, MAX; I lost track of the acronyms. There were dozens of little boxes will all kinds of little acronyms on them that all fed with arrows going all kinds of places and a couple of big buses where all this --you know, it said all of it goes onto these things and this goes over here, and then this goes up there, and all these back and forth. Is that all for divisions, all PACs, SAX -- the whole main control room setup, is that all -- every component, every box set up at the factory and then integrated all that information and all those communications integrated at the factory or not? Yes or no.

MR. JACKSON: I'll let AREVA verify the answer, but our understanding is, yes, it is a full integrated --

MEMBER BROWN: So the whole main control room control panel, the bus where all the stuff goes up will be put together at the factory. Every one of these, I'll just pick a couple of these: The safety information control system dotted line area, the priority and actuator control dotted line area, all oaf those things will be put together in every box that's involved? Every box that's involved will be hooked up hooked up in that integrated test at the factory, and I'm waiting for AREVA to shake their head up and down?

MR. TALLY: This is Charley Tally from AREVA.

I'm hesitant to answer yes unequivocally.

MEMBER BROWN: I bet you are, because I don't believe -- I would not believe it. Now that's not a negative or I'm not trying to cast aspersions. That's a very extensive test.

MR. TALLY: Yes.

MEMBER BROWN: And that is the basis I think for Dr. Powers' question of how this whole thing -- where do you draw that differentiation. In my mind, rightly or wrongly, there's a set of what I call individual piece part performance requirements.

MR. TALLY: No.

MEMBER BROWN: In other words you got detectors -- no, at the factory. Well, let me finish. No. You're demonstrating the plant has to demonstrate accuracies, performances, response times for certain pieces so that you meet the overall performance requirements of the analyses and other type things for demonstrating plant performance. Those types of things, I would think, are not going to be done at the site. They would have to be demonstrated at the factory. You've got to show that when I put a range of inputs in from a detector into the system, I get a range of outputs that are within some minor uncertainty or accuracy band and you have nice well calibrated instrumentation to prove that.

Now, how far you go after that is where it gets mushy and what then has to be done at the site. And I think that's the point, correct me if I'm, Dana, did I kind of --

CHAIR POWERS: No, I think you --

MEMBER BROWN: -- touch or expand on what you were trying to get to?

CHAIR POWERS: I think -- I mean my conundrum is understanding the basis for making that decision. I think you've articulated it much better than I could.

MEMBER BROWN: Because the end --

CHAIR POWERS: You may even understand the answer better than I do.

MEMBER BROWN: That's been one of my concerns with these because my past experience with levels of complexity and this level of integration when we did this, and I can say this without any -- violating any confidential type security type issues, is that we took every Vendor's design, brought it into one of the laboratories, every piece of equipment, every detector input for the first unit, you know for the prototype setup and we integrated it and made sure that all communicated and provided the proper inputs, the range data, all your digital data that went around and everything else, we confirmed. And we actually even hooked up a complete plant simulator where you could actually control it as if you have an operator in the place and made sure the same response, you could run all your procedures and everything else. They're not going to do that at the factory. I could bet the ranch that they're not going to do that.

MR. TALLY: We'll take an action item to clarify what's in acceptance testing.

MEMBER BROWN: The way we could get through this is to have you guys say how do you envision this and separate qualifications, factory acceptance tests and what is the level of overall integration tests that are performed and how are they defined in the ITAAC? Because it's not obvious in looking at the ITAAC in how that's done.

MR. TALLY: Yes. I would just comment that the check out of the OL3 I&C system --

MEMBER BROWN: I have no -- OL3 is the Finnish?

MR. TALLY: Yes.

MEMBER BROWN: Okay. Thank you.

MR. TALLY: That setup is just as you have described in regard to a complete plant simulator that's been --

MEMBER BROWN: At the factory?

MR. TALLY: --put together -- that is interfaced with all of the actual cabinetry. And I believe it is a extremely comprehensive integrated test.

MEMBER BROWN: But it's the same as this one.

MR. TALLY: We'll take an action item to--

MEMBER BROWN: But it's not the same as this one. Your design is not the same totally as that one is.

MR. STACK: So, again, we will take the action look at the scope of the factory acceptance test and the scope of the on-site testing.

MEMBER BROWN: Okay. A good question, Dana. Thank you. It'll be interesting to hear the answer.

CHAIR POWERS: I'm as much interested in the philosophy behind as I am the specifics. In fact, the specifics only make it so I can understand the philosophy.

MEMBER BROWN: Well, there's another

aspect of this, is that because we separated the design part of this and because of the level of integration, is how does the NRC ensure that their inspectors win their own site and they are doing whatever integrated tests they do; how do they make judgments? I mean, it's a decision we've had before at the level --

CHAIR POWERS: Yes. I have to admit that I put great big stars and circled on my notes when the terms "inspectability" came up in the presentation by the staff.

MEMBER BROWN: Yes.

CHAIR POWERS: Because I think that is going to be one of the crucial things to understand about this plant. Because, I mean quite frankly it is a unique plant and it is -- there are lots of things in this plant. When you have trains there are lots of things. And so inspection and monitoring becomes a challenge. And it strikes, as much as I hate to admit it, one of the great virtues of PRA is that it tells us what things work at.

MEMBER STETKAR: Can you make sure we get this transcript embossed in gold? I want it on my wall.

CHAIR POWERS: I have said this before

that the bottom line. coordinated frequency is easily one of the most useless numbers that I can think of. Risk achievement worth, risk reduction worth, Fussell-Vesely is an incredibly useful things.

MEMBER STETKAR: I'm not arguing with you on that statement.

MEMBER RYAN: I still take it with a grain of salt.

MEMBER STETKAR: I still want the --

CHAIR POWERS: Some day we're going to solve that. I trust a guy with a lot of experience with the PRA.

MR. JAFFE: That completes the staff presentation.

CHAIR POWERS: My goodness.

MR. JAFFE: Thank you.

CHAIR POWERS: Thank you.

MR. TESFAYE: Dr. Powers, this gives us a segue to go to that hardware watchdog thing the IRA created --

CHAIR POWERS: Fantastic. Let's do it. The digital I&C guys are off to -- and speaking therefore in the unknown tongue.

MEMBER BROWN: But I would suspect he didn't know what tongue I was speaking. Don't take that the wrong way.

CHAIR POWERS: Don't feel bad about it, Terry. I haven't understood him in all the years he's been on the Committee.

MR. TESFAYE: Dr. Powers, as I suggested earlier, what we're going to do with this is issue an RAI. It's going to be tracked as an open item and we'll be closing Phase IV and we'll describe the content of what the RAI is.

MEMBER BROWN: We may have thrown a little bit of extra stuff here to cover in the RAI as well.

CHAIR POWERS: Yes. The general philosophy of moving this into Phase IV I have absolutely no trouble with it. Does anybody else have any objection to doing this? No, I think that's perfectly fair. Philosophically I have no objection to that.

MR. TESFAYE: Thank you.

MR. JAFFE: I mean, I don't detect any objection. It doesn't really matter whether I have an objection, but I don't think the ACRS has a whole has any objection to moving this into Phase IV for resolution.

MR. TESFAYE: We do have some Phase IV RAIs.

CHAIR POWERS: Name a few --

MR. TESFAYE: Fukushima issue, for example will be a Phase IV activity, so this fits in right in there.

CHAIR POWERS: Yes. absolutely.

MR. TESFAYE: So, let's go ahead.

CHAIR POWERS: Sure. Welcome back.

MR. JACKSON: Again, Terry Jackson, I'm the Chief of the I&C Branch and Office of New Reactors. I've been doing that job for about four years now, and before then it was resident, Senior Resident at Diablo Canyon. And before that Research, I&C Engineer here at the NRC. And before that I got a Bachelor's in Computer Engineering, Master's in Electrical Engineering.

We reported specific questions from Charlie, and this was in regards to the watchdog timer. And since the AREVA design, specifically the actuation logic unit or call it ALU becomes the building logic for reactor trip and ESF actuation. The question came is if these micro processor systems, if they receive corrupt data from say one division it gets transferred to all divisions and it could lock up the voting processors, what kind of mechanism is there to be able to ensure reactor trip?

So, the staff had, of course from

experience with AP1000 had already looked at that in the EPR design, and we addressed it. But I think the issue was is that the description between the FSAR and then the technical reports, because it's in about four different documents, the description, the design and then in some cases there are some terminology that's different between their documents as well. So Charlie asked if there was a way that we could get clarification to this.

So basically what the staff -- the information that we gave is basically the information that we have addressed. So what we plan on doing is issuing a Phase IV RAI to AREVA, and it's basically asking for a description, a better description that's concise in one location and describes how the watchdog timer, which is the device used to trip -- to perform the reactor trip if the processors locked up; to give a better description of how that operation actually occurs as a watchdog timer interface with other processor aspects, including software, hardware. And so that it's more clear as to how the watchdog timer actually perform if the processors were to lock up.

So, I didn't have a chance to talk to Charlie about the draft question. I wrote it up and stuff, but I hope I captured his question.

MEMBER BROWN: Well, to the more integrated as opposed to a piecemeal, because right now it's kind of scattered around. It took me a day and a half just getting all the various parts from the various people together to try to look to see if it made any sense. And there was some ambiguities and some things that weren't clear of how the interrupts and/or "hardware or hardwired signals" were actually in between first and second timeouts, how those worked together and things like that. So just a more integrated look at how that whole operation is performed.

And that was the thrust of my questions for you.

MR. JACKSON: So that's basically what our plan was to address that particular issue, was to address it in our Phase IV review.

MEMBER BROWN: Yes. Related to Dr. Powers' question a little while ago, I remember from one of the previous projects that reviewed where the system wasn't quite as integrated, distributed as this one is. There were, I hate to use this word, DAC which actually said you actually go do such-and-such and then you demonstrate the acceptance criteria was this happened or that happened. And within the context of this project, there are none, which I'm happy with. There's not DAC for this. But yet the question arises how do we make sure once we get all these things hooked up in the plant at the site that in fact some of these functions that we reply on to ensure that we've got a fully independent state system, how do they actually work on an integrated basis? And do we get a trip when we expect it to?

MR. JACKSON: Right.

MEMBER BROWN: And that's an aspect of this that I would think would be --

MR. JACKSON: I can talk a little bit about what we plan on doing. Well, specifically with the EPR design I think and some of the earlier designs where DAC was used, when we did the EPR review I think the desire both for the NRC and for the applicant was to avoid DAC if we could. So --

MEMBER BROWN: I'm not asking for DAC. I'm just looking for --mostly put in and installed in the site that there's a test -- part of the test program demonstrates with all the various aspects when you have a trip, you're going to get an overpower, you got pressure, you got temperatures; whatever the protection functions are that have to operate, you ought to demonstrate that you actually generate a trip because of the distributed nature and the overall integrated nature. You want to make sure everything's hooked up and the data is where it is.

And I'm remembering once circumstances the last thing I heard this thing, this similar system being hooked up at a particular plant, they ended up getting to some power level before they found they did not have any indication from some critical protection function, or they had the wires hooked up wrong, which is -- and you know it raised the real question is what the quality of the inspection process on the actual installation drums.

MEMBER STETKAR: Charlie, let me ask you. I hate to get into these discussions in these meetings. But it's probably worthwhile given the timing here.

You repeatedly mention your concerns, and the reason I bring it up is it may influence the way the RAIs were in the context of tripping the reactor, which is an important function certainly, but it's only one of the functions of this distributed safeguards actuation system.

Another function is, indeed, actuating safeguards. Things like starting injection 00

MEMBER BROWN: I've meant to encompass

that in --

MEMBER STETKAR: Okay. Be careful when you use "trip," because that tends to get translated into the reactor --

MEMBER BROWN: The reactor --

MEMBER STETKAR: Shutdown the reactor, insert the control rods which may be easier to demonstrate because --

MEMBER BROWN: No, I appreciate that.

MEMBER STETKAR: than the safeguards actuation function --

MEMBER BROWN: Yes, I appreciate that.

MEMBER STETKAR: -- which is energized to actuate kind of different --

MEMBER BROWN: Exactly right.

MR. JACKSON: I think maybe to address the issue about reactor trip and ESF if a processor, say a single processor fails, then the watchdog timer is there to put it into the safe state. So for a reactor trip, the safe state is to send the reactor trip signal.

For ESF it's to fail as is, so it won't actuate --

MEMBER STETKAR: We know that.

MR. JACKSON: -- it won't actuate.

MEMBER STETKAR: It won't actuate.

MR. JACKSON: Right. Now the other part about the design is that the design has a diverse actuation system as well. So --

MEMBER BROWN: That still doesn't say you shouldn't test the primary actuation systems --

MR. JACKSON: Right.

MEMBER BROWN: -- that it performs all of its functions.

MR. JACKSON: Right.

MEMBER BROWN: And you can demonstrate in your test program that they all respond when they're being asked for it.

MR. JACKSON: Right. And that wasn't an answer to your first question. It was more I think responding to --

MEMBER STETKAR: Because I understand certainly how the system works. But I wanted to forestall any ambiguity in terms of terminology --

MEMBER BROWN: Well, I agree with you.

MEMBER STETKAR: -- when we come back, you issue the RAI, there's an answer and it's all focused on control rods.

MEMBER BROWN: Yes. That's not my intent.

MEMBER STETKAR: And my intent was

forestall any questions about the other functions.

MEMBER BROWN: The intent was to ensure all safety functions demonstrate that they will, whether they're ESF or whether they're reactor trip, that they all perform their function and actuate the devices when they are called upon based on a simulated or some type of signal during the pre-operational test program.

MR. JACKSON: So in response to Charles' question, the staff does have guidance in the area to perform a site acceptance test. So that -- and the intent of the site acceptance test is to verify:

(1) That the system is connected properly so you don't have a situations like we had at the Des Moines site.

MEMBER BROWN: Yes.

MR. JACKSON: The other purpose of the site acceptance site is that when you're doing the design, the I&C design is well known over here, you know in a particular silo, but eventually you've got to integrate them. So that the integrated test and site acceptance test is to verify that the assumptions that you had in your design with how the mechanical systems are going to interface with it are in fact true. So that's where, you know if you're doing the, say, reactor trip test it's actually singleway and single from the sensor through to the reactor trip mechanism itself and the rods drop. So that's the kind of test that we would expect at the site as well as like ESF tests that you test from, you get the single light signal from the sensor itself but it goes through the I&C system and actually starts the pumps, moves valves and things like that. So, that's the staff's expectations for doing these types of site acceptance test and the --

MEMBER BROWN: But the COL has to develop those tests, isn't that correct?

MR. JACKSON: Right, right

MEMBER BROWN: I'm trying to remember. At this time those aren't specified, if I remember in the ITAAC. That's an overall thing that's done as part of the COL, I would have imagined. I don't know that for sure. I just don't remember.

MR. JACKSON: I don't have the actual ITAAC with me, but some ITAAC --

MEMBER BROWN: If you can point them out to us, that would be useful. I just know that somebody's got to do something.

MR. JACKSON: What I wanted to say is part of one of them in EPR that's installation has. So I'm not exactly sure of the wording because I don't have the ITAAC in front of me, but that's the intent.

MEMBER BROWN: Okay. Well, the purpose of my comments was to amplify to make sure that we covered something and you've had a better understanding of my somewhat cryptic. I've tried to make it a page, it turned out to be four pages or five by the time I wrote it up. But at least I've tried to provide the background so you knew what the stuff I referred to.

MR. JACKSON: Yes. And I think we understand where the question was coming from with regards to --

MEMBER BROWN: Okay. Thank you.

And thank you, John, for making sure --

MR. TESFAYE: Thank you, Terry.

Dr. Powers, I have one more item to close if I may.

CHAIR POWERS: Yes.

MR. TESFAYE: Yesterday I took action to Dr. Skillman's question on the drainage in the spent fuel storage facility.

CHAIR POWERS: Yes.

MR. TESFAYE: We had requested this in RAI 9.1.4-18. We asked AREVA what it was leaking from the spent fuel storage process -- where it goes. And they told us it goes into the nuclear island drain and vent system. Now they didn't tell us what the capacity of this drain system is. But in Section 9.3.3 it says "the floor drains in the nuclear island drain system has the capacity to have committed the maximum expected flow rate from a rupture of the largest water pipe in the nuclear fuel storage facility. The flow drain systems are gravity fed to building sump because there are no drain connection on the plane header high in the elevation than the NFSF flow drains, but flow is prevented.

Now the only question I have on this is we don't if this largest pipe bounds the water that could potentially be coming out of the flow. So we have an existing RAI similar to that, and I'm trying to get an answer as part of that RAI question.

MEMBER SKILLMAN: Getachew, I appreciate that. I looked at the RAIs also and did not see one that would address the concern I had about the leakage from a, if you will, a failure of that seal.

MR. TESFAYE: Yes.

MEMBER SKILLMAN: So I'll ask you to persevere and just get an answer to this question.

MR. TESFAYE: Yes. Absolutely.

MEMBER SKILLMAN: The floor drains might be mighty fine for 40, 50, 120 gallons per minute. But if we were to get a 400 or 500, 800 gallon a minute leak, my hunch is that we would have water standing on the floor.

MR. TESFAYE: We'll submit a supplemental RAI to get that particular question answered.

MEMBER SKILLMAN: Thank you, Cetachew.

MR. TESFAYE: Yes. Thank you.

CHAIR POWERS: We have -- I guess we're done with these three chapters, right?

MR. TESFAYE: Yes.

CHAIR POWERS: And our intention is to move them to the full Committee in May right now, is that correct?

MR. TESFAYE: Yes.

CHAIR POWERS: Okay. So we'll have a presentation for the full Committee in March? In April we'll get presentation from the COLA. And so now we want to do something in May.

I think from my perspective the advice I can give you, the difficulty is that that gives us a very short period of time relative to the volume of material. I suspect they will give us two hours.

MS. WEAVER: But you want an additional 45 minutes?

CHAIR POWERS: And I want an additional 45 minutes on a specific topic, but that's --

MR. TESFAYE: Not for the March one. You're talking about the May -=-

CHAIR POWERS: May, yes.

But, I mean, two hours sounds like forever, but it's not to cover this material. Especially because many of the members are going to be less than current on what the APR design is. There's an obligation from the -- of the design, and that falls on the applicant to do that, I think. And so you have to be relatively terse in this material.

What I can say is that you can be especially terse on the spent fuel pool if we indeed get the 45 minutes to discuss that because they'll be able to cover a lot of things there.

I suspect there will be a lot of interest in the ITAAC and like that, just because there always is. And I would think I speak very much philosophically about it. I mean, you have to kind of outline your general approach, but I would speak much more philosophically there. And certainly want to acquaint them of the limited use you're making of DAC. Sadly, it's one of the -- particularly interested in how you use DAC.

For the staff presentation I would generally recommend not emphasizing the number of OIs you had at the beginning and now how many you have remaining, I would emphasize what you have remaining.

And again, I would always emphasize where you have done independent analysis. Where you can speak to the issues of what you've forecast or what you're thinking about on Fukushima related outcomes is always useful. You may not be able to do anything there, but if things we're forecasting or concerned about, you might want to share that with the ACRS just to get some feedback from them. Whether you're doing anything with it or not, what you're thinking about and with respect to other plants of EPR design around the world that are being done, it's also useful. You know, what you know and what you think about and what you think you can derive from that; that's always kind of useful for them to know what you're doing in that area. But again, it's such a terse period of time. You're not going to be able to go plunging into a lot of detail. You're going to be very synoptic.

And we'll try -- the ACRS Chairman and I will both try to emphasize that what we're doing is moving a set of chapters from Phase III to Phase IV here. And so this is an interim view that's being taken and not a final word. That will give you a little bit of freedom to say however there's more on this and stay tuned.

MEMBER STETKAR: Could I float something?

CHAIR POWERS: Absolutely.

MEMBER STETKAR: Think about Chapter 3. There's, obviously, a heck of a lot of stuff in Chapter 3 and knowing things that the Committee has expressed an interest in the past, it's they're interested in what's different about this plant, which is why Dana highlighted the cast issue.

I think that it would be useful to make sure that the full Committee members understand the scope and what you've done in terms of the certified structures; the nuclear island, the diesel buildings and their cooling water buildings versus the remaining structures on the site and how you address potential interactions either from seismic loading. You know, we got into this wind loading thing, and things like that. So that the Committee understands sort of what is in the Certified Design, what's immediately adjacent to the Certified Design and how you try to address those structural notions. I think that might be worthwhile, you know in terms of things to focus on.

Dana, does that --

CHAIR POWERS: Yes. I think it's always absolutely true that the Committee as a hole is going to be most interested in those things that are different, unique, innovative and --

MEMBER STETKAR: I mean, there isn't anything innovative there, it's just an understanding of the Committee to get their hands on what level of analysis and what level of qualifications has been done for what issues at that level of the structures.

CHAIR POWERS: I'll ask the Committee if they can provide any advice? This is a very difficult chore for both the staff and the applicant because it's an interim piece, it's part of the whole, it's necessarily somewhat out of context, and it's a very crunch period of time. So any advice we can give them to kind of help them through this and at the same -- and the other challenge that we face is it's very easy to make a kind of a crunch presentation to get the ACRS Members that have not been day-to-day involved in this confused or misled and things like that.

So, I'll ask the other Members, do you have any advice to pass on?

MEMBER ARMIJO: Well, in the testing

program, you know it's a mind-boggling list of tests.

CHAIR POWERS: Yes.

MEMBER ARMIJO: And, you know I think in terms of graphic representation, here's the plants, here's the other tests, here are a couple of areas that we'd like to focus on and describe our approach. That would help I think a lot.

CHAIR POWERS: Yes. I think the philosophy of the approach, and like you say anything that's graphical --

MEMBER ARMIJO: Makes it a lot easier than--

CHAIR POWERS: -- makes it a lot more comprehensible. Because they're not interested at this stage in the specifics. They're interested in the generalities.

MEMBER SKILLMAN: Yes. I think information that explains and defends how fuel is brought into the plant and how spent fuel is discharged from the plant through a hole in the floor, why that's acceptable--

CHAIR POWERS: Well, what I'm going to try to get out of P&P is more of an information briefing specifically on that system.

MEMBER SKILLMAN: On that system.

CHAIR POWERS: Because it's unique and

because they already have photographic -- I mean, I don't think they have to work to put that presentation together, I think they already have it. And that they can present as a whole and probably deal with that treat it somewhat cursorily in their actual --

MEMBER STETKAR: The more graphics -- you know, as I understand we had a little bit of discussion yesterday, some of the stuff -- I don't know where you cross the line into proprietary photographs of systems that are already installed over in France. But the more photographs of actual installations to give the Members a feel of size, geometry, you know notion of how the thing actually works along the stages of the processes, an scales of things. You know, we talked about that little graphic about the fact that the bellows probably aren't -- they might not even be this big in the real world, would help an awful lot.

I recognize our meetings are fully open so you need that trademark, but --

CHAIR POWERS: Similar for the staff they had wonderful presentations where they had a couple of plots that said okay here's what we independently calculated and this was your big points. So to the extent you have that, do that.

And it also communicates to the ACRS what the staff thinks a critical issue is. If they've done an independent analysis, then obviously they think that's fairly important to -- a completely independent analysis.

Quite frankly, these charts that you put up that said okay, well going in we had 650 open items and now we're down to 12 don't help the ACRS very much. Where you can say we have 13 open items, here are the two that we think are really important, that helps a lot.

MR. TESFAYE: That's what we did to the first Committee meeting. And that's what I plan to do.

CHAIR POWERS: Yes. Come in and say look I've got 12 open items here, five of them are formalities, I'm not going to go into them. Here are two that I think we're going to pay a lot of attention to.

Similarly, here we've got an open item on watchdog timers. Here's the problem. We're going to resolve that in Phase IV. And it'll all be straightened out, but here's conceptually what the issue is, here's what we're doing about it.

MEMBER BROWN: Well we're not doing the

watchdog timers in May.

CHAIR POWERS: It's actually being done in March.

MEMBER BROWN: Yes, because Chapter 7 is being done in March.

CHAIR POWERS: March.

MEMBER BROWN: And that'll be just the two hours. So I was trying to separate. When you threw that one in, that kind of threw me for a loop here.

CHAIR POWERS: Very easy to throw for a loop.

MEMBER BROWN: Yes.

CHAIR POWERS: I used it as an example.

MEMBER BROWN: Yes. Yes.

MEMBER STETKAR: Dana, in that sense one thing also kind of -- you guys have some experience presenting to the full Committee. Less emphasizes on we met this paragraph of Reg. Guide 1.2.3.4 standard and .7 versus technical issue and how it's being addressed; the latter is better.

CHAIR POWERS: Yes. Yes.

Okay. Any other? Steve, do you have any?

MEMBER SCHULTZ: Well, I would just emphasize what you had said, perhaps in order of importance for the applicant as well as the staff.

The focus for the full Committee being the discussion of where the U.S. EPR stands in relationship to the EPR fleet and information that is going to be derived from what is being constructed and delivered. I would expect the applicant would take the lead there, but if the staff can also address that issue, that would be important.

And I would expect the staff to be taking a lead with respect to Fukushima items that will have been further developed by the time May rolls around. It will be very high on the list of questions that the full Committee may have.

CHAIR POWERS: You can almost count they're going to ask you a Fukushima question.

MR. TESFAYE: We'll be ready.

CHAIR POWERS: What did you say?

MR. TESFAYE: We'll be ready.

CHAIR POWERS: Okay, yes. And the answer may be we haven't done anything on this yet. But you can anticipate the questions are going to come down.

You can anticipate in the spent fuel pool to get questions on instrumentation.

Other than that, I can't --

MEMBER RYAN: Nothing else, the spent fuel pool and the fuel handling I think are the two issues.

CHAIR POWERS: Yes. And I really think it'll be quite useful to before we go into the actual chapters to give what amounts to an information briefing on the spent fuel handlings.

MEMBER STETKAR: I'd almost do it after in terms of scheduling because I would suspect that we could eat up, unless you're really vigorous in terms of cutting them off at 2:45, we could spend easily an hour and a half talking about that interesting system. That's a matter of how you orchestrate the thing.

MS. WEAVER: Would you want to split it up? Do chapter review of the two hours and then have an information briefing?

CHAIR POWERS: I want to do the information briefing first.

MS. WEAVER: Okay.

CHAIR POWERS: And I have been running ACRS meetings for 18 years. I suspect I can follow the schedule. I have a vague sense that maybe I know how to do that. Yes, I think it's fairly finite, and we did it in about 45 minutes with us for which you actually presented as opposed to us going off on tangents and things like that. And I think it's doable since it's an information briefing and not something that we're going to --don't you, Sam?

MEMBER ARMIJO: Yes, I think it's needed. I think it's needed for people who haven't been to all your Subcommittee meetings.

CHAIR POWERS: And you weren't here, but it's a very unique -- it is a unique system. And somewhat counterintuitive.

MEMBER SKILLMAN: And if the staff and AREVA have some one liners that address, one might say, the obvious failure issues, but I could say here's how we address that and here's how we address that, I think that it will go quite smoothly.

CHAIR POWERS: Well, I think the failure issues and things like that I would tend to move that into the chapter discussions and be more here's what it looks like, here's what it's doing, here's why we like it, here's the experience in other countries with it. You know, really an information briefing sort of thing. And then they'll give the regulatory aspects of it during the chapters itself.

MEMBER ARMIJO: Yes.

CHAIR POWERS: Okay. As always, I'm available if you have questions on how to help you put together the presentations and whatnot. And similarly, if you need help from me to try to avoid rough spots, let me know.

And as with all the Members, they're here to offer their advice. It is exactly worth exactly what you pay for it.

Anything else?

MS. WEAVER: Just I'll go over the chapters, so long as we're all on the same page that's going to be in March. That's Chapter 6, 7, portions of Chapter 6, all of Chapter 7, all of Chapter 11, all of Chapter 13, portions of Chapter 15. No GSI-191. All of Chapter 16 and all of Chapter 18, which is Human Factors. Okay. If you have any questions, you can give me a call.

CHAIR POWERS: That's a lot. Okay.

Again, they won't give us more than two hours for the combined presentation.

MS. WEAVER: So that's what you're on the schedule for.

CHAIR POWERS: And I mean, they'll never give us more than two hours. But again, we'll try to do a preface that says our objective here is more of a progress report than it is anything final. We're just moving from Phase III to Phase IV and we're reporting on status here.

Unavoidably, the applicant is going to have to remind them of what the plant looks like. I mean, it just takes out of your time, but you still got to do it. And consequently you have to be much more summary and everything else.

Then with the staff it's very useful to know where you stand, where you think you're going and where you've done independent analyses to substantiate your findings. It's just very useful.

Okay. No other point?

Gentlemen, I thank you all very much for a very interesting set of meetings.

MR. TESFAYE: Thank you.

CHAIR POWERS: I kind of somewhat dreaded coming here for these meetings. My eyes rolled at Chapter 3. I thoroughly enjoyed the Chapter 4 presentations. Loved the stuff on the spent fuel. Even enjoyed the ITAAC presentations.

I thank you all for what you've done. I congratulate you on all your hard work.

And emphasize again the only way this works is because you guys is putting in a quality product, even though they're piecemeal, they're quality products and the work behind it shows. I know you're doing it, the applicant especially is doing it, belabored by having Sloan on your case all the time, even though she doesn't show up. And I know that's held you back some, but you've done well. And the staff has really done a bang up job.

And we are adjourned.

(Whereupon, at 10:50 a.m. the Subcommittee meeting was adjourned.)

Presentation to ACRS U.S. EPR Subcommittee Design Certification Application FSAR Tier 2 Chapter 3

February 21, 2012

EPR™ by AREVA

AREVA

Chapter 3 ACRS Meeting Outline

Section	Presenter
3.1 Compliance with Nuclear Regulatory Commission General Design Criteria.	D. Gardner
3.2 Classification of Structures, Systems, and Components	D. Newton
3.3 Wind and Tornado Loadings	T. Oswald
3.4 Water Level (Flood) Design	T. Oswald
3.5 Missile Protection	T. Oswald
3.7 Seismic Design	T. Oswald
3.8 Design of Category I Structures	T. Oswald
3.6 Protection Against Dynamic Effects Associated with Postulated Rupture of Piping	C. McGaughy
3.9 Mechanical Systems and Components Piping	C. McGaughy
3.12 ASME Code Class 1, 2, and 3 Piping Systems, Piping Components, and their Associated Supports	C. McGaughy

Chapter 3 ACRS Meeting Outline

Section	Presenter
3.13 Threaded Fasteners (ASME Code Class 1, 2, and 3)	C. McGaughy
3.10 Seismic and Dynamic Qualification of Mechanical and Electrical Equipment	N. Burstein
3.11 Environmental Qualification of Mechanical and Electrical Equipment	N. Burstein

Section 3.1 - Compliance with Nuclear Regulatory Commission General Design Criteria

- U.S. EPR conforms to the GDC in 10 CFR 50, Appendix A
- Section 3.1 provides a comparison of the U.S. EPR design to the NRC GDC and refers to specific FSAR sections for further discussion of the criteria
- The COL applicant will identify the site-specific QA Program Plan that demonstrates compliance with GDC 1

Section 3.2 - Classification of Structures, Systems, and Components

Dennis Newton

Section 3.2 - Classification of Structures, Systems, and Components

- The U.S. EPR safety classification methodology uses the following designations:
  - Safety-Related (S)
    - SSCs that meet the definition of safety-related in 10 CFR 50.2
  - Supplemented Grade (NS-AQ)
    - SSCs that do not meet the safety-related definition in 10 CFR 50.2, but have a licensing requirement or commitment based on an NRC regulation or guidance. For example:
      - RCP oil collection tanks - addressed in RG 1.189 “Fire Protection Program for Nuclear Power Plants”
      - Station blackout diesel generators - addressed in RG 1.155 “Station Blackout”
      - Liquid waste storage tanks - addressed in RG 1.143 “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed In Light-water-cooled Nuclear Power Plants”
  - Non-safety-related (NS)
    - SSCs that do not meet safety related definition in 10 CFR 50.2 and have no licensing requirement or commitment (e.g., main feed water heater)

Section 3.2 - Classification of Structures, Systems, and Components

Section 3.2.1 - Seismic Classifications

- Based on RG 1.29, RG 1.143, and SRP 3.2.1
- Seismic Category I: (I)
  - SSC remains functional during and following an SSE
  - Safety-related SSCs
- Seismic Category II: (II)
  - SSCs whose failure could degrade performance of Seismic Category I SSC during or following an SSE
  - Could cause incapacitating injury to main control room occupant during or following an SSE
- Radwaste Seismic (RS)
  - Radioactive waste management SSCs that are classified as RW-IIa (high hazard) per RG 1.143 (designed to 1/2 SSE)
- Conventional Seismic (CS)
  - Commercial codes apply seismic design criteria
  - Radioactive waste management SSCs that are classified as RW-IIb (hazardous) and RW-IIc per RG 1.143
- Non-Seismic (NSC)
  - SSCs that are not subject to any seismic design criteria

Section 3.2 - Classification of Structures, Systems, and Components

- Section 3.2.2 - Quality Group Classifications
  - Based on RG 1.26 and SRP 3.2.2
  - Applies to pressure–retaining components
    - Includes components and supports such as pressure vessels, heat exchanges, pumps, piping and valves
    - Excludes structures, electrical components and instrumentation
  - Quality Group A
    - Components of reactor coolant pressure boundary and their supports (e.g., reactor pressure vessel and pressurizer)
  - Quality Group B
    - Components and their supports (including core support structures) as identified in RG 1.26 and SRP Section 3.2.2, Table A-1 (e.g., medium head safety injection pump)
  - Quality Group C
    - Components and their supports not included in Quality Groups A and B as identified in RG 1.26 and SRP Section 3.2.2, Table A-1 (e.g., component cooling water pump)
  - Quality Group D
    - Non safety-related pressure-retaining portions and supports for other systems that contain or may contain radioactive material (e.g., spent fuel coolant purification system filter)
    - Supplemented grade components and their supports (e.g., RCP oil collection tank)
  - Quality Group E
    - Components and their supports that do not meet the definition of Quality Groups A through D (e.g., condensate system isolation valve)

Section 3.2 - Classification of Structures, Systems, and Components

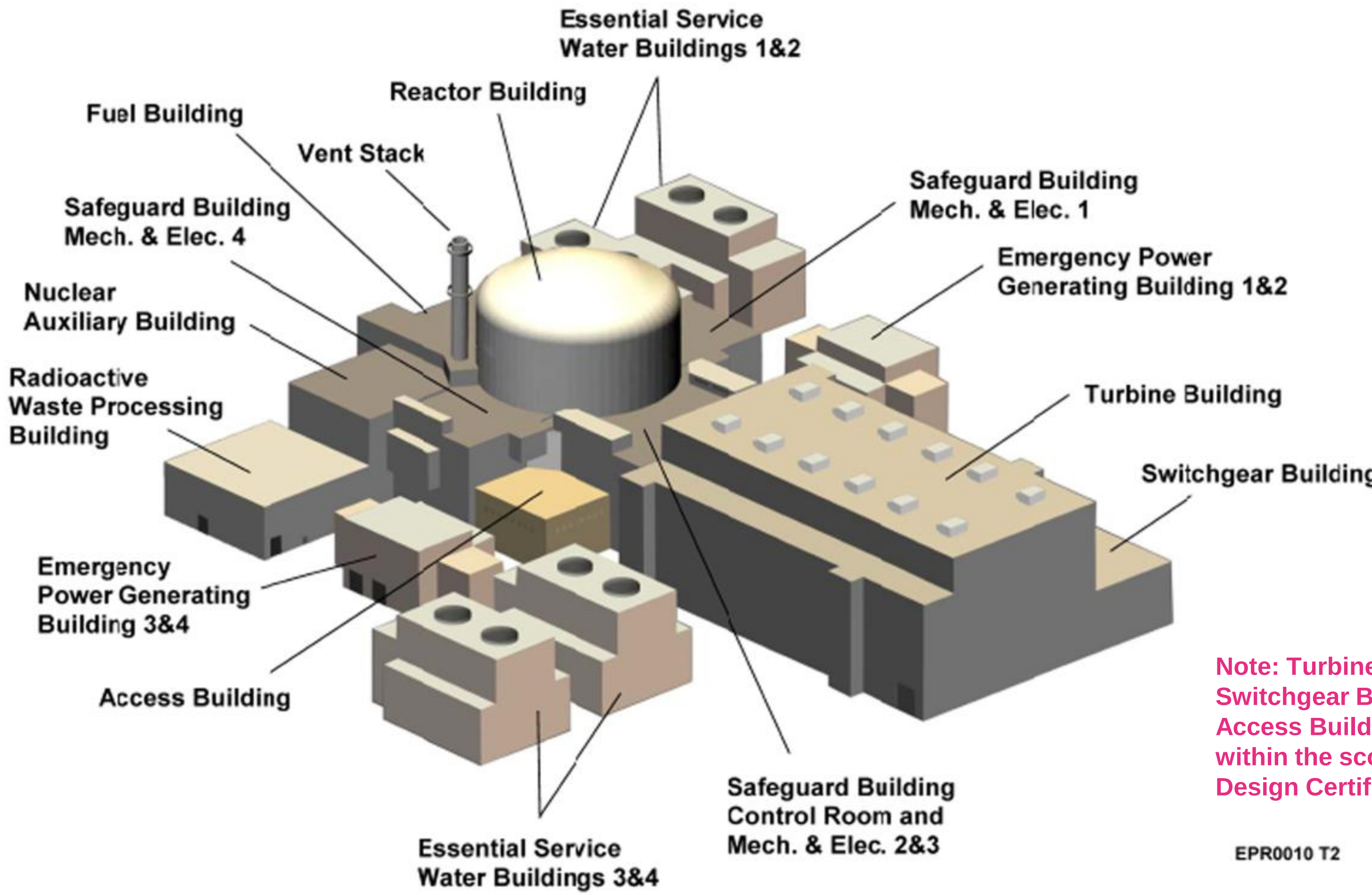
- Safety, seismic, and quality group classifications are shown in U.S. FSAR Tier 2, Table 3.2.2-1

- A COL applicant will identify site-specific SSC

Sections 3.3, 3.4, 3.5, 3.7. and 3.8

Todd Oswald

Chapter 3
U.S. EPR Structures



Note: Turbine Building, Switchgear Bldg and Access Building are not within the scope of Design Certification

Section 3.3 – Wind and Tornado Loadings

- Section 3.3 describes the basis used in the U.S. EPR design for wind and tornado loading
- Basic Wind Design
  - ASCE/SEI Standard 7-05, “Minimum Design Loads for Buildings and Other Structures”
    - Basic Wind Speed 145 mph in open terrain (includes hurricane)
    - Exposure Category C
    - Importance factor 1.15
  - ASCE paper 3269, “Wind Forces on Structures”
    - External pressure coefficients for distribution of wind pressures on round structures
- Tornado Wind Design
  - Seismic Category I and II structures are designed to resist tornado loadings per R.G. 1.76
  - Radwaste Seismic Structures are designed to resist tornado wind loadings per R.G. 1.143
  - Tornado Wind Parameters (R.G. 1.76, Region 1)
    - Tornado Wind Speed- 230 mph wind (184 mph rotational, 46 mph translational)
    - Radius of maximum rotational speed -150 ft.
- COL information items are identified for applicants to reconcile wind and tornado parameters and ensure wind and tornado loads will not affect the ability of any structure to perform its intended safety function

Section 3.4 – Water Level (Flood) Design

- Section 3.4 describes the basis used in the U.S. EPR design for flood
- Seismic Category I structures are designed for the effects of flooding
- Internal Flood Protection
  - Physical Separation
    - Strategy is to limit flood damage to one division
    - SB, EPGB, ESWB physical separation of divisions for flooding
    - FB separated into 2 divisions
    - Division walls below grade- No doors, no unsealed penetrations
    - Watertight doors between divisions above grade
  - Reactor Building and Annulus have no divisional flood separation
    - Reactor Building layout such that water flows to IRWST
    - No components required to function below flood level
- External Flood Protection
  - U.S. EPR uses a "Dry Site" concept → Site platform level (grade level) is arranged above the maximum level of the design basis flood
    - U.S. EPR FSAR requires grade level to be at least 1 foot above the maximum design basis flood (or tsunami) level
    - Maximum groundwater elevation is 3.3 ft below finished grade
    - Finished grade slopes away from Seismic Category I structures
- COL applicants are required to determine the probable maximum flood, probable maximum precipitation, evaluate seiche and other hydrologic conditions per RG 1.159 and 1.102

Section 3.5 – Missile Protection

- Section 3.5 describes the approach to protect safety related SSCs from externally and internally generated missiles
- Missiles are non-credible if the risk is less than 1 x 10-7
  - Risk is probability of missile occurrence x probability of impact x probability of significant damage
- Missile Sources
  - Internal
    - High energy fluid systems
    - Rotating equipment
    - Postulated pipe ruptures
  - External
    - Turbine Missiles
    - Tornado Generated Missiles – Region I missile spectrum in Table 2 of R.G. 1.76
- Protection Strategy
  - Location in a missile resistant structure
  - Separating redundant systems from missile path or range of the missile
  - Local shields and barriers
  - Design to withstand impact of missiles
  - Design features to prevent the generation of missiles
  - Orienting missile sources to prevent strike on safety-related equipment
- COL information items are identified for the applicant to evaluate any site specific missiles

Section 3.7 – Seismic Design

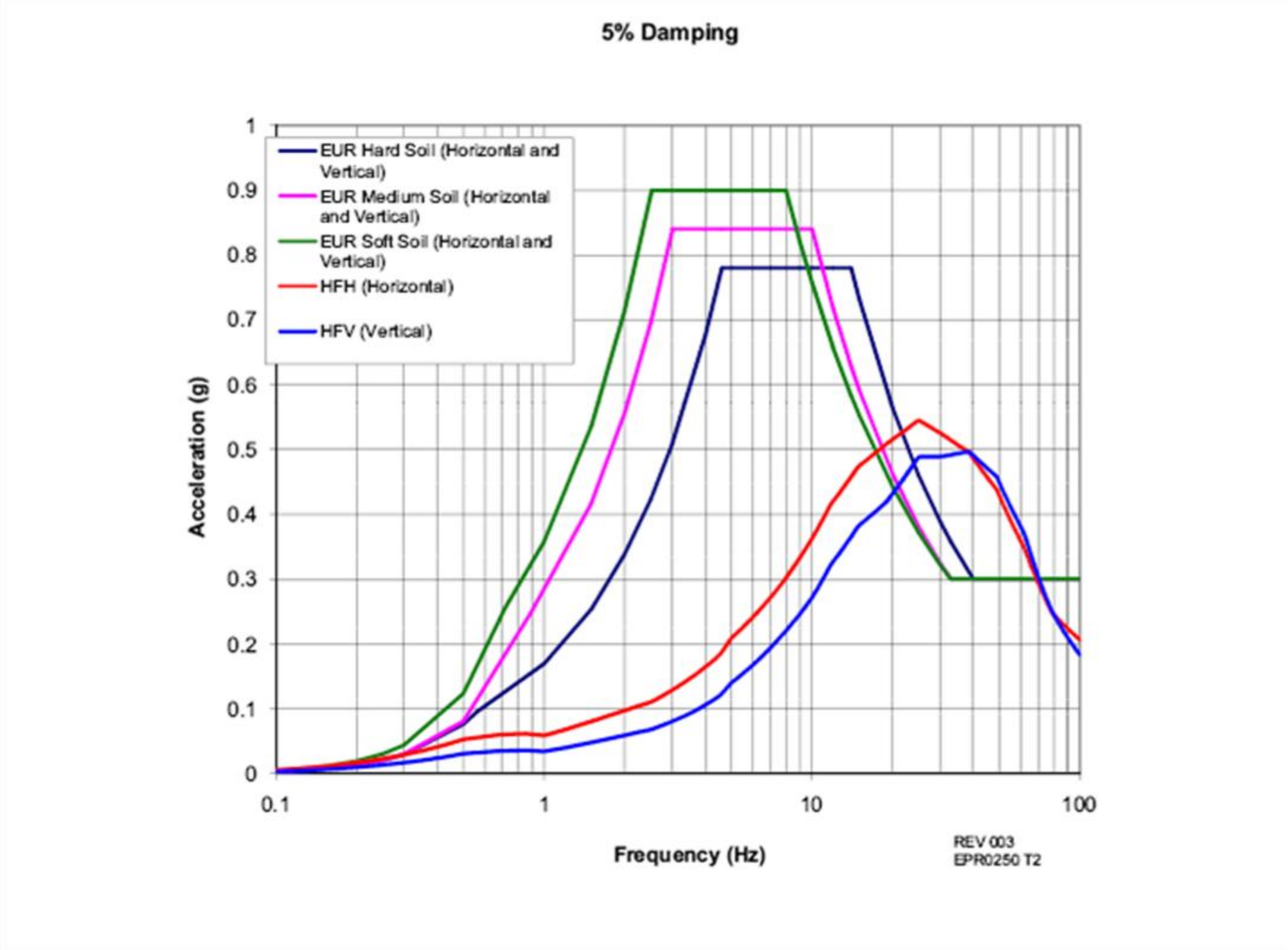
- Describes the seismic analysis methods for designing structures, systems and components to withstand the effects of the CSDRS (Certified Seismic Design Response Spectra or SSE for Standard Design)
- 3.7.1 Seismic Design
- 3.7.2 Seismic System Analysis
- 3.7.3 Seismic Subsystem Analysis
- 3.7.4 Seismic Instrumentation

Section 3.7.1 – Seismic Design Parameters

- Section 3.7.1 describes the vibratory ground motion and site conditions assumed for the U.S. EPR standard design
- CSDRS
  - The U.S. EPR CSDRS is based on individual sets of 3 control motions developed for hard, medium and soft soil conditions anchored at 0.3g PGA. In addition, a high frequency control motion is added anchored at a 0.21g horizontal PGA and a 0.18g vertical PGA
  - Hard, soft, and medium control motions meet 10 CFR 50 Appendix S requirements
  - CSDRS are modified to account for structure-soil-structure interaction effects for the buildings not on the Nuclear Island Common Basemat
  - Time histories meet NUREG/CR-6728 criteria
- The COL applicant is required to reconcile with the seismic design parameters

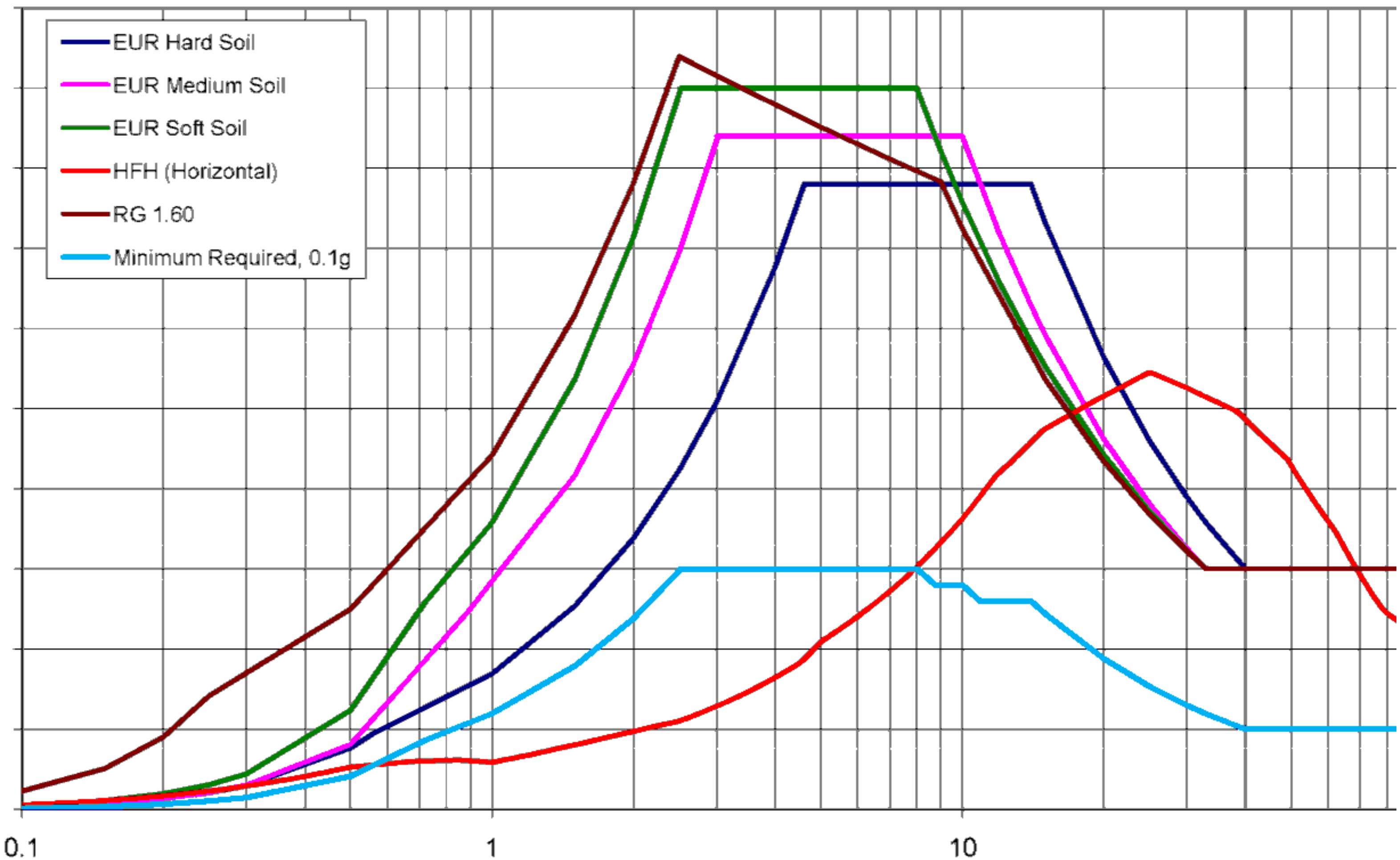
Section 3.7.1 – Seismic Design Parameters

Input Control Motions (CSDRS)



Section 3.7.1 – Seismic Design Parameters

CSDRS Comparison with 10 CFR 50 App. S and R.G. 1.60



Section 3.7.1 – Seismic Design Parameters

- Soil Profiles
  - The U.S. EPR seismic analysis considers 8 soil profiles, including high frequency soil profiles
  - Each soil profile is associated with one of the control motions (hard, medium, soft, high frequency)
- Damping
  - Damping based on R.G. 1.61, Rev. 1

Section 3.7.1 – Seismic Design Parameters

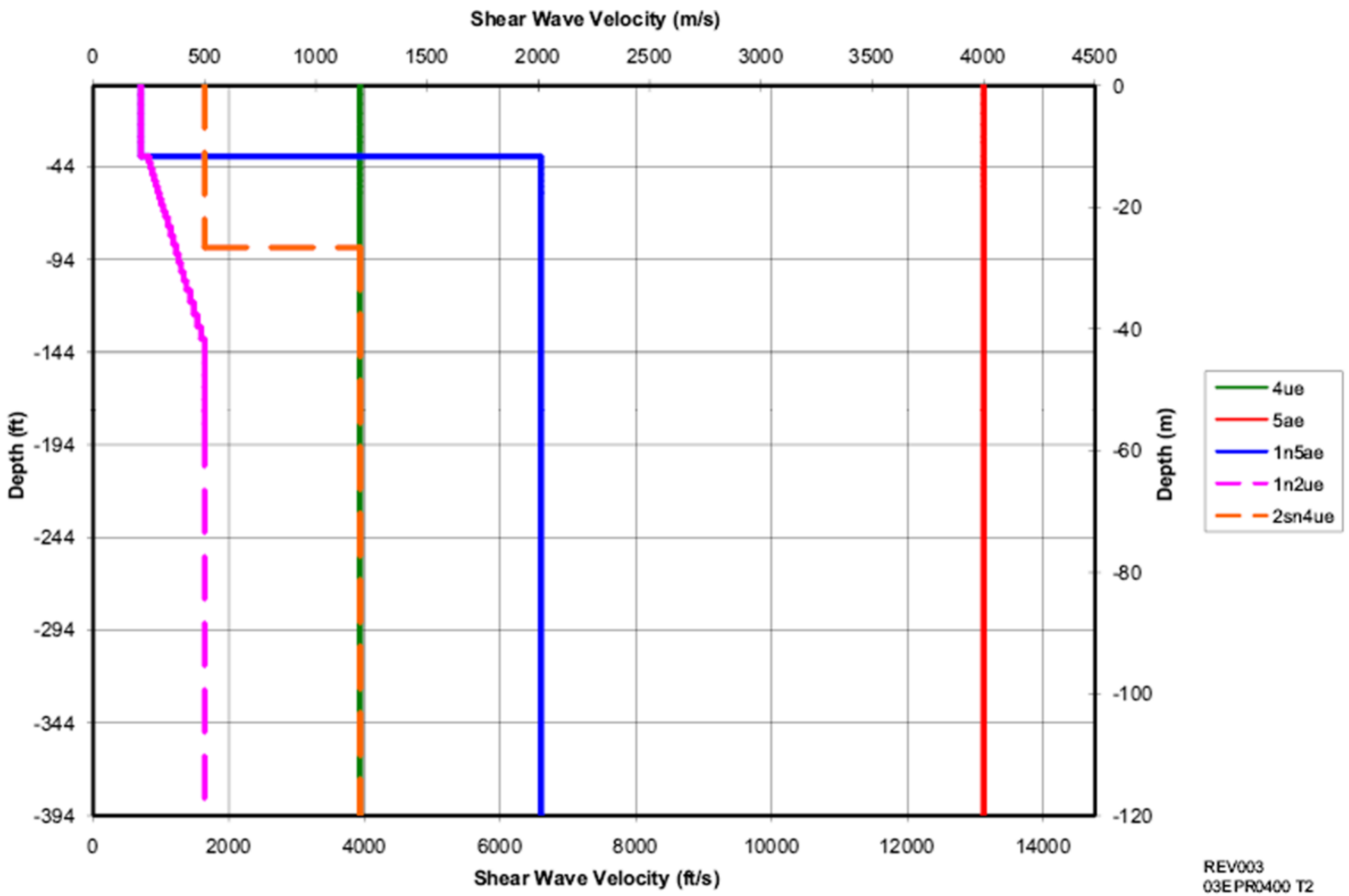
Soil Profiles

Soil Case No.	Seismic Control Motion Applied	Soil Profile (Half-space or Layered)	Shear Wave Velocity of Soil[1] Below Elevation -38 ft, 10-1/2 inches (-11.85 m)	Shear Wave Velocity of Soil1 Above Elevation -38 ft, 10-1/2 inches (-11.85 m)
4ue	EUR Medium	Half-space	3937 ft/s	3937 ft/s
5ae	EUR Hard	Half-space	13,123 ft/s	13,123 ft/s
1n5ae	EUR Hard	38 ft uniform layer followed by stiffer soil half-space	6601 ft/s	700 ft/s
1n2ue	EUR Soft	38 ft uniform layer followed by linear gradient within a 100 ft layer over a half-space	820 ft/s to 1640 ft/s	700 ft/s
2sn4ue	EUR Medium	87 ft uniform layer over a half-space	1640 ft/s to 3937 ft/s	1640 ft/s
hfub	HF	300 ft layer of varying shear wave velocities	8143 ft/s to 11,759 ft/s	1408 ft/s to 2817 ft/s
hflb	HF	300 ft layer of varying shear wave velocities	5427 ft/s to 7838 ft/s	470 ft/s to 719 ft/s
hfbe	HF	300 ft layer of varying shear wave velocities	6647 ft/s to 9600 ft/s	578 ft/s to 908 ft/s

1. Shear wave velocities of soil profiles are strain-compatible.

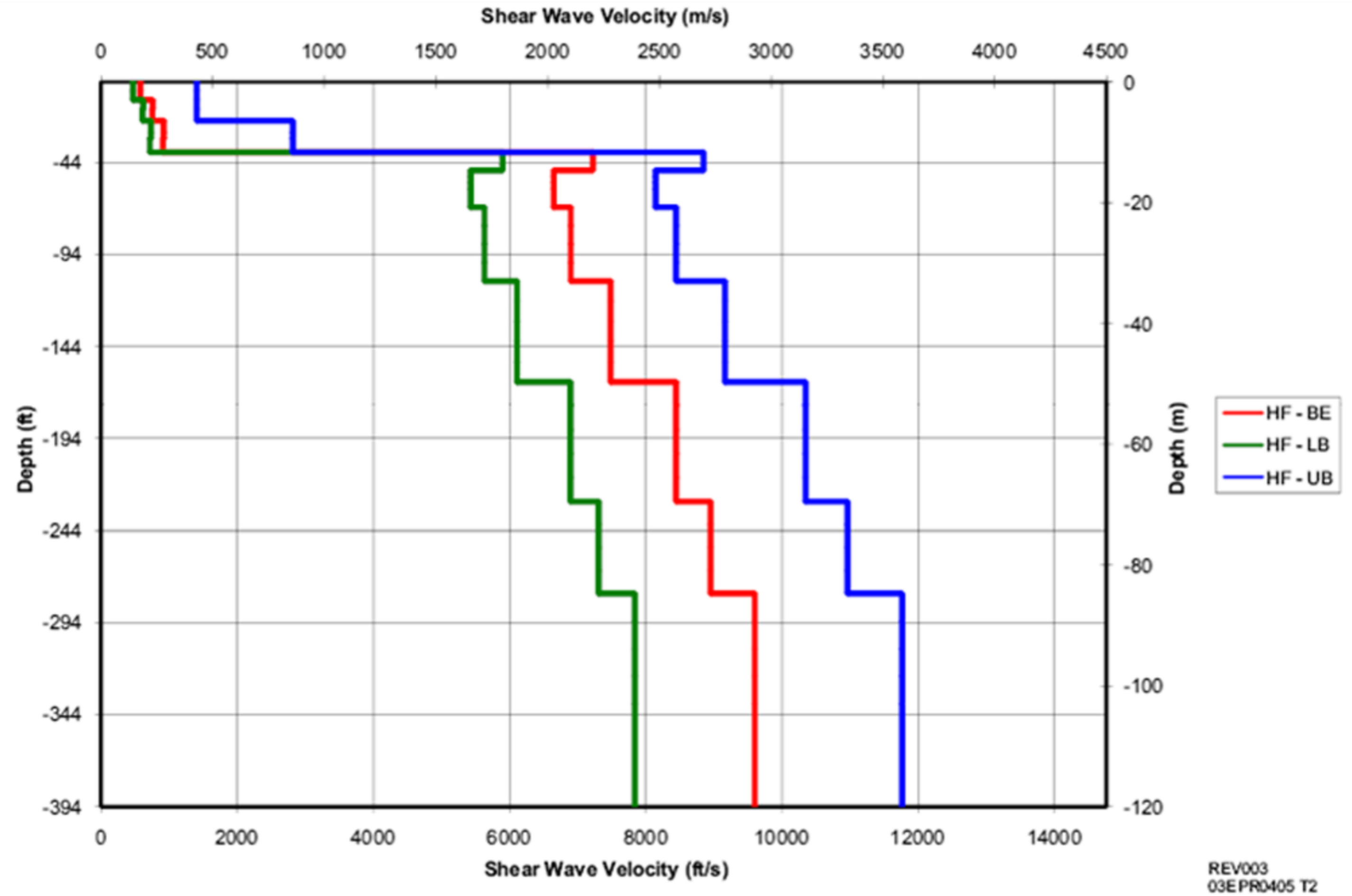
Section 3.7.1 – Seismic Design Parameters

5 Standard Soil Profiles



Section 3.7.1 – Seismic Design Parameters

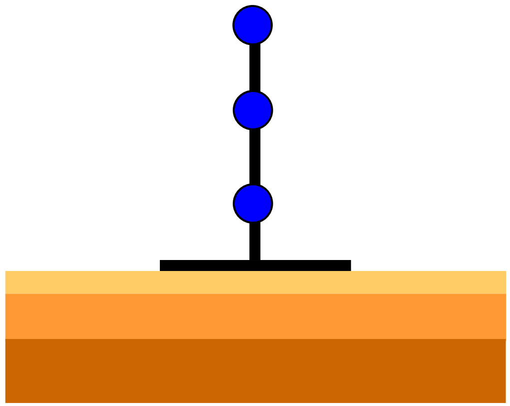
3 High Frequency Soil Profiles



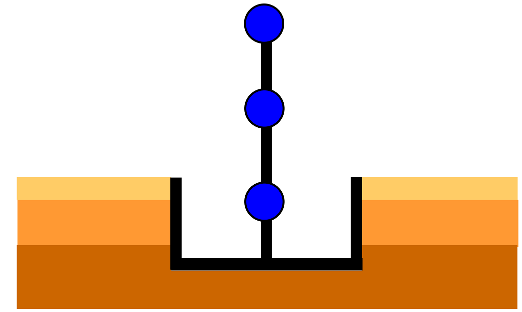
Section 3.7.2 – Seismic System Analysis

- Section 3.7.2 provides seismic analysis details for Seismic Category I, II, and Radwaste Seismic structures
- Seismic Category I
  - NI Common Basemat (Reactor Bldg, Safeguard Bldgs 1-4, Fuel Building, associated shield structures, and Vent Stack)
  - Essential Service Water Buildings (1-4)
  - Emergency Power Generation Buildings (1/2, 3/4)
- Seismic Category II
  - Nuclear Auxiliary Building
  - Access Bldg [Site Specific Structure]
  - Turbine Bldg/Switchgear Building [Site Specific Structure]
- Radwaste Seismic
  - Radwaste Building
  - Nuclear Auxiliary Building
- COL applicant to address the seismic design requirements for other site specific structures

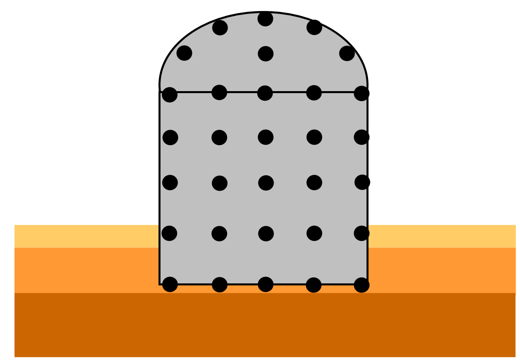
Evolution of U.S. EPR Nuclear Island SSI Model



Surface-Founded Stick on Rigid Basemat



Embedded Stick on Rigid Basemat



Embedded Finite Element Model

Section 3.7.2 – Seismic System Analysis SC I Structures

- Seismic Models
  - Dynamic 3D finite element models are used to determine the seismic response of the SC I structures
  - Embedded effects are modeled
  - Both cracked and un-cracked concrete properties are considered
  - The NI Common Basemat seismic model includes stick models of the NAB and RCS to capture their influence on the NI Common Basemat seismic response and provide input for the seismic design of the NAB and RCS
- Seismic Analysis
  - A soil structure interaction analysis is performed using the MTR/SASSI computer code for each of the control motion and soil profile combinations for each of the SC I structures
  - In-structure response spectra and zero period accelerations are generated for design of SSCs
  - Structure to soil to structure interaction effects are considered for SC I and II structures not on the Nuclear Island Common Basemat

Section 3.7.2 – Seismic System Analysis SC II and Radwaste Seismic

- SC II Structures (NAB, AB, TB/Swgr)
  - Analyzed and Designed to SC I Criteria
    - Construction materials, testing and examination is to conventional standards
    - AB and TB/Swgr Criteria are conceptual in U.S. EPR
  - The AB & TB/Swgr are analyzed and designed to the Site Specific SSE by the COL applicant
  - Gap between structures is evaluated to ensure the SC II structure will not impair the function of any SC I structure
    - COL Applicant are required to confirm adequate gaps for Site Specific Structures
- Radwaste Seismic (RWB and NAB)
  - RWB and NAB are designed in accordance with RG 1.143 Category RW-IIa

Section 3.7.3 – Seismic Subsystem Analysis

- Section 3.7.3 describes seismic analysis methodologies for standard plant subsystems including-
  - HVAC duct
  - Cable tray
  - Conduit and tubing distribution systems
  - Equipment and component supports
  - Platforms and support frame structures
  - Buried piping and conduits
  - Yard structures
  - Atmospheric tanks

Section 3.7.3 – Seismic Subsystem Analysis

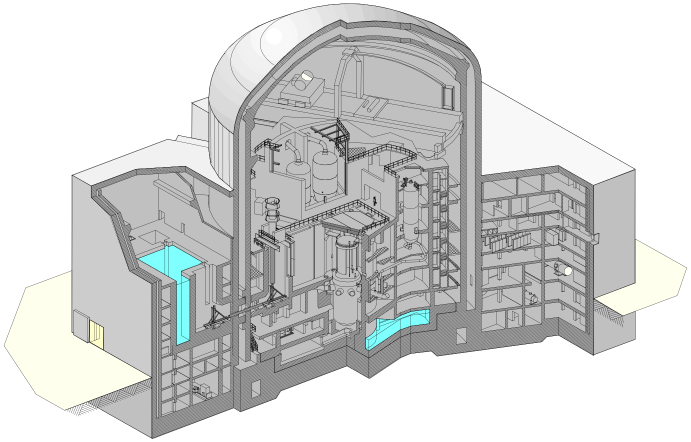
- Seismic Category I subsystems are designed to withstand the CSDRS and maintain the capability to perform their safety functions
  - Methods used for analysis include response spectrum method, time history method, or equivalent static load method
- Operating Basis Earthquake (OBE)
  - OBE is not explicitly considered in design per SECY 93-087, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs.”
    - The exceptions for elimination of OBE identified in SECY 93-087 are considered
- COL applicants are required provide the method of analysis for site specific subsystems

Section 3.7.4 – Seismic Instrumentation

- Section 3.7.4 describes requirements for seismic instrumentation to ensure the plant features important to safety can be evaluated promptly following an earthquake
- Instrumentation conforms to R.G. 1.12, Rev. 2
  - Instrumentation components are qualified to IEEE-344-2004
- Pre-earthquake planning and post-earthquake actions conform to R.G. 1.166
  - Exceedance Criteria are per EPRI reports NP-6695 and NP-5930
  - Cumulative Absolute Velocity (CAV) is calculated in accordance with EPRI TR-100082
- Restart requirements following an earthquake conform to R.G. 1.167
- COL applicant required to establish location of free-field sensors

Section 3.8 – Design of Category I Structures

- Section 3.8 describes information on the design of SC I Structures
- 3.8.1 Concrete Containment
- 3.8.2 Steel Containment
- 3.8.3 Concrete and Steel Internal Structures of Concrete Containment
- 3.8.4 Other Seismic Category I Structures
- 3.8.5 Foundations

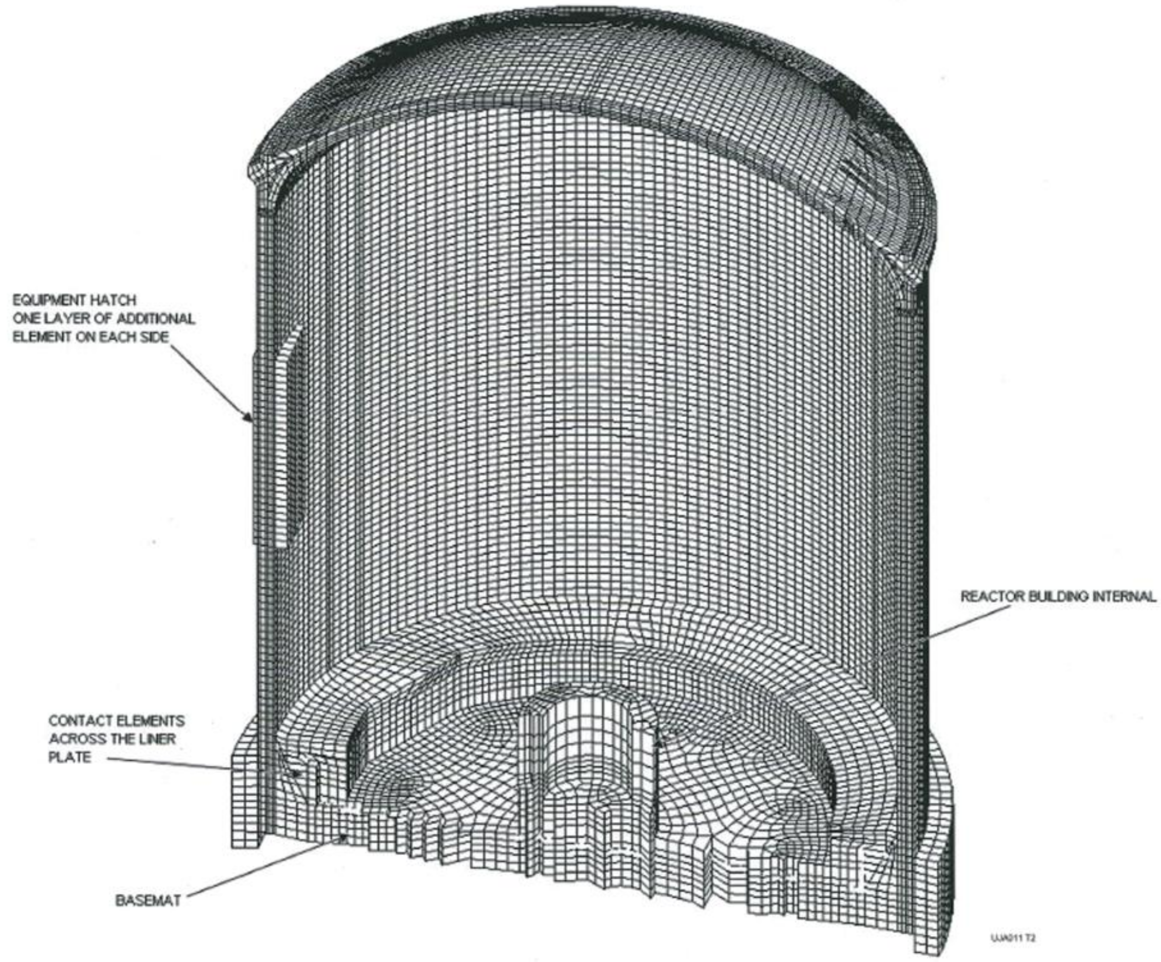


Section 3.8.1 – Concrete Containment

- Section 3.8.1 describes the post tensioned reinforced concrete containment structure
- The containment is shielded by a reinforced concrete shield building designed for protection against missiles, including a large commercial aircraft
- Design meets the requirements of ASME Section III, Division 2
- A steel liner plate is provided
- The containment uses a grouted tendon design
  - ISI fully compliant with R.G. 1.90
  - Grout control per R.G. 1.107
- Designed for normal loads, severe environmental loads, extreme environmental loads, and abnormal loads (e.g., combustible gas per 10 CFR 50.44)
- Containment design pressure is 62 psig
- The COL applicant will verify that the site specific loads are enveloped by the U.S. EPR design

Section 3.8.1 – Concrete Containment

Finite Element Model of Containment



Section 3.8.2 – Steel Containment

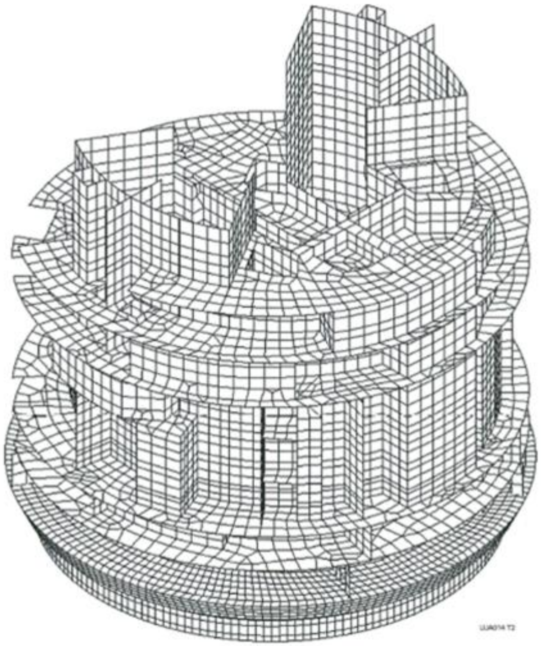
- Section 3.8.2 describes the steel components of the post tensioned reinforced concrete containment structure
- For the U.S. EPR, this applies to major containment penetrations and portions of penetrations not backed by structural concrete that are intended to resist pressure
- Penetrations include
  - Equipment hatch
  - Dedicated spare penetration
  - Airlocks
  - Construction opening
  - Pipe penetration sleeves
  - Electrical penetration sleeves
  - Fuel transfer tube sleeve
- Meets the requirements of ASME Section III, Div 1, Subsection NE
- Designed for service loads, factored loads, and other loads

Section 3.8.3 – Concrete and Steel Internal Structures of Concrete Containment

- Section 3.8.3 describes the reinforced concrete walls and floors, steel framing members, and other concrete and steel structural elements that are located within the concrete containment structure
- Major internal structures Include
  - Reactor vessel support structure and reactor cavity
  - Steam generator support structures
  - Reactor coolant pump support structures
  - Pressurizer support structure
  - Operating floor and intermediate floors
  - Secondary shield walls
  - Refueling canal walls
  - Polar crane support structure
  - Internal structures basemat
  - IRWST
  - Core melt retention area

Section 3.8.3 – Concrete and Steel Internal Structures of Concrete Containment

- Meets the requirements of ACI-349 and AISC/ANSI N690
- Designed for normal loads, severe environmental loads, extreme environmental loads, and abnormal loads (e.g., high energy pipe break)
- The COL applicant will verify that the site specific loads are enveloped by the U.S. EPR design



Finite Element Model of Reactor Building Internal Structures

Section 3.8.4 – Other Seismic Category I Structures

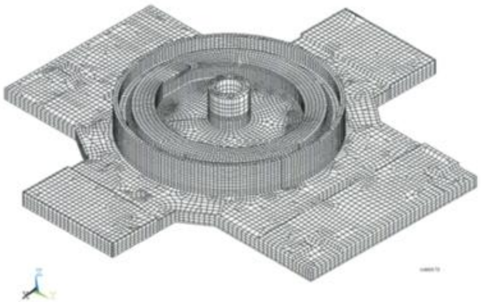
- Section 3.8.4 describes the other SC I structures on the Nuclear Island Common Basemat and SC I structures located away from it
- Other SC I Structures include
  - Reactor Shield Building and Annulus (on Common Basemat)
  - Fuel Building and Fuel Building Shield (on Common Basemat)
  - Safeguard Buildings 1 thru 4 (on Common Basemat)
  - Vent Stack (on Fuel Building Roof)
  - Emergency Power Generating Buildings 1/2 and 3/4
  - Essential Service Water Buildings 1 thru 4
  - Distribution system supports in above structures
  - Platforms and miscellaneous structures in above structures
  - Buried conduit and duct banks (COL Scope)
  - Buried pipe and pipe ducts (COL Scope)

Section 3.8.4 – Other Seismic Category I Structures

- Meets the requirements of ACI-349 and AISC/ANSI N690
- No masonry walls are used in U.S. EPR SC I structures
- Designed for normal loads, severe environmental loads, extreme environmental loads, and abnormal loads (e.g., high energy pipe break)
- The COL applicant will verify that the site specific loads are enveloped by the U.S. EPR design

Section 3.8.5 – Foundations

- Section 3.8.5 describes the Seismic Category I structure foundations
- The SC I Structure Foundations include
  - The Nuclear Island Common Basemat Structure foundation basemat
  - The EPGB foundation basemat
  - The ESWB foundation basemat
- Meets the requirements of ACI-349 and ASME Section III, Div. 2
- Stability (i.e., sliding and overturning) is checked per SRP 3.8.5
- Designed for normal loads, severe environmental loads, extreme environmental loads, and abnormal loads
- The COL applicant will verify that the site specific loads, such as settlement are enveloped by the U.S. EPR design



Nuclear Island Common Basemat Foundation

Section 3.8 – Design of Category I Structures

- Critical Sections identified to demonstrate essentially complete design per requirements of 10 CFR 52.47(c)
- Three-tiered critical section selection methodology
  - Qualitative criterion
    - SC I structures that perform a safety-critical function such as a barrier to radioactive release
  - Quantitative criterion
    - Selected through a thorough numerical analysis of the NI FE analysis results
    - Intended to identify sections that are highly stressed, but not chosen under the qualitative criterion
  - Supplementary criterion
    - Intended to capture critical sections not screened by the other two criteria
    - Based on engineering judgment
    - Necessary to obtain an adequate representation of typical structural elements

Sections 3.6, 3.9, 3.12, 3.13

Chris McGaughy

Section 3.6 - Protection Against Dynamic Effects Associated with Postulated Rupture of Piping

- Section 3.6.1 - Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside of Containment
- Section 3.6.2 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping
- Section 3.6.3 Leak-Before-Break (LBB) Evaluation Procedures

Section 3.6.1 - Plant Design for Protection Against Postulated Piping Failures in Fluid Systems Outside of Containment

- Design of protection for essential systems against postulated pipe rupture is per the SRP and BTP 3-3:
  - In the event of a high- or moderate-energy pipe rupture within the plant, protection is provided so that the essential systems and components are not adversely impacted by the effects of postulated piping failure
- A combination of redundancy and separation is utilized:
  - Four redundant safety trains for many essential systems
  - Protection of essential systems is also achieved by physically separating them from other high- and moderate-energy lines through:
    - Distance
    - Intervening structures or barriers
    - Protective enclosures for essential systems/components
    - Enclosures around high- or moderate-energy piping that could damage essential system piping after a rupture

Section 3.6.2 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping

- Ruptures in high- and moderate- energy piping inside and outside containment are located per SRP (BTP 3-4) requirements:
  - Circumferential and longitudinal breaks, and leakage cracks in high-energy lines
  - Leakage cracks in moderate-energy lines

- Pipe whip analysis of ruptured pipe follows the guidance of the SRP with consideration of:
  - Location of pipe whip hinges
  - Non-linear properties of pipe whip restraints
  - Pipe rebound

Section 3.6.2 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping

- Jet Impingement Effects
  - Technical Report ANP-10318P: AREVA NP proprietary methodology for calculating external loading effects on essential SSC due to jet impingement, including unsteadiness, jet resonance and jet reflection effects
  - Methodology is independent of ANSI/ANS 58.2
  - A flow chart of the methodology is provided in Figure 03.06.02-33-1 of RAI 354, Supplement 29
- Blast Effects
  - Ruptures in lines containing steam are capable of generating blast waves
  - Steam lines inside containment are qualified for LBB; therefore, they are not evaluated for blast potential
  - Steam lines outside of containment have been evaluated to identify essential SSC susceptible to blast from their rupture and it was determined that essential SSC in safeguard buildings are subject to blast loading

Section 3.6.3 – Leak-Before-Break Evaluation Procedures

- LBB methodology is used to demonstrate that the probability of pipe rupture is extremely low for a given piping system; therefore, consideration of dynamic effects of pipe ruptures can be eliminated
- The methods and criteria to evaluate LBB are consistent with the guidance in NUREG-1061, Volume 3, and SRP 3.6.3:
  - Leak rate analysis considers leakage crack sizes with recommended margin of 10 on leak detection capability
  - Detailed flaw stability analysis considers safety margin of two on leakage crack size
- LBB methodology is applied to the following high energy piping systems:
  - Main coolant loop (MCL) piping (hot legs, crossover legs, and cold legs)
  - Pressurizer surge line (SL)
  - Main steam line (MSL) piping inside containment
- LBB results are in the form of "Allowable Load Limit" (ALL) diagrams
  - If applied loading points lie within the ALL window, LBB is justified
- Critical location is the SL dissimilar metal welds (DMW)
  - Material properties of the DMW established via FEA

Section 3.6.3 - Leak-Before-Break Evaluation Procedures

- Leakage Detection
  - Leak rates of 5.0 gpm for the MCL and SL and 1.0 gpm for MSL were used for determining the leakage flaw sizes - provides a factor of ten to the actual plant leakage detection system capabilities
  - RCPB leakage detection conforms to the sensitivity and response times recommended in RG 1.45, Revision 1, described in FSAR Section 5.2.5
  - MSL Leakage Detection:
    - Primary method is local humidity detection system
    - Secondary method is containment sump level
    - Containment air cooler condensate flow and containment atmosphere pressure, temperature, and humidity also provide an indication of possible MSL leakage

Section 3.9 - Mechanical Systems and Components

- Section 3.9.1 - Special Topics for Mechanical Components
- Section 3.9.2 - Dynamic Testing and Analysis of Systems, Components, and Equipment
- Section 3.9.3 - ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures
- Section 3.9.4 – Control Rod Drive System
- Section 3.9.5 - Reactor Pressure Vessel Internals
- Section 3.9.6 - Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

Section 3.9.1 - Special Topics for Mechanical Components

- Design Transients:
  - Pressure, temperature and flow transients for normal, upset, emergency, faulted and test conditions are described and design cycles are based on 60 year plant life
- Computer programs used in the structural, stress and fatigue analysis of piping, components, supports and component internals are listed in Section 3.9.1
- Experimental stress analysis methods are not used
- Section 3.9.3 describes the analytical methods used to evaluate stresses for Seismic Category I systems and components subjected to faulted condition loading

Section 3.9.2 - Dynamic Testing and Analysis of Systems, Components, and Equipment

- Describes the general startup functional tests and the vibration and dynamic analyses to be performed on specified high-energy and moderate-energy piping and the associated piping supports and restraints, and on reactor internals to verify they meet structural and functional requirements
- U.S. EPR conforms to RG 1.20 R3 with the following exceptions:
  - Vibration program for steam generator internals not required since PWR SG upper internals are not subject to excessive vibration
  - Vibration for the condensate system will be measured during start-up testing using hand-held vibration monitors rather than fixed instrumentation
- U.S. EPR RPV internals are classified as prototype per guidance of RG 1.20 R3
- The comprehensive vibration assessment program for reactor internals is described in Technical Report ANP-10306P (AREVA Proprietary) and conforms to the guidance of RG 1.20 R3

Section 3.9.3 - ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures

- Structural design and stress/fatigue analysis of pressure-retaining components, component supports, and core support structures is in accordance with the ASME Boiler and Pressure Vessel Code, Section III, Division 1 and applicable GDC
  - Effects of RCS environment on component fatigue are considered
- Structural design of piping and pipe supports is described in Topical Report ANP-10264NP-A, "U.S. EPR Piping Analysis and Pipe Support Design" - modeling techniques, analysis methods and acceptance criteria for ASME Class 1, 2 and 3 piping
- The functional design and qualification of safety-related pumps, valves, and snubbers is performed in accordance with ASME QME-1-2007

Section 3.9.4 – Control Rod Drive System (CRDS)

- The CRDS includes the CRDM and the RCCA
- The CRDM is an electromagnetic jack design and is mounted on top of the RPV head - based on a proven design that has been in use for over 30 years
- Design of CRDS is in accordance with the ASME Boiler and Pressure Vessel Code (Section II – Materials, Section III – Class 1 construction rules)
- To confirm the mechanical adequacy of the CRDS, a prototype testing program was created that integrates the CRDM and appurtenances, the CRDM drive rod, the CRGA, the RCCA, and the fuel assembly:
  - Functionality testing at simulated operating conditions
  - Endurance (wear) testing
  - Drop testing

Section 3.9.5 - Reactor Pressure Vessel Internals

- RPV Internals:
  - Upper and lower internals
  - Classified as Core Support Structures or Internal Structures
- Core Support Structures:
  - Class CS per ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NG
  - Design, analysis, fabrication, and non-destructive examination is in accordance with Subsection NG
- Internal Structures:
  - Designated as internal structures in accordance with ASME Code, Section III, Subsection NG-1122
  - Design meets the guidelines of Subsection NG Article NG-3000

Section 3.9.6 - Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

- Describes the functional design and qualification provisions and IST programs for safety-related pumps, valves, and dynamic restraints (snubbers)
- Section 3.9.6 fully describes the functional design, qualification, and IST programs for the U.S. EPR
- IST of safety-related pumps, valves and snubbers is performed in accordance with 10 CFR 50.55a(f), the 2004 edition of the ASME OM Code, and the guidance in RG 1.192, and NUREG-1482, Revision 1
- The functional design and qualification of safety-related pumps, valves, and snubbers is performed in accordance with ASME QME-1-2007, as endorsed in RG 1.100, Rev. 3
- System design allows full flow testing of pumps and valves under the IST program
- The U.S. EPR design incorporates provisions to permit safety-related check valves to be tested for performance in both the forward and reverse flow directions

Section 3.9.6 - Functional Design, Qualification, and Inservice Testing Programs for Pumps, Valves, and Dynamic Restraints

- IST of safety-related MOVs also incorporates the guidance of:
  - GL 96-05 which supersedes GL 89-10
  - Joint Owners Group (JOG) MOV Periodic Verification
  - ASME Code Case OMN-1, as accepted by the NRC with conditions in RG 1.192
- IST of POVs, other than MOVs, incorporates the guidance of:
  - Regulatory Issue Summary 2000-03 (incorporates the lessons learned from MOV analysis and tests in response to GL 96-05)
  - GL 89-10
  - JOG AOV program
- A list of pumps included in the IST program is provided in U.S. EPR FSAR Tier 2, Table 3.9.6-1 and a list of valves included in the IST program is provided in U.S. EPR FSAR Tier 2, Table 3.9.6-2
- Visual examination of snubbers will be performed in accordance with Code Case OMN-13 as accepted by the NRC in RG 1.192

Section 3.12 - ASME Code Class 1, 2, and 3 Piping Systems, Piping Components, and their Associated Supports

- Addresses the design of the piping systems and piping supports
- AREVA NP Topical Report ANP-10264NP-A contains the details regarding design of safety related piping and addresses the interaction of non-seismic piping with Seismic Category I piping
- Piping design addresses thermal stratification:
  - The pressurizer SL is continuously sloped from the pressurizer to the hot leg and there is continuous flow from the pressurizer to the hot leg, both of which act to minimize thermal stratification
  - The main nozzle and the adjacent feedwater line are sloped downward from the SG and there is continuous flow, both of which act to minimize thermal stratification during normal operations
  - To assess for stratification, the COL applicant will monitor temperatures during the first fuel cycle of initial plant operation to verify that the design transients are representative of actual plant operations
- The effects of reactor coolant environment, using the methodology described in RG 1.207, are considered when performing fatigue analyses for Class 1 piping and components

Section 3.13 - Threaded Fasteners (ASME Code Class 1, 2, and 3)

- Class 1, 2 and 3 pressure boundary threaded fasteners are designed in accordance with ASME B&PV Code Section III, Subsection NB, NC and ND, respectively
  - Ferritic Class 1 fasteners also meet 10 CFR 50, Appendix G, fracture toughness requirements
- Selection and testing of bolting material is per the SRP (ASME B&PV Code, Section III, Subsections NCA and NB/NC/ND)
  - Material and testing of the RV closure stud bolting conforms to RG 1.65
- Lubricants for the U.S. EPR are selected in accordance with the guidance provided in NUREG-1339
- Inservice inspection of ASME Class 1, Class 2, and Class 3 threaded fasteners is performed in accordance with ASME Section XI

Section 3.10 - Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

Section 3.11 - Environmental Qualification of Mechanical and Electrical Equipment

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Section 3.10 - Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

- Provides the requirements for seismic and dynamic qualification of mechanical, electrical, and I&C equipment
- Seismic qualification is performed by test, analysis, or a combination of test and analysis
- Seismic qualification in accordance with IEEE 344-2004 and ASME QME-1-2007, as endorsed by RG 1.100, Revision 3
- Seismic qualification based on experience, per Section 10 of IEEE Std 344-2004, is not utilized for the U.S. EPR
- Electrical and mechanical equipment for the U.S. EPR is qualified for the SSE as defined in Section 3.7.1, with low-level effects considered via five OBEs, as noted in Section 3.7.3.2, also in accordance with IEEE 344
- The U.S. EPR FSAR provides a list of electrical and I&C equipment that is being seismically qualified in accordance with IEEE Std 344

Section 3.10 - Seismic and Dynamic Qualification of Mechanical and Electrical Equipment

- An SQDP is developed for each equipment (or equipment class) to document the qualification results that establish the seismic capability of the equipment. A sample SQDP format is included in Attachment F to Appendix 3D
- The seismic qualification procedures for mechanical and electrical equipment are described in more detail in Attachment E to Appendix 3D
- A COL applicant will identify any site-specific components that need to be added to the equipment list in Table 3.10-1

Section 3.11 - Environmental Qualification of Mechanical and Electrical Equipment

- Provides the U.S. EPR approach to the EQ of equipment and identifies the equipment that is within the scope of 10 CFR 50.49 including I&C and certain post-accident monitoring (PAM) equipment
- Equipment in the scope of the EQ program is qualified based on the guidelines provided in IEEE Std 323-1974 as endorsed by RG 1.89 and related standards shown in U.S. EPR FSAR Tier 2, Table 3.11-4
- The environmental conditions include anticipated operational occurrences and normal, accident and post-accident environments due to DBE
- U.S. EPR FSAR includes a detailed listing by equipment tag number of electrical and I&C equipment located in an environmental harsh or radiation harsh environment that require qualification
- A new service condition for plant equipment (especially for digital I&C systems) is EMC, from the standpoint of susceptibility and emissions

Section 3.11 - Environmental Qualification of Mechanical and Electrical Equipment

- PAM equipment is also environmentally qualified in accordance with RG 1.97
- Section 3.11.2.2 demonstrates that the U.S. EPR approach to qualification of mechanical equipment is in accordance with SRP 3.11 and GDC 4
  - Mechanical pressure boundary components qualified by virtue of the application of an ASME Boiler and Pressure Vessel stamp
  - Components that contain mechanical non-metallic or consumable parts that require EQ (i.e., classification C/NM) are qualified in accordance with App QR-B to ASME QME-1-2007
  - Qualification maintained via preventive and surveillance maintenance, and periodic testing
- The summaries and results of qualification tests for electrical equipment and components are documented in the EQDP. An EQDP sample format is provided in Appendix 3D
- A COL applicant that references the U. S. EPR design certification will identify site-specific components that need to be added to the environmental qualification list in Table 3.11-1

Acronyms

Acronym	Definition
AB	Access Building
ACH	Aircraft Hazard
ALL	Allowable Load Limit
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOV	Air Operated Valve
ASME	American Society of Mechanical Engineers
ATWS	Anticipated Transient Without Scram
B&PV	Boiler and Pressure Vessel
BTP	Branch Technical Position
CAV	Cumulative Absolute Velocity
CFR	Code of Federal Regulations
CRDM	Control Rod Drive Mechanism
COL	Combined License
CRDS	Control Rod Drive System
CRGA	Control Rod Guide Assembly
CS	Conventional Seismic
CSDRS	Certified Seismic Design Response Spectra
CVCS	Chemical and Volume Control System
DBE	Design Basis Event
DMW	Dissimilar Metal Weld
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
EMC	Electromagnetic Compatibility
EPGP	Emergency Power Generating Building

Acronyms

Acronym	Definition
EQ	Environmental Qualification
EQDP	Equipment Qualification Data Packages
ESWB	Essential Service Water Building
FB	Fuel Building
FEA	Finite Element Analysis
GDC	General Design Criteria
GL	Generic Letter
I&C	Instrumentation and Controls
IEEE	Institute of Electrical and Electronics Engineers
IRWST	In-Containment Refueling Water Storage Tank
ISI	Inservice Inspection
IST	Inservice Testing
JOG	Joint Owners Group
LBB	Leak-Before-Break
MCL	Main Coolant Loop
MOV	Motor Operated Valve
MSL	Main Steam Line
NAB	Nuclear Auxiliary Building
NI	Nuclear Island
NRC	Nuclear Regulatory Commission
NS	Non- Seismic
OBE	Operating Basis Earthquake
PAM	Post-Accident Monitoring
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood

Acronyms

Acronym	Definition
PMP	Probable Maximum Precipitation
POV	Power Operated Valve
PWR	Pressurized Water Reactor
PWSCC	Primary Water Stress Corrosion Cracking
QA	Quality Assurance
RAI	Request for Additional Information
RCCA	Rod Cluster Control Assembly
RB	Reactor Building
RCPB	Reactor Coolant Pressure Boundary
RCS	Reactor Coolant System
RG	Regulatory Guide
RHR	Residual Heat Removal
RPV	Reactor Pressure Vessel
RS	Radwaste Seismic
RWB	Radwaste Building
SB	Safeguard Building
SG	Steam Generator
SL	Surge Line
SQDP	Seismic Qualification Data Package
SRP	Standard Review Plan
SSC	Structures, Systems and Components
SSE	Safe Shutdown Earthquake
TB	Turbine Building

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Presentation to the ACRS Subcommittee

AREVA U.S. EPR Design Certification Application Review

Safety Evaluation Report with Open Items

Chapter 3: Design of Structures, Components, Equipment and Systems

February 21-22, 2012

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Overview of DCA – Chapter 3

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SRP Section/Application Section		No. of Questions	Status Number of OI
3.2	Classification of Structures, Systems, and Components	33	8
3.3	Wind and Tornado Loadings	10	1
3.4	Water Level (Flood) Design	28	1
3.5	Missile Protection	17	0
3.6	Protection Against Dynamic Effects Associated with Postulated Rupture of Piping	83	3
3.7	Seismic Design	153	8
3.8	Design of Category I Structures	153	13
3.9	Mechanical Systems and Components	251	33
3.10	Seismic and Dynamic Qualification of Mechanical and Electrical Equipment	31	0
3.11	Environmental Qualification of Mechanical and Electrical Equipment	40	1
3.12	ASME Code Class 1, 2, and 3 Piping Systems, Piping Components, and their Associated Supports	25	0
3.13	Threaded Fasteners (ASME Code Class 1, 2, and 3)	4	0
Totals		828	68

Description of Open Items

- RAI 420, Question No. 03.02.01-12: Requests clarification on how the terms “safety related” and “important to safety” are applied to satisfy the seismic and quality group clarification requirements of GDC 2.

- RAI 510, Question No. 03.02.01-19: Requests that the applicant describe the basis for classification of the Passive Autocatalytic Recombiners as Seismic Category II.

- RAI 72, Question No. 03.02.02-6: Verification via audit of design documents regarding quality group classifications of important to safety SSCs.

- RAI 420, Question No. 03.02.02-7: Requests that the applicant review classification Table 3.2.2-1 and identify those additional risk-significant SSCs that should apply the 10 CFR Part 50, Appendix B program or similar special treatment .

- RAI 420, Question No. 03.02.02-8: Requests that the applicant identify the special treatment, or if not yet developed, revise FSAR Tier 2, Section 3.2.2 to reference the D-RAP or other process to ensure the integrity and reliability assumed in the PRA and identify when special treatment requirements are to be identified.

Description of Open Items

- RAI 420 , Question No. 03.02.02-11: Requests an update the figures included in Tier 1 to be consistent with Tier 2 figures in terms of level of detail for ASME classifications.

- RAI 435, Question No. 03.02.02-12: Requests that that the applicant clarify in the FSAR how compliance with GDC 1 for non-safety-related SSC's that are important to safety is accomplished or identify where this methodology is described.

- RAI 504, Question No. 03.02.02-14: Requests clarification on why the refueling cavity seal/ring is not considered a structural or pressure-retaining component and describe the extent that codes and standards are applied to its design.

- RAI 508, Question No. 03.03.01-5: Requests that the applicant add wind loads to the list of external event design basis loads for Seismic Category I structures to ITAAC tables of FSAR Tier 1, Section 2.1. (resolved)

- RAI 377, Question No. 03.04.01-13: Requests that the applicant identify in FSAR a new COL Information Item to provide a maintenance program for water resistant door seals.(resolved)

Description of Open Items

- RAI 533, Question No. 03.06.01-13: Requests the applicant to revise COL information items 3.6-1 and 3.6-1 to remove the reference to the reconciliation of deviations between the as-built configuration and the as-design analysis since this activity is addressed in an existing ITAAC.

- RAI 354, Question No. 03.06.02-35: Requests the applicant to provide a description of the evaluation approach to be used to account for dynamic loads caused by pipe rupture blast waves.

- RAI 467, Question No. 03.06.03-28: Requests the applicant to revise FSAR Tier 2 Section 3.6.3 figures to provide allowable load limit (ALL) diagrams.

- RAI 370, Question No. 03.07.01-27: Requests justification for the use of RG 1.61 SSE structural damping values in the generation of Nuclear Island in-structure response spectra.

- RAI 370, Question No. 03.07.02-64: Requests applicant to demonstrate that the Nuclear Auxiliary Building does not impair the structural integrity of a Seismic Category I structure during an SSE event.

Description of Open Items

- RAI 371, Question No. 03.07.02-66: Requests verification that the tendon gallery of the Reactor Building , which acts as a shear key during and SSE event, has stresses within design code limits. Also requests verification that the modeling of the NI mat/superstructure interface in SASSI model is an accurate representation of the actual building stiffness at this location.

- RAI 371, Question No. 03.07.02-67: Requests dynamic compatibility be demonstrated between the NI SASSI finite element model used for soil-structure interaction analysis and the NI ANSYS finite element model used for structural design.

- RAI 489, Question No. 03.07.02-75: Requests the applicant to demonstrate that the SASSI computer code subtraction method of analysis provides seismic responses that are equal to or greater than those obtained when using the SASSI computer code direct method of analysis.

- RAI 508, Question No. 03.07.03-41: Requests that the applicant provide the basis of strain criteria for buried piping. (resolved)

- RAI 381, Question No. 03.07.04-6: Requests the applicant to address the requirements of RG 1.12 and RG 1.166 regarding the installation of free field seismic sensors. (resolved)

Description of Open Items

- RAI 400, Question No. 03.07.04-7: Requests the applicant to provide the correct Tier 1 section information which describes the location of the seismic monitoring system equipment. (resolved)

- RAI 155, Question No. 03.08.01-24: Tracks the review of design configuration details for critical sections, as described in FSAR Tier 2, Appendix 3E, "Design Details and Critical Sections for Safety-Related Category I Structures.

- RAI 306, Question No. 03.08.01-39: Requests the applicant to address testing requirements in ASME Code Subarticle CC-3542(b) to validate concrete prestress losses due to friction assumed in design of RCB.

- RAI 306, Question No. 03.08.01-40: : Requests information regarding analysis methodology for localized abnormal loads (e.g., sub-compartment pressure loads, pipe break loads, local flood loads) applied to RBIS, not included in global FE model of the NI, as described in FSAR Tier 2, Appendix 3E, "Design Details and Critical Sections for Safety-Related Category I Structures."

Description of Open Items

- RAI 155, Question No. 03.08.04-6: Tracks the review of the actual design of the selected critical sections, as described in FSAR Tier 2, Appendix 3E, “Design Details and Critical Sections for Safety-Related Category I Structures.

- RAI 445, Question No. 03.08.04-15, Review of Spent Fuel Racks: Requests information regarding dimensional gaps, evaluation of erection tolerances, and description of auxiliary crane handling of spent fuel assemblies, as described in Report TN-Rack.0101 and FSAR Tier 2 Chapter 9.

- RAI 445, Question No. 03.08.04-17, Review of Spent Fuel Racks: Requests updated results of stress analysis in Report TN-Rack.0101.

- RAI 445, Question No. 03.08.04-19, Review of Spent Fuel Racks: Requests: additional analyses which model fuel assemblies discretely and additional values of friction coefficient between racks and concrete floor of the spent fuel pool.

Description of Open Items

- RAI 445, Question No. 03.08.04-20, Review of Spent Fuel Racks: Requests information to demonstrate adequacy of seismic response spectra used as input to fuel rack analyses; requests stress evaluation for additional rack components; requests additional evaluation of stress analyses for critical racks.

- RAI 445, Question No. 03.08.04-21, Review of Spent Fuel Racks: Requests buckling evaluation; requests information to demonstrate adequacy of spent fuel assemblies for thermal and mechanical properties when stored in spent fuel pool; requests seismic qualification of racks in NFS area.

- RAI 445, Question No. 03.08.04-26, Review of Spent Fuel Racks: Requests results of additional bounding stress analysis assuming different boundary conditions of support legs.

- RAI 445, Question No. 03.08.04-27, Review of Spent Fuel Racks: Requests results of additional bounding thermal analysis assuming different cases of hot and cold cells.

- RAI 376, Question No. 03.08.05-28: Requests static and dynamic soil bearing pressures under basemat and dynamic soil pressures on sidewalls and shear key (tendon gallery) for the NI.

Description of Open Items

- RAI 376, Question No. 03.08.05-31: Requests information to demonstrate stability against sliding in accordance with SRP 3.8.5 for ESWB; requests static and dynamic soil bearing pressures under basemat and dynamic soil pressures on sidewalls and shear keys for ESWB and EPGB; requests additional information pertaining to seismic analysis and seismic response of the ESWB.

- RAI 179, Question No. 03.09.01-2: Requests applicant to provide a list of all computer programs used for generating hydraulic forcing functions and performing structural analysis. (resolved)

- RAI 458, Question No. 03.09.01-13: Requests the applicant to demonstrate the conservatism in the utilization of the weighted average Fen method ,described in NUREG/CR-6909, in performing fatigue analysis for Class 1 piping and components. (resolved)

- RAI 458, Question No. 03.09.01-14: Requests that the applicant provide the benchmark justification for the local thermal stratification stress calculation. (resolved)

- RAI 458, Question No. 03.09.01-15: Requests that the applicant provide validation for the utilization of the RESPECT computer program that generates the response spectrum from an acceleration time history for piping analysis. (resolved)

Description of Open Items

- RAI 407, Question No. 03.09.02-69: Requests additional design details of the core barrel flange, hold down spring, heavy reflector and flow distribution device. (resolved)

- RAI 407, Question No. 03.09.02-71: Requests that the applicant describe how manufacturing tolerances (e.g. reactor vessel ID) are addressed in the analysis. (resolved)

- RAI 422, Question No. 03.09.02-87: Requests the applicant to discuss how the reactor internals comprehensive vibration assessment program addresses the SRP provisions on vibration prediction, adverse flow effects, bias errors and uncertainties. (resolved)

- RAI 422, Question No. 03.09.02-99: Requests the applicant to provided justification for not including the loop acoustics in the lower internals numerical model. (resolved)

- RAI 422, Question No. 03.09.02-100: Requests the applicant to provide the anticipated frequency range and amplitude of the loop acoustic source and the basis of the estimates. (resolved)

Description of Open Items

- RAI 422, Question No. 03.09.02-101: Requests the applicant to justify not including the loop acoustics in the upper internals numerical model. (resolved)
- RAI 422, Question No. 03.09.02-103: Requests the applicant to explain why the additional fuel assembly mass will not impact the lower internals structural frequency and the justification for performing the hot functional test without the core installed. (resolved)
- RAI 422, Question No. 03.09.02-104: Requests additional information on the calculation method of viscous damping over a frequency band. (resolved)
- RAI 422, Question No. 03.09.02-107: Requests details of the flow-induced vibration analysis and measurement evaluation of the heavy reflector tie rods. (resolved)
- RAI 422, Question No. 03.09.02-108: Requests the applicant to discuss the method for combining bias errors and uncertainties and the effect of these on the overall stress and vibration response of the reactor internals.

Description of Open Items

- RAI 422, Question No. 03.09.02-112: Requests the applicant to discuss the application of frequency bias and uncertainty in the core barrel finite element analysis prediction and the lower internals small scale model setup details (resolved)

- RAI 422, Question No. 03.09.02-114: Requests details on the primary forcing function, inlet jets, reactor vessel downcomer and lower support plate to determine if the lower internals scale model pressure measurement is acceptable (resolved)

- RAI 422, Question No. 03.09.02-119: Requests the applicant to reconcile the discrepancies for the lower internals scale model test frequency results tabulated in the Comprehensive Vibration Assessment Program Technical Report ANP-10306P Section 4.2.4 (resolved)

- RAI 467, Question No. 03.09.02-161: Requests additional details on the FA finite element model to ensure that the FA loads are properly represented in the reactor internals isolated model under SSE and LOCA.

- RAI 503, Question No. 03.09.02-168: Requests the applicant to provide the list of all reactor internals components included or exclude in the reactor internals isolated model, and the design methodology of these components for SSE and LOCA events.

Description of Open Items

- RAI 508, Question No. 03.09.02-169: Requests the applicant to discuss the reactor vessel upper internals CFD models and the ROMEO tests which address the CFD model validation and the grid size sensitivity.

- RAI 522, Question No. 03.09.02-170: Requests documentation of the responses for Questions 03.09.02-68, 74, 88, 96, 113, 117, 122, 123, 144, and 150 in the FSAR or Technical Report ANP-10306P.

- RAI 404, Question No. 03.09.03-24: Requests that the applicant make available for audit, the ASME design specifications for all risk-significant mechanical components.

- RAI 404, Question No. 03.09.03-25: Requests that the applicant make available for audit, the design specifications for all ASME Code Class 1, 2, and 3 components and supports.

- RAI, 503, Question No. 03.9.03-26: Requests the applicant to revise FSAR Tier 2 Section 3.9.3 tables to provide the service load combinations for design pipe breaks.

Description of Open Items

- RAI 510, Question No. 03.09.05-28: Requests the applicant to provide, and include in the FSAR ,more information regarding the relevant flow induce vibration analyses of the in-core instrumentation supporting structures.
- RAI 510, Question No. 03.09.05-29: Requests the applicant to provide information about the design arrangement of the upper vessel internals and an evaluation of the potential effects of flow induced vibration and vortex shedding. (resolved)
- RAI 510, Question No. 03.09.05-30: Requests the applicant to revise the FSAR to provide design details associated with the inside of the control rod guide assemblies. (resolved)
- RAI 522, Question No. 03.09.05-31: Requests the applicant to include in the FSAR the figure which illustrates various clearances in the design of the core barrel radial support keys.
- RAI 381, Question No. 03.09.06-15: Requests the applicant to revise FSAR to specify use of ASME QME-1-2007 as accepted in RG 1.100 (Rev 3) for functional design and qualification of pumps, valves, and dynamic restraints (or describe the functional design and qualification process).

Description of Open Items

- RAI 381, Question No. 03.09.06-16: Requests that applicant clarify the reference in FSAR to ASME OM Code IST requirements for demonstrating design-basis capability of pumps an valves. (resolved)
- RAI 381, Question No. 03.09.06-17: Requests the applicant to specify in FSAR : MOV testing frequency, periodic testing of power operated valves (other than MOV's), and that AOV testing program attributes will be applied to other POV's where applicable. (resolved)
- RAI 381, Question No. 03.09.06-18: Requests the applicant to clarify several provisions for functional design, qualification, and IST for pumps, valves, and dynamic restraints, including FSAR Tier 2 Table 3.9.6-2. (not included in SER) (resolved)
- RAI 381, Question No. 03.09.06-19: Requests the applicant to confirm the IST provisions for specific valves listed in FSAR Tier 2 Table 3.9.6-2. (not included in SER)
- RAI 249, Question No. 03.11-14: Requests that the applicant provide updated temperature and pressure curves shown on FSAR Tier 2, Appendix 3D, Figures 3D-1 through 3D-2.

Technical Topics of Interest

Section 3.6.2 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping

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<u>Key Regulations and Review Guidance</u>

- GDC 4
- SRP Sections: 3.6.2 including BTP 3-4 and 3.6.1 including BTP 3-3
- Industry Standards: ANSI/ANS 58.2 (portions <u>no longer acceptable</u>)
  - Technical journal articles and reports
- 10 CFR 50.47(b)(1) - ITAAC

Technical Topics of Interest
Section 3.6.2 (continued)

SER Items of Interest

- Criteria used to define pipe break and crack locations and configurations
- Evaluation of jet impingement and pipe whip effects

  Potential nonconservative assessments of the jet impingement loads due to inaccuracies and omissions in ANS 58.2 identified by

  - ACRS (Wallis-ADAMS ML 050830344, Ransom- ADAMS ML 050830341)

Technical Topics of Interest
Section 3.6.2 (continued)

RAIs 03.06.02-6 through 03.06.02-13 and their associated supplemental RAIs address inaccuracies and omissions in ANSI/ANS 58.2

- Effects of blast waves
- Jet expansion modeling
- Jet pressure distribution
- Jet dynamic loading and structural dynamic response including potential feedback amplification of blowdown force and jet resonance effects

Technical Topics of Interest
Section 3.6.2 (continued)

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RAIs Status Summary:

- For jet dynamic effects, the staff found applicant's jet impingement assessments are conservative. However, their final documentation is pending, and remains a confirmatory item.

- For blast wave, the applicant is examining their plant design along with potential blast wave assessment. The blast wave issue remains an open item.

Actual postulated HELBs have:

- A powerful initial blast wave, particularly in enclosed spaces
- Jets that:
  - have plumes which depend strongly on source fluid properties, and properties in the external fluid region
  - Have spatial pressure distributions that vary throughout the plume
  - are dynamic, with strongly oscillating pressure fields

Technical Topics of Interest
Section 3.6.2 (continued)

To address Open Item 03.06.02-35 (blast wave effects), the applicant will:

- Examine the EPR plant layout to determine regions which must be assessed for blast wave effects
  - So far, it appears that only steam line ruptures are capable of generating blast waves
- Pursue software which assesses the time-varying loads induced by blast waves on target SSCs
  - To be validated against data in existing literature
  - Will consider effects of mesh discretization, time step size, and model inputs

Technical Topics of Interest
Section 3.6.2 (continued)

To address jet dynamic loading the applicant is:

- Referencing a technical report in their FSAR – “Pipe rupture external loading effects on US-EPR Essential Structures, Systems, and Components,” ANP-10318P
- Including a summary of their procedure in FSAR Tier 2, Section 3.6.2.4.1

The updates and report are not yet finalized, and remain a Confirmatory Item

Technical Topics of Interest
Section 3.6.2 (continued)

In their technical report and FSAR, the applicant:

- Provides a detailed, conservative procedure for assessing the dynamic response of SSCs and barriers/shields to oscillatory jet loads
- For a given break:
  - Source flow parameters are determined throughout the blowdown process using thermal-hydraulic codes such as RELAP and CRAFT2
  - Jet shapes are determined using thermodynamic analyses
  - Target SSCs are identified, including single jet reflections
  - Static initial impulses are applied to all target SSCs
  - Dynamic loads are applied to all SSCs within acceptable distances for two-phase and steam jets per the technical report

Technical Topics of Interest
Section 3.6.2 (continued)

<ins>In their technical report, the applicant (continued):</ins>

- Commits to protecting all lightly constructed SSCs
- Assesses the potential for resonance within an impinging jet:
  - Pressure ratio between source and ambient fluids must be less than 3.8 per literature (will occur in later stages of blowdown)
  - Source must be within 5 pipe diameters of target per literature (applicant assumes a greater distance for conservatism)
- In cases of resonance:
  - Computes bounding, worst-case oscillatory loads
    - Dramatically higher than loads cited in literature - conservative
  - Computes minimum jet resonance frequencies for given breaks

Technical Topics of Interest
Section 3.6.2 (continued)

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In their technical report, the applicant (continued):

- In cases of resonance:
  - Simple structures (pipe supports, whip restraints, jet shields) with resonance frequencies 40% below the jet loading frequency are evaluated using static calculations and dynamic load factors (DLFs)
  - All other structural modal responses with contributions up to a minimum of 500 Hz (plates/shells) and 95% of the peak modal response (beams) are assessed with FE stress modeling
    - Conservatively assumes all modal frequencies are coincident with jet frequency
    - Assumes damping 1% of critical
    - Stress convergence assured via convergence studies
    - Stresses evaluated against applicable standards

Technical Topics of Interest
Section 3.6.2 (continued)

<u>The applicant's jet loading approach is conservative:</u>

- Static and dynamic loads are considered throughout blowdown
- Dynamic loads, in case of resonance, are worst-case
  - In amplitude
  - In matching loading and structural modal frequencies
- Structural response will be converged, and uses conservative 1% damping
- Stresses assessed against applicable standards

Section 3.6.3
Leak-Before-Break (LBB) Design

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Overview

- LBB is part of piping design acceptance criteria (DAC)
- Use of LBB in DC applications
- Use of LBB for ALWRs discussed in SECY-93-087
- LBB review for EPR addressed PWSCC lessons learned

Section 3.6.3
Leak-Before-Break (LBB) Design

Presentation Outline

- Regulatory approach for reviewing leak-before-break (LBB) methodology
- Confirmatory Analysis of Leak-Rate Prediction Procedures
- Confirmatory Analysis of Flaw Stability Analyses Procedures in the Allowable Load Limit (ALL) Diagram
- Overall Conclusions on LBB

Technical Topics of Interest

Section 3.6.3
Leak-Before-Break (LBB) Design

Regulatory Requirements and Acceptance Criteria

- 10 CFR Part 50, Appendix A, GDC 4, "Environmental and dynamic effects design bases" states "….However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low with the design basis for the piping…"

- Safety margins for LBB analysis procedure
  - 10 on leak rate
  - 2 on crack size

Section 3.6.3
Leak-Before-Break (LBB) Design

Staff's Review of EPR LBB Methodology

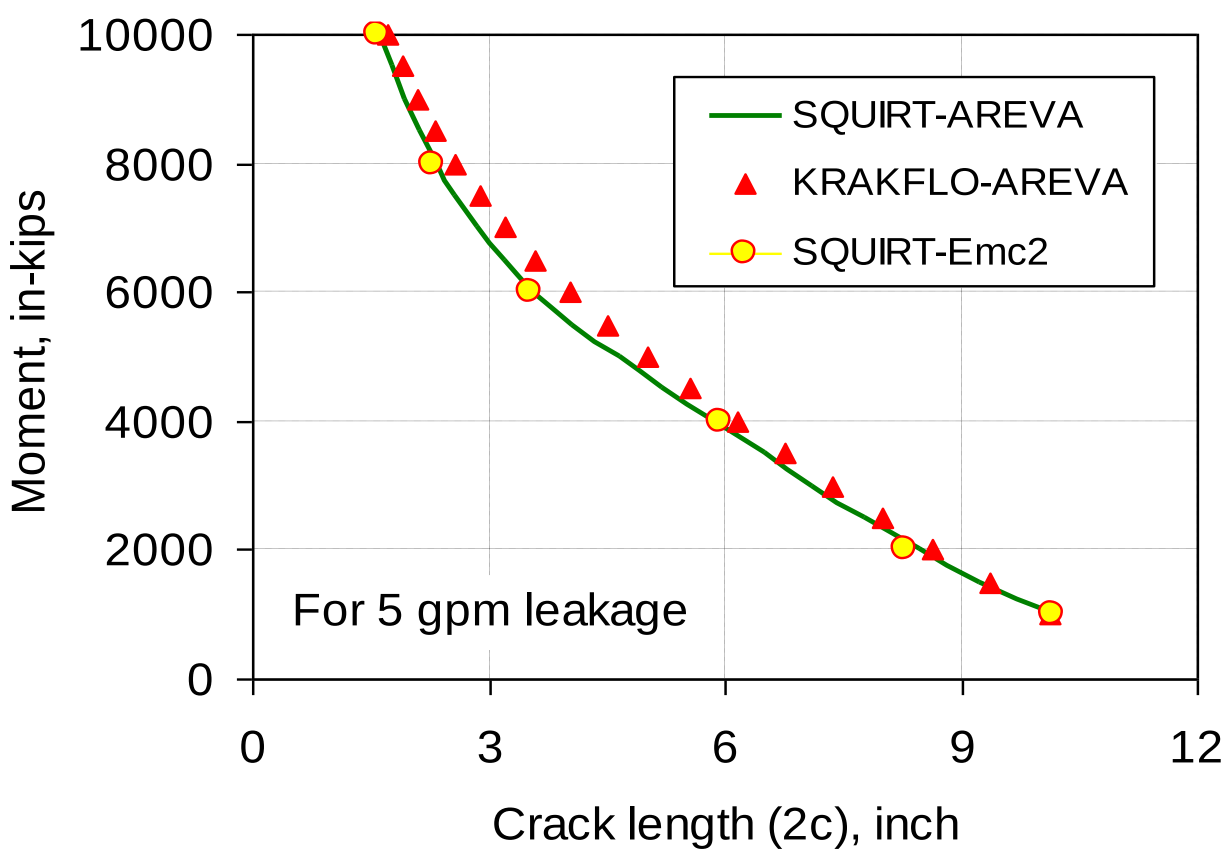
Allowable Load Limit (ALL) methodology was used to bound LBB criteria

- Water hammer, corrosion, creep, fatigue, erosion, environmental conditions, and indirect sources are extremely low causes of pipe rupture
- Deterministic fracture mechanics evaluation has been completed and approved by the staff
- Leak detection systems are sufficiently reliable, redundant, diverse and sensitive, and that margin exists to detect the through-wall flaw used in the deterministic fracture mechanics evaluation

Section 3.6.3
Leak-Before-Break (LBB) Design

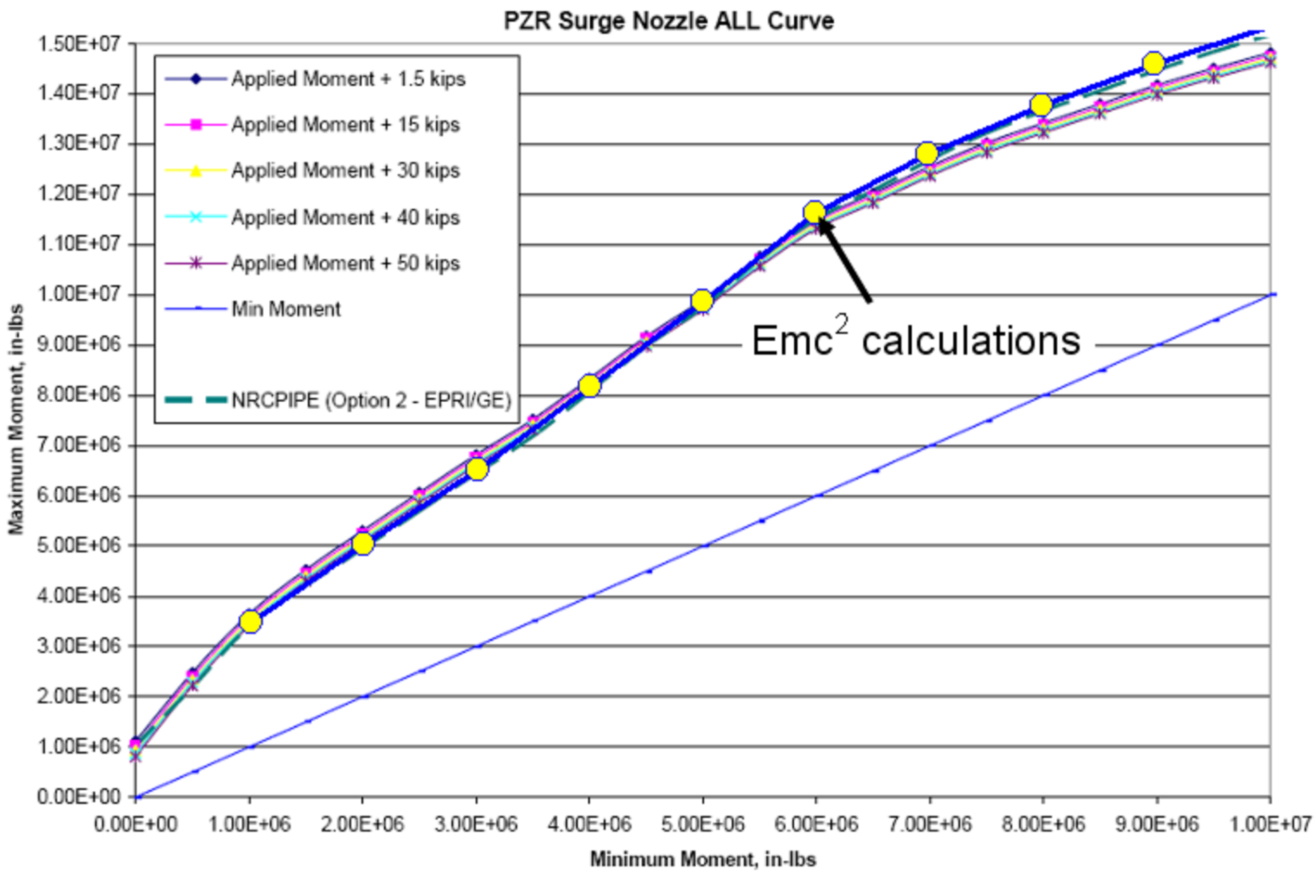
Review of Critical Technical Issues

Confirmatory Analysis of Leak-Rate Prediction Procedure



Review of Critical Technical Issues

Confirmatory Analysis of ALL Diagram for Surge-Line Case



Overall Conclusions on LBB

- The staff evaluation concludes on a design specific and piping system specific basis that the acceptance criteria are satisfied, and, therefore, that dynamic effects of pipe rupture may be eliminated from design consideration
- There is one Open Item on Section 3.6.3 LBB Analyses - RAI 467, Question 03.06.02-28

Technical Topics of Interest Section 3.7.1-Seismic Design Parameters

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Design Ground Motion

- Design Ground Motion is defined by three European Utilities Requirements (EUR) spectra representing soft, medium and hard soil sites plus an additional spectra representing a rock site.
- EUR spectra envelopes RG 1.60 spectra at all frequencies above 3.5 Hz (horiz.) and 0.65 Hz (vert.). The rock spectra envelopes RG 1.60 spectra at frequencies between 18 Hz to 70 Hz.
- Staff Evaluation: The response of Seismic Category I (SC I) structures is based on seismic input covering a broad frequency range. The staff finds the input spectra to be acceptable.

Percentage of Critical Damping Values

- Damping values follow RG 1.61 values except damping values for cable trays in the transverse direction which use 15% damping. Staff accepted 15 percent damping on the basis of testing done on tray systems which demonstrated damping values of 20% and higher.
- Development of in-structure response spectra for the Nuclear Island (NI) used RG 1.61 SSE structural damping instead of OBE damping.
    - Staff Evaluation: Additional information is needed regarding the state of stress in the NI to justify the used of SSE damping.
    - **Open Item:** RAI 370, Question 03.07.01-27 requested stress levels be provided which support the use of SSE structural damping.

Technical Topics of Interest Section 3.7.1-Seismic Design Parameters

Supporting Media for Seismic Category I Structures

- Multiple soil profiles used for seismic analysis of SC I structures
- Strain compatible shear wave velocities range from 700 ft./s to 9600 ft./s
- Most profiles include variation of properties with depth of soil
- Staff Evaluation: Soil profiles provide a broad range of properties for determining design loads/ISRS and are acceptable.

Technical Topics of Interest
3.7.2-Seismic System Analysis

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Seismic Analysis Methods

- Includes time history analysis, response spectrum, and complex frequency response methods.
- Complex frequency response used for seismic analysis of SC I structures and the Nuclear Auxiliary Building (NAB).
- Response spectrum method is used for slab analysis of the NAB and for the vent stack (SC1).
- Time history used to develop seismic loads on mat and for stability analysis of NAB.
- Staff Evaluation: Methods used are appropriate and acceptable

Technical Topics of Interest
3.7.2-Seismic System Analysis

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Procedures Used for Analytic Modeling

- Finite element models (FEMs) are used to represent dynamic behavior of SC I structures
- Staff Evaluation:
- Staff asked for verification that modeling of the NI mat/superstructure interface was an accurate representation of the actual building stiffness
- **Open Item**: RAI 371, Question No. 03.07.02-66(b) requested demonstration of modeling compatibility at the NI mat/superstructure interface
- Staff asked for demonstration of dynamic compatibility between SASSI FEM of the NI and ANSYS FEM upon which the SASSI model is based.
- **Open Item**: RAI 371, Question 03.07.02-67 requested comparison of dynamic responses between SASSI model and ANSYS model

Technical Topics of Interest
3.7.2-Seismic System Analysis

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Soil Structure Interaction

- Seismic analysis of SC I structures is performed using the subtraction method option of the SASSI computer code
- Dynamic models account for the embedment of each structure.
- Structure-soil-structure interaction effects due to NI seismic response are included in the analysis of structures not supported on the NI common basemat.
- Staff Evaluation:
  - The tendon gallery extends below the bottom of the NI common basemat and acts as a shear key during a seismic event.
  - **Open Item:-**RAI 371, Question No. 03.07.02-66 requested it be confirmed that stresses within the shear key meet code allowables.
  - Questions have been raised by the Defense Nuclear Safety Board regarding the use of the subtraction method for SSI analysis.
  - **Open Item**:-RAI 489, Question No. 03.07.02-75 requested a demonstration that the subtraction method provides results that are comparable to, or exceed, the results using the direct method of analysis.

Technical Topics of Interest 3.7.2-Seismic System Analysis

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Interaction of Non-SC I Structures with SC I Structures

- Non-SC I structures which could interact with SC I structures are the NAB, Access Building (AB) and the Turbine Building (TB)
- Design of the AB and TB are the responsibility of the COL applicant
- COL applicant must demonstrate the seismic response of AB and TB will not impair the ability of SC I SSC's to perform their design basis safety functions
- NAB is designed to have the same seismic margin of safety as that of a SC I structure. Sliding or uplift is allowed providing there is no interaction with an adjacent SC I structure.
- Staff Evaluation:
  - Requirements for the AB and TB are acceptable to the staff
  - Regarding the NAB, the staff is waiting for the results of an NAB seismic analysis which needs to demonstrate there is no interaction between the NAB and adjacent SC I structures
  - **Open Item**: RAI 370, Question No. 03.07.02-64 requested the results of the stability analysis for the NAB

Technical Topics of Interest
3.7.2-Seismic System Analysis

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Determination of Dynamic Stability of SC I Structures

- Seismic demands for SC I structures are determined from the SASSI SSI analysis
- Hydrodynamic forces and vertical seismic response is included in the stability evaluation
- Restoring forces include the dead weight of a structure and passive side-wall soil pressures
- The review of computed factor's of safety against sliding and overturning is covered in Section 3.8.
- Staff Evaluation: The methods used for stability analysis are acceptable to the staff

Technical Topics of Interest 3.7.3-Seismic Subsystem Analysis

- Methods of analysis include response spectrum, time history and equivalent static load methods.
- Response spectra development meets RG 1.122 guidance
- Three directions of earthquake motion are considered in accordance with RG 1.92
- Analysis of above ground tanks meets the guidance of SRP 3.7.3
- Staff Evaluation: Methods for subsystem analysis meet RG’s and SRP acceptance criteria and are acceptable to the staff.

Technical Topics of Interest
3.8 Design of Cat. I Structures

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3.8.1 and 3.8.2 Containment – "Critical Sections"

- Initial staff review found no documented criteria for identification of critical sections (applicable to all 3.8 sections)
- Applicant developed detailed methodology for selection of critical sections
- Screening of all Cat. I structures based on complementary three-tiered criteria
  - Qualitative: selects safety-critical sections
  - Quantitative: numerical algorithm selects most highly stressed sections
  - Supplemental: engineering judgment to select sufficiently representative sections
- List of critical sections provided
- Staff Evaluation
  - Acceptable systematic methodology results in appropriate combination of safety-critical, highly stressed, and different types of sections of Cat. I structures within NI and beyond NI
- Open Items
  - Design of critical sections remains to be completed

Technical Topics of Interest
3.8 Design of Cat. I Structures

3.8.1 and 3.8.2 Containment – Design and Analysis Procedures

- Issues regarding design and analysis procedures arising from initial review (applicable to all 3.8 sections)
  - Nonlinear FE model of NI (uplift of basemat, trilinear soil springs) inconsistent with code-based linear design process
  - 100-40-40 directional combination method for seismic loads not applicable to nonlinear analysis
  - Unjustified equivalent-static seismic analysis method with “modification factors” less than 1.0
  - Staff confirmatory seismic analysis of RBIS demonstrated that the method of analysis (3rd bullet above) is not acceptable
- Staff Evaluation - Applicant made acceptable modifications to design/analysis procedures
  - Superstructure design based on linear model
  - Basemat model (nonlinear uplift, linear soil springs, time-history seismic analysis)
  - 3-directional seismic loads combined with SRSS rule (superstructure model) and algebraic summation (basemat model)
  - Eliminated 100-40-40 rule and “modification factors”

Technical Topics of Interest
3.8 Design of Cat. I Structures

U.S.NRC
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3.8.1 and 3.8.2 Containment – Other technical issues

- Inadequate evaluation of RCB integrity for hydrogen generation/burn event (75 psi, greater than design pressure 62 psi)
- Concrete cracking effects not adequately accounted for in determining seismic loads and DBA temperature/pressure loads
- ISI program for RCB grouted post-tensioning system inconsistent with RG 1.90 (different pressure test schedule, no force-monitoring of ungrouted test tendons, limited U.S. NPP experience)
- Lack of design details for RCB major steel penetrations
  - airlocks
  - equipment hatch
  - construction opening
  - fuel transfer tube

Technical Topics of Interest
3.8 Design of Cat. I Structures

3.8.1 and 3.8.2 Containment – Resolution of other technical issues

- Staff Evaluation
  - Additional nonlinear FE analyses of RCB (including steel penetrations) demonstrated integrity for hydrogen generation/burn event
  - Additional FE analyses with explicit modeling of concrete cracking demonstrated seismic loads conservative and RCB design sufficiently robust for possible DBA pressure/temperature force redistributions
  - Design RCB grouted post-tensioning system follows ASME Code, RG 1.90 (ISI program), and RG 1.107 (grouting procedures) without exceptions
  - Applicant completed design of RCB major steel penetrations

Technical Topics of Interest
3.8 Design of Cat. I Structures

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3.8.3 Containment Internal Structures

- RBIS structure not physically anchored to RCB but included in global FE model of NI (appropriate modeling of global loads and load transfer)
- RBIS sub-models used in analysis/design for localized abnormal loads
- Initial review identified incomplete evaluation of
  - RBIS seismic overturning stability
  - Integrity of liner plate from potential RBIS uplift/rocking/impact
- Nonlinear FE analysis of RBIS demonstrated minimal uplift, bearing pressures on surrounding RCB within code limits, and demonstrated integrity of liner plate (minimal strains)
- Open Item
  - Staff review of analysis methodology for localized abnormal loads to be completed during review of critical section design

Technical Topics of Interest
3.8 Design of Cat. I Structures

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3.8.4 Other Cat. I Structures
Review of Fuel Rack Structural Analysis and Design (Technical Report TN-Rack.0101)

- Spent fuel racks
  - Free standing, submerged in spent fuel pool
  - Aluminum cell tube assembly supported vertically by a bottom base plate with legs and horizontally by a stainless steel frame
  - 17 racks: range between 7x8 to 10x9 tubes per rack
- New fuel racks
  - Laterally braced to NFS vault structure, not submerged in water
  - 2 racks: 7x8 and 8x8 tubes per rack
- Challenges in seismic analysis of spent fuel racks due to highly nonlinear response
  - Sliding, tipping, impact with spent fuel pool walls and floor, impact between racks
  - Fluid-structure interaction
  - Friction between rack legs and spent fuel pool floor
  - Fuel assemblies may rattle inside tubes and impact tube walls
  - Series of LS-DYNA analyses with whole pool multi-rack model (all racks) and individual rack model (used for design)

Technical Topics of Interest
3.8 Design of Cat. I Structures

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3.8.4 Other Cat. I Structures
Review of Fuel Rack Structural Analysis and Design (Cont.)

- **Staff Evaluation**
  - Seismic analyses adequately account for range of base friction coefficients between 0.2 and 0.8
  - Whole pool multi-rack model did not account for interaction between fuel assemblies, water, and tube cell walls
    - Justification needed to demonstrate adequacy of representing fuel assemblies and water inside tube cells by simply lumping the fuel assembly and water mass onto the tube cell walls
  - Effects of tolerances on gaps (e.g., rack to rack and rack to wall) in the seismic analyses were not considered
    - Gap tolerances affect magnitude of hydrodynamic coupling between components and impact forces
  - Stress results for some key structural elements (e.g., aluminum cell tubes, support legs, and rack corner angles) were not provided

Technical Topics of Interest
3.8 Design of Cat. I Structures

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3.8.4 Other Cat. I Structures
Review of Fuel Rack Structural Analysis and Design (Cont.)

- **Open Items**
  - Applicant will modify whole pool multi-rack model to include a simplified representation of the fuel assembly inside the tube cells with water and an additional analysis will be performed for comparison with the existing approach
  - Applicant will perform additional study to evaluate the effects of variation in gaps between components on the seismic response of the racks
  - Applicant will provide additional stress results for key structural components

Technical Topics of Interest
3.8 Design of Cat. I Structures

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3.8.5 Foundations of Cat. I Structures – Seismic Sliding/Overturning Stability Analysis of NI, EPGB, and ESWB

- Methodology for stability analysis described in Sect. 3.7 discussion
- Coefficient of friction limited to 0.5 for sliding
- Incorporated tendon gallery as shear key for NI basemat
- Shear keys credited for sliding analysis of EPGB basemat
- Increased dimensions of ESWB basemat to satisfy stability criteria
- Time-dependent Factors of Safety found to be equal to or greater than 1.1
- Staff Evaluation
  - Stability evaluation acceptable for NI and EPGB
- Open Items
  - Stability analysis of ESWB remains to be completed

Technical Topics of Interest

3.8 Design of Cat. I Structures

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3.8.5 Foundations of Cat. I Structures – Differential Soil Settlements and Construction Sequence

- Design of Cat. I foundations needs to account for loads induced by construction sequence and differential soil settlements
- Applicant developed acceptable design criteria and guidance for COL applicants to ensure loads induced by site-specific conditions are bounded by those postulated in the generic design (pre and post-construction phases)
- Postulated construction sequence and soil conditions determine induced loads considered in design (added as separate load cases)
- Detailed guidance for COL applicants
  - Settlement profiles at different construction and post-construction phases added to FSAR
  - Specific guidance for COL applicants to estimate site-specific settlement profiles (based on site-specific soil conditions and actual construction sequence) and compare with settlement profiles in FSAR
  - COL applicants to implement settlement monitoring program

<u>3.8.5 Foundations of Cat. I Structures - Resolution of other technical issues</u>

- Applicant adequately considered seismic soil pressures on sidewalls
  - SSI analysis
  - ASCE 4-98 (Wood's elastic solution)
  - passive pressure capacity of the soil
- Applicant will evaluate soil bearing pressures under basemats to capture Boussinesq effects (stiffer edges, softer interior)
- Open Items
  - Static and dynamic soil bearing pressures under basemats and dynamic soil pressures on sidewalls and shear keys for NI, ESWB, and EPGB remains to be completed

ACRONYMS

U.S.NRC
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- AB - Access Building
- ALWR - Advanced Light Water Reactor
- ANS - American Nuclear Society
- AOV - Air Operated Valve
- ASCE - American Society of Civil Engineers
- ASME - American Society of Mechanical Engineers
- ASTM - American Society for Testing and Materials
- BTP - Branch Technical Position
- CFD - Computational Fluid Dynamics
- COL - Combined License
- DAC - Design Acceptance Criteria
- DBA - Design-Basis Accident
- D-RAP - Design Reliability Assurance Program
- EPGB - Emergency Power Generating Buildings
- ESWB - Essential Service Water Buildings
- FE - Finite Element
- FSAR - Final Safety Analysis Report
- GDC - General Design Criteria
- HELB - High Energy Line Break
- ISI - Inservice Inspection
- ISRS - Instructure Response Spectra
- IST - Inservice Testing

ACRONYMS

- ITAAC - Inspections, Tests, Analyses, and Acceptance Criteria
- LOCA - Loss of Coolant Accident
- MOV - Motor Operated Valve
- NAB - Nuclear Auxiliary Building
- NFS - New Fuel Storage
- NI - Nuclear Island
- NPP - Nuclear Power Plant
- OBE - Operating Basis Earthquake
- OM - Operations and Maintenance
- PRA - Probabilistic Risk Assessment
- PWSCC - Primary Water Stress Corrosion Cracking
- QME - Qualification of Active Mechanical Equipment
- RAI - Request for Additional Information
- RBIS - Reactor Building Internal Structures
- RCB - Reactor Containment Building
- RG - Regulatory Guide
- SASSI - Structural Analysis Software System Interface
- SER - Safety Evaluation Report
- SSC- Structures, Systems, and Components
- SSE - Safe Shutdown Earthquake

Backup

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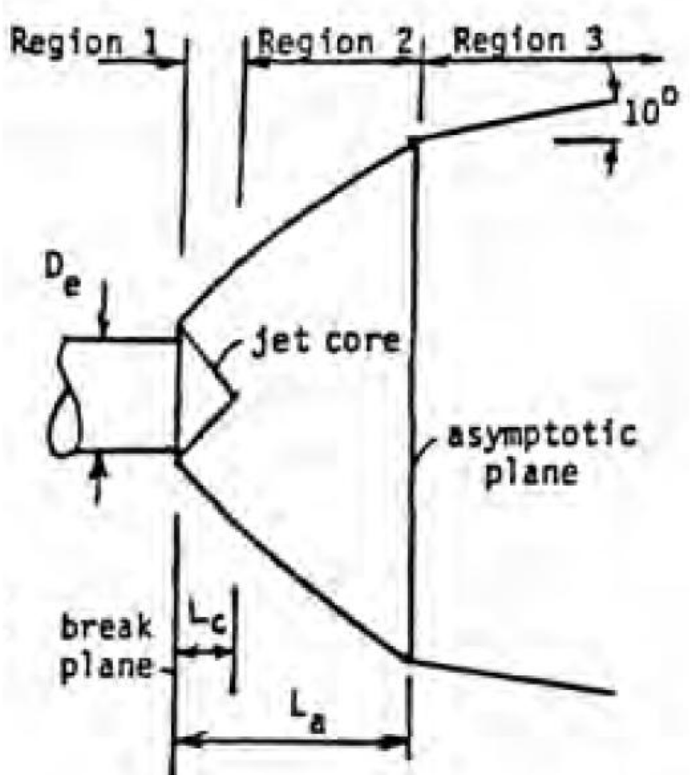
ANS 58.2 Standard

- Ignores initial blast waves
- Treats all jets as:
  - Having uniform plume expansion shapes
    - Non expanding incompressible plume remains constant with distance from source; compressible plume expands at 10 degree half angle
    - Expanding plume has rapid expansion until 'asymptotic plane' (where pressure is assumed to be atmospheric), and 10 degree expansion angle afterward
  - Having simplified spatial pressure distributions along the plume, with peak pressures at the centerline
  - Static (except for rise time at beginning of postulated HELB)



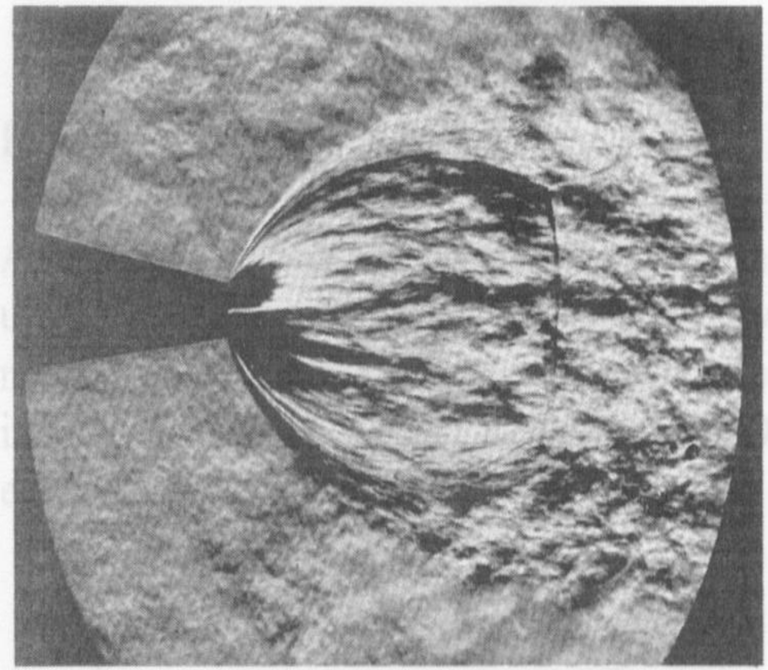
Technical Topics of Interest
Section 3.6.2 (backup)

Blast Waves:

- Short duration transient pressure waves which may be analyzed separately from the ensuing jets
- NEA/CSNI/R (95) 11: Knowledge Base for Emergency Core Cooling System Recirculation Reliability (Feb 1996) repeatedly cites blast waves have caused significant damage in several large scale reactor LOCA tests

Jet Plumes:

- For high source pressure/external pressure ratios
    - similar to those at the beginning of a HELB
    - In this example, a shock wave appears at about 10 L/D (plume distance/jet opening diameter)
        - Not considered in ANS 58.2, which assumes static, and simplified pressure distribution



Schlieren photograph of a jet of air issuing from an axially symmetric convergent nozzle. The Mach number at the exit from the nozzle is unity. The pressure at the exit is 105 times the outside pressure. (Courtesy of NASA Langley Research Center, Va.)

From Wallis and originally from Owczarek

Technical Topics of Interest
Section 3.6.2 (backup)

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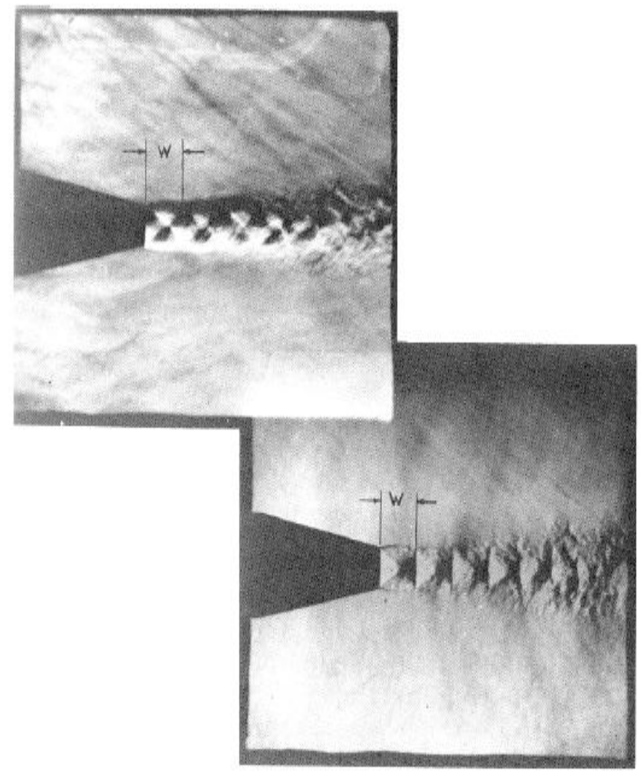
Jet Plumes:

- For low source pressure/external pressure ratios
  - Similar to conditions at the end of a HELB blowdown
  - Jets can travel a long distance near end of blowdown
  - Note multiple shock wave patterns in cross section
- Conclusion: jet plumes vary significantly throughout a HELB blowdown



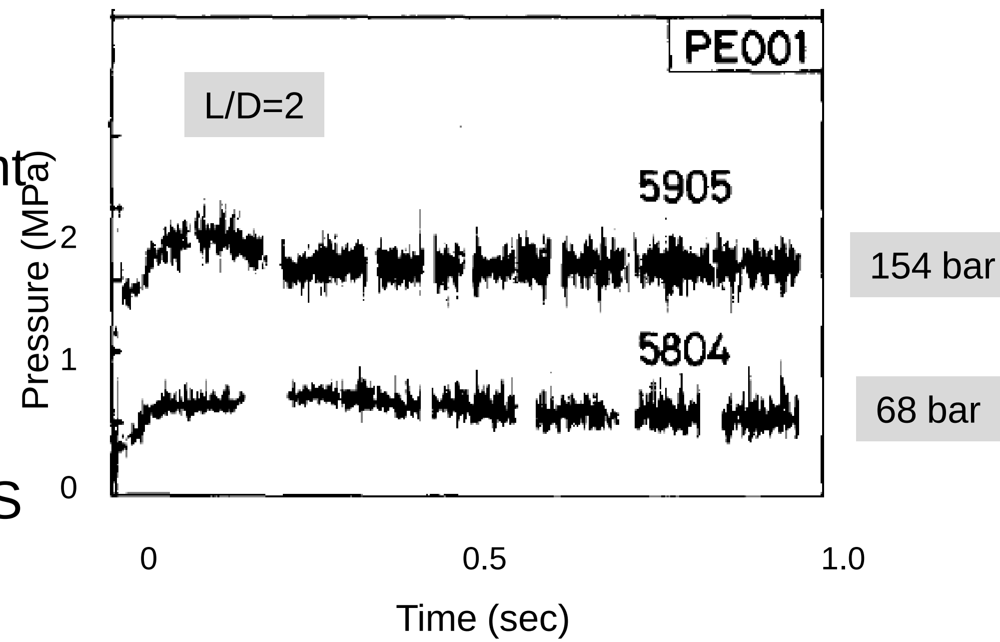
Diamond wave patterns from an axisymmetric free jet (similar to the exhaust from a rocket engine). Taken from E. S. Love, C. E. Grigsby, L. P. Lee, and M. J. Woodling, "Experimental and Theoretical Studies of Axisymmetric Free Jets," NASA Tech. Report No. TR R-6, 1959. *W* is the wavelength of the first diamond.

From Wallis, and originally from Anderson

Technical Topics of Interest
Section 3.6.2 (backup)

Jet Loading:

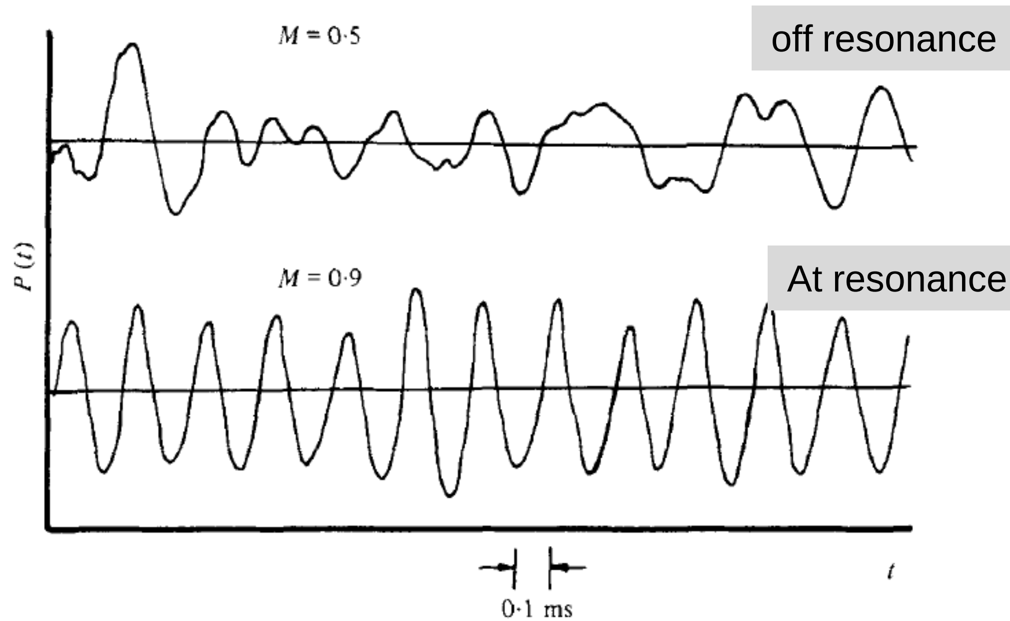
- Pressures impinging on surfaces are dynamic
  - Dynamic pressures oscillate about the mean impingement pressure at discrete frequencies
  - To date, dynamic pressures have been ignored in HELB assessments which use ANS 58.2



From Isozaki and Miyazono, Nuc. Eng. & Des., 96 (1986), based on Japan AERI sponsored measurements

Jet Loading:

- Dynamic pressures can also be amplified by factors of 2-3 (or perhaps more) when at resonance
  - Resonance occurs when flow speed and distance from the jet opening align at key frequencies fd/U (varies between about 0.3 and 0.5)
  - Literature indicates significant resonance only occurs for L/D < 10



From Ho and Nosseir, J. Fluid Mech., 105 (1981), Dynamics of an impinging jet: The feedback phenomenon

Technical Topics of Interest
Section 3.6.2 (backup)

Jet Loading:

- Structures can be damaged significantly by dynamic loading, particularly when structural resonances are aligned with the loading frequency(s)

Technical Topics of Interest
Section 3.6.2 (backup)

Selected Technical Journal Articles and Reports:

- Wallis, G., "The ANSI/ANS Standard 58.2-1988: Two-Phase Jet Model," ADAMS ML050830344, (15 Sep 2004)
- Ransom, V., "Comments on GSI-191 models for debris generation," ADAMS ML050830341, (15 Sep 2004)
- NEA/CSNI/R (95) 11: "Knowledge Base for Emergency Core Cooling System Recirculation Reliability" (Feb 1996)
- Joint Reactor Safety Experiments in the Marviken Power Station, Sweden, Summary Report: The Marviken Full Scale Jet Impingement Tests, 4th Series, Sponsored by numerous international organizations including the US-NRC, (March 1982)
- Ho and Nosseir, J. Fluid Mech., 105, "Dynamics of an impinging jet: The feedback phenomenon" (1981)

1. Isozaki and Miyazono, Nuc. Eng. & Des., 96, "Experimental study of jet discharging test results under BWR and PWR loss of coolant accident conditions" (1986)

Presentation to ACRS U.S. EPR Subcommittee Design Certification Application FSAR Tier 2 Section 9.1 Fuel Storage and Handling

February 22, 2012

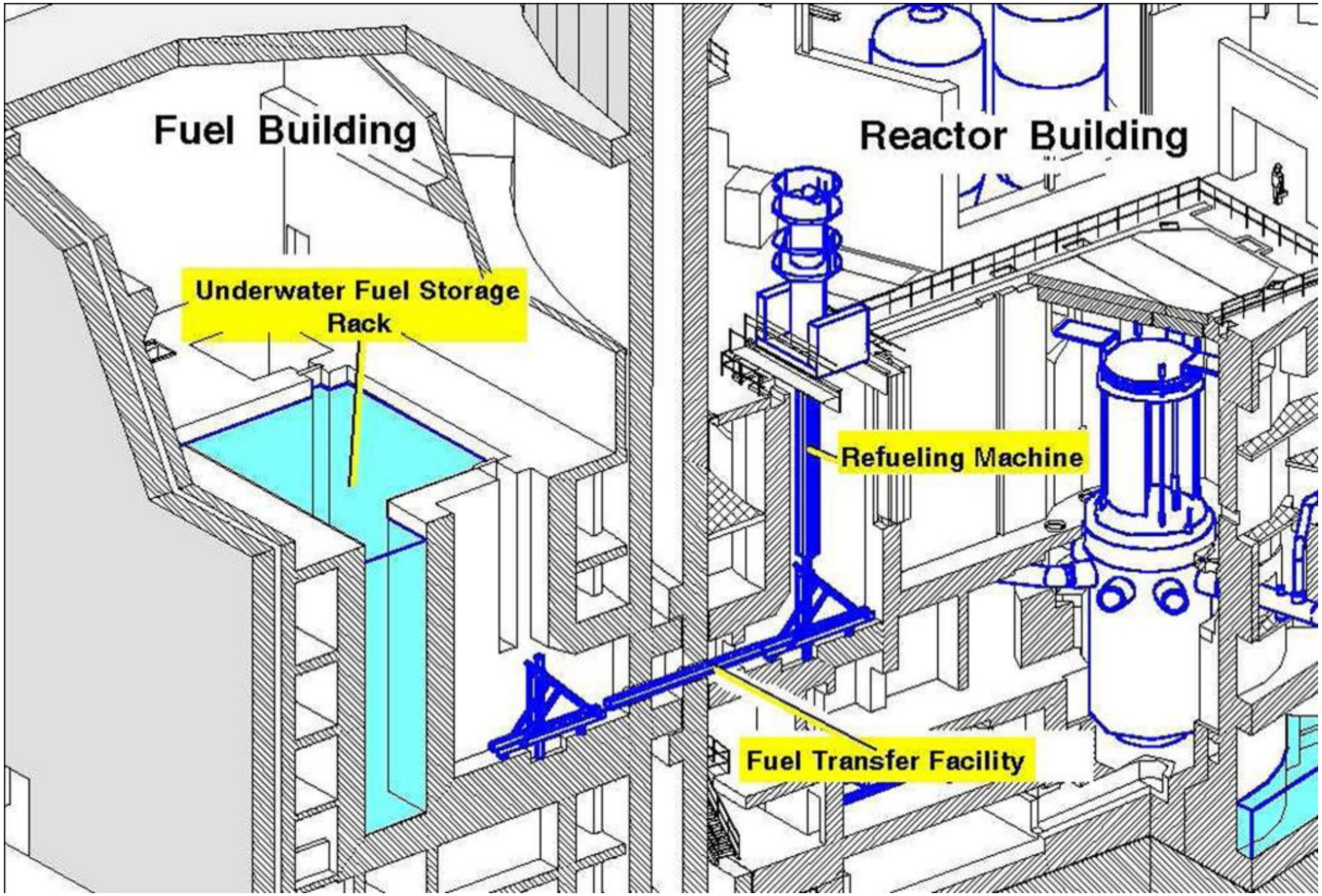
Section 9.1 ACRS Meeting Outline

Topic	Presenter
Overview of U.S. EPR Fuel Storage and Handling System (Section 9.1.1)	P. Thallapragada
Spent Fuel Cask Transfer Facility (Section 9.1.4)	P. Thallapragada
Overview of Fuel Racks (Sections 9.1.1 and 9.1.2)	I. McInnes
Fuel Pool Cooling and Purification System (Section 9.1.3)	G. Ifebuzo
Prevention and Mitigation of Fuel Building and Reactor Building Pool Drain Down (Sections 9.1.2, 9.1.3 and 9.1.4)	D. Newton
Overhead Heavy Load Handling System (Section 9.1.5)	R. Parler

Section 9.1.1
Overview of U.S. EPR Fuel Storage and Handling System

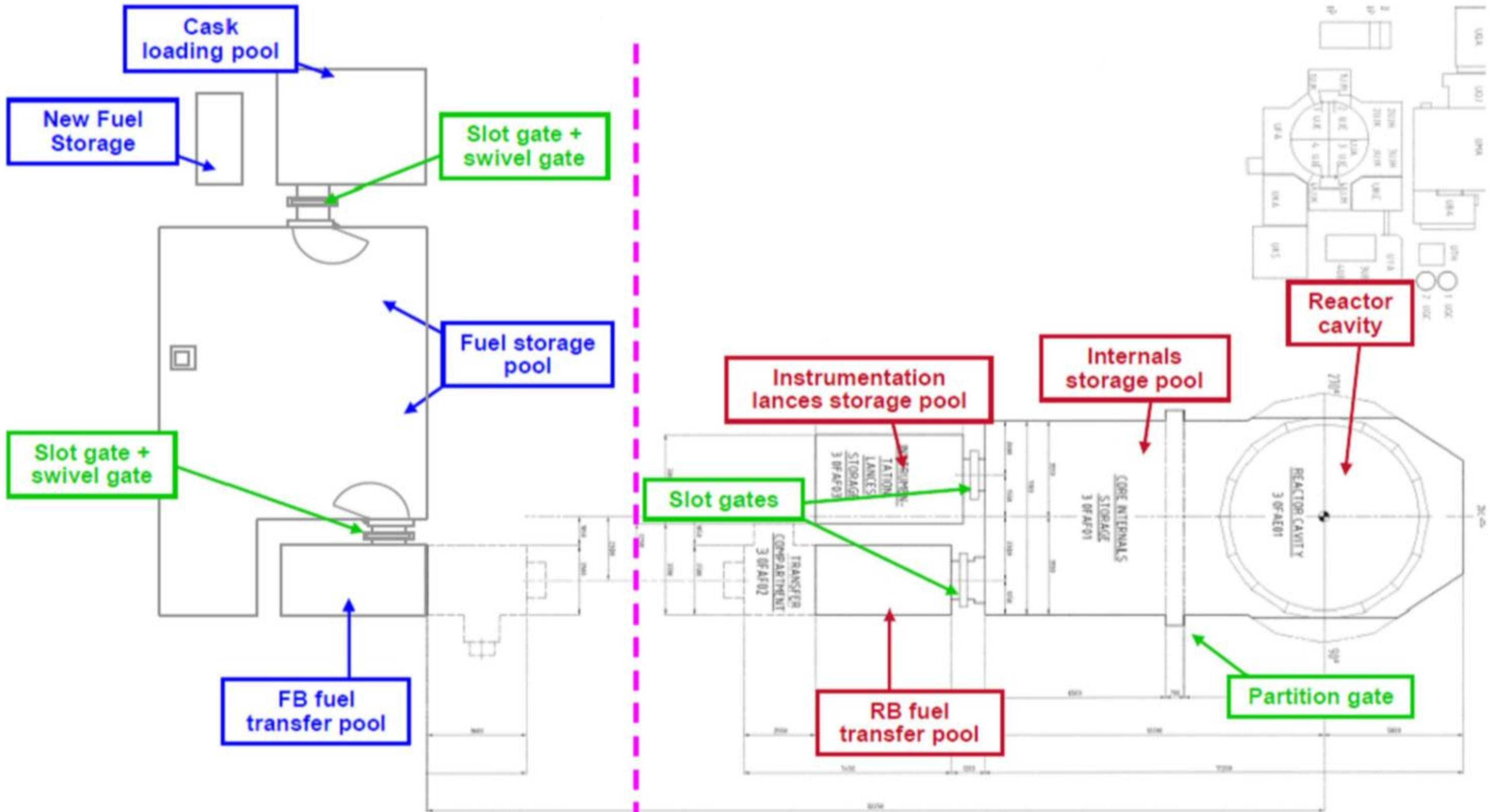
Pavan Thallapragada

Overview of the Fuel Storage and Handling System

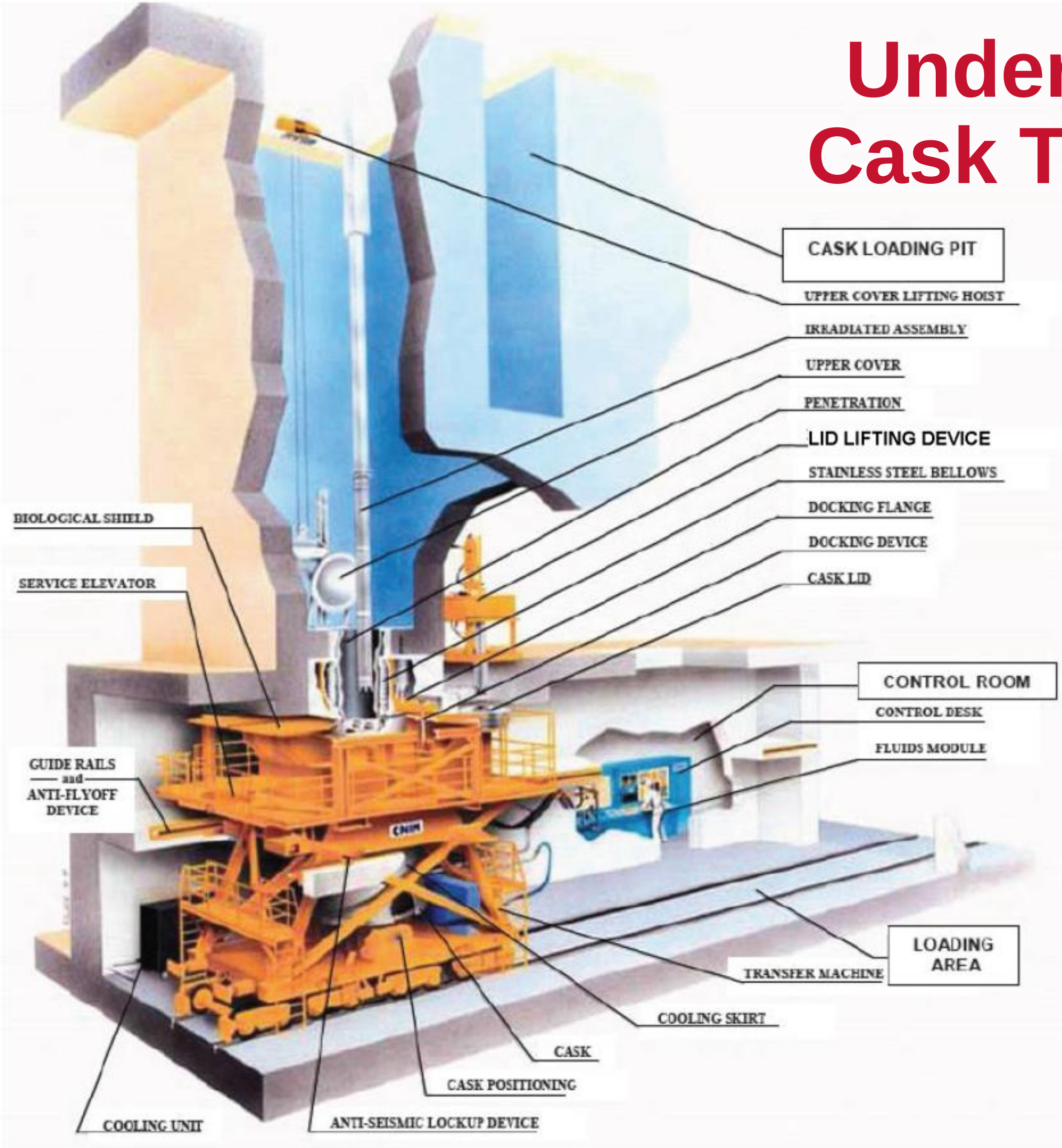


Similar to Current PWR Operating Plants

Overview of the Fuel Storage and Handling System



Under Pit Spent Fuel Cask Transfer Facility



Design is Unique to the U.S. EPR

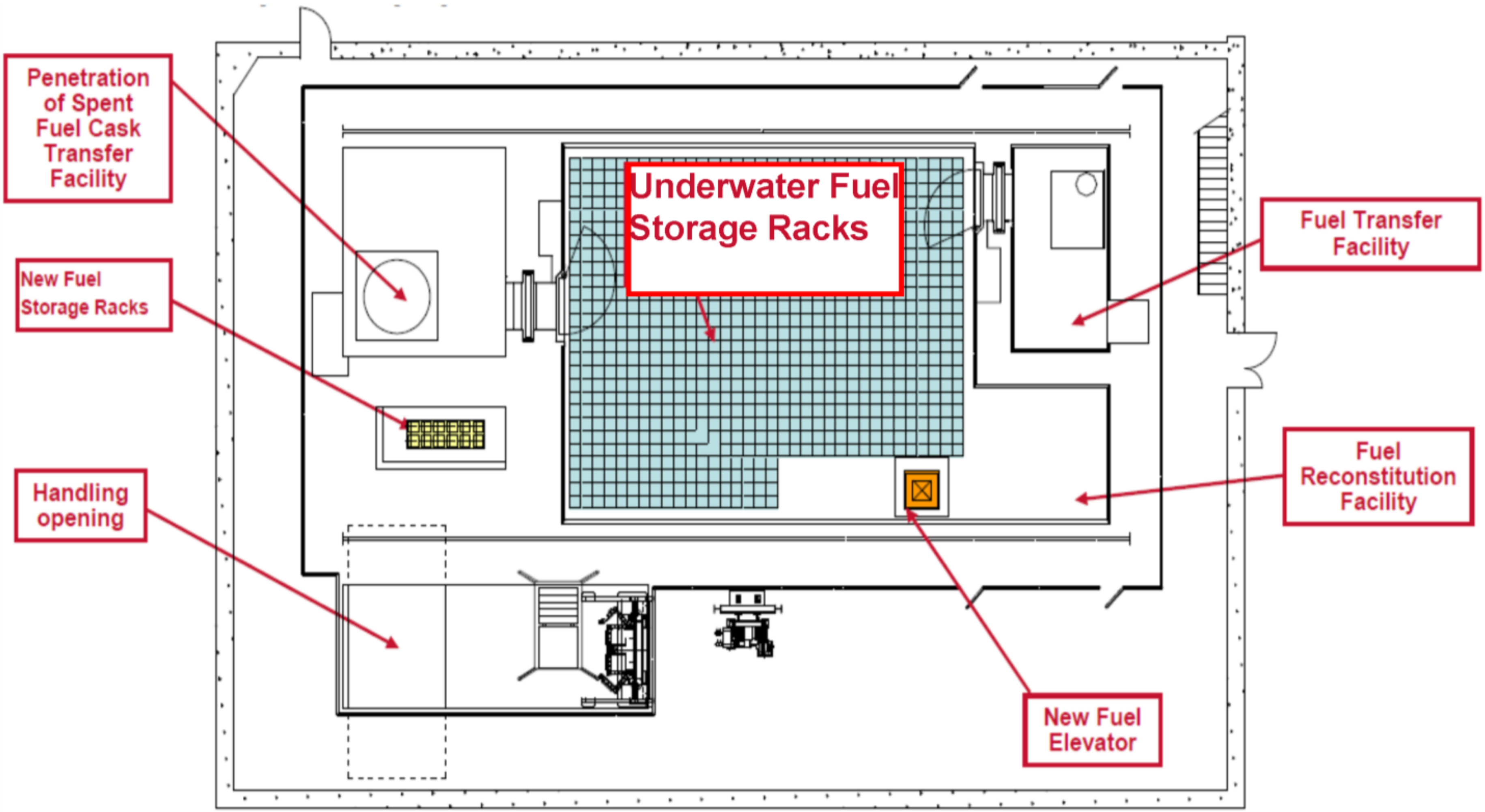
Design Bases

- The following major components are safety-related and designed to Seismic Category I requirements:
  - New and spent fuel storage racks
  - Transfer tube, isolation devices and expansion joints
  - Cask loading pit (CLP) penetration assembly
  - Spent Fuel Cask Transfer Machine (SFCTM)
  - Spent Fuel Cask Transfer Facility (SFCTF) fluid and pneumatic systems, up to isolation devices
- The design of the fuel handling system conforms to the requirements of GDC 2, 5, 61 and 62.
- Fuel handling components are designed based on ANSI/ANS 57.1, “Design Requirements for Light Water Reactor Fuel Handling Systems.”
  - Prevention of criticality, protection from physical damage to the fuel assemblies and radiological protection

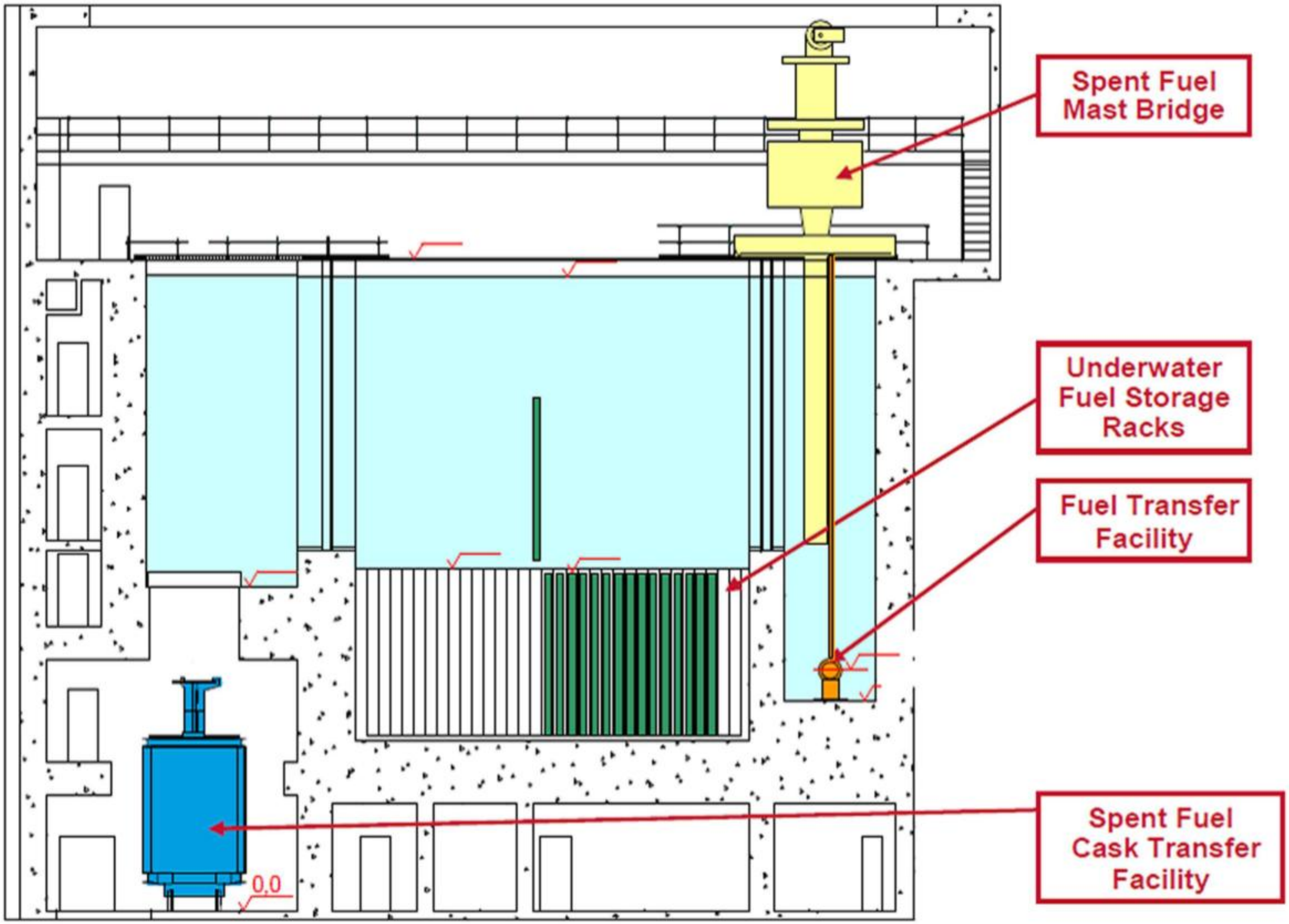
Section 9.1.4
Spent Fuel Cask Transfer Facility

Pavan Thallapragada

Fuel Building Layout



Fuel Building Section



Spent Fuel Cask Transfer Facility Overview

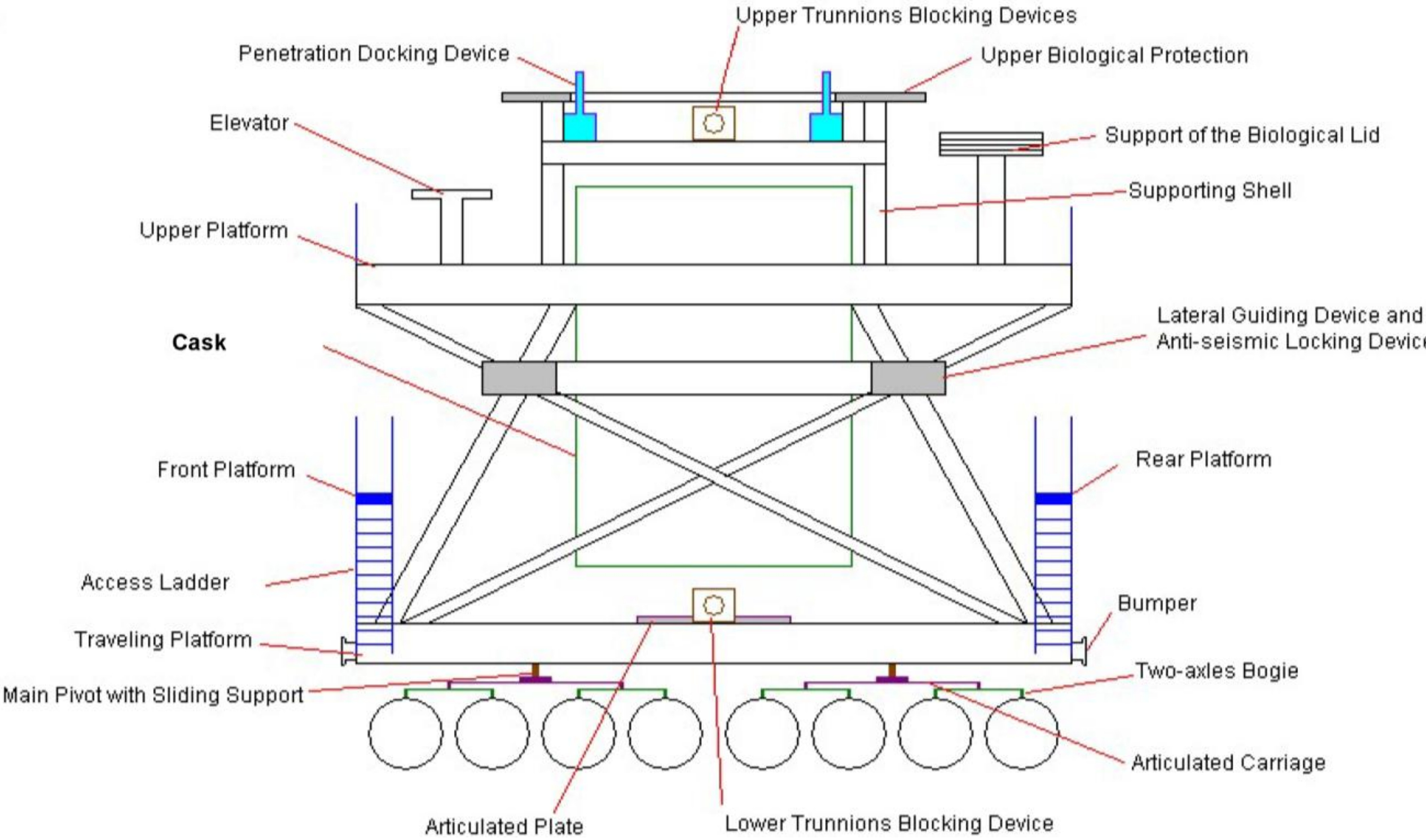
- **The SFCTF primarily consists of :**
  - **SFCTM**
  - **CLP penetration assembly**
  - **SFCTF fluid and pneumatic systems**

- **Operations are conducted at the following stations:**
  - **Lifting station**
  - **Handling opening station**
  - **Biological lid handling station**
  - **Penetration station**

SFCTM Description

- **The SFCTM is a trolley which moves on rails**
  - **Main purpose is to carry the cask in vertical position between the lifting station and the three workstations in the loading hall.**
- **Safety-related function:**
  - **During cask loading, the SFCTM serves as part of the cask loading pit fluid boundary structural support when the cask is docked with the cask loading pit penetration to prevent draining the spent fuel pool (SFP), including during and following a Safe Shutdown Earthquake (SSE).**

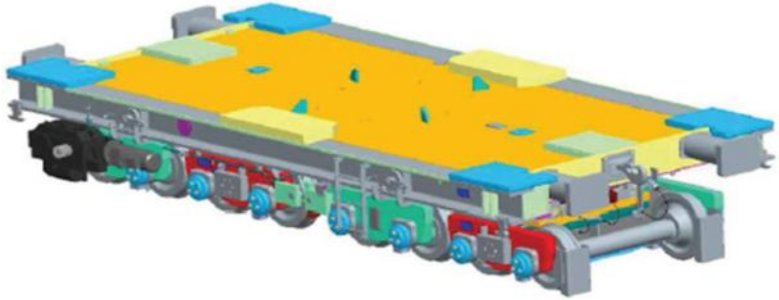
SFCTM



Upper Trunnions Blocking Devices
Penetration Docking Device
Upper Biological Protection
Elevator
Support of the Biological Lid
Supporting Shell
Upper Platform
Cask
Lateral Guiding Device and
Anti-seismic Locking Device
Front Platform
Rear Platform
Access Ladder
Bumper
Traveling Platform
Two-axles Bogie
Main Pivot with Sliding Support
Articulated Carriage
Articulated Plate
Lower Trunnions Blocking Device

SFCTM

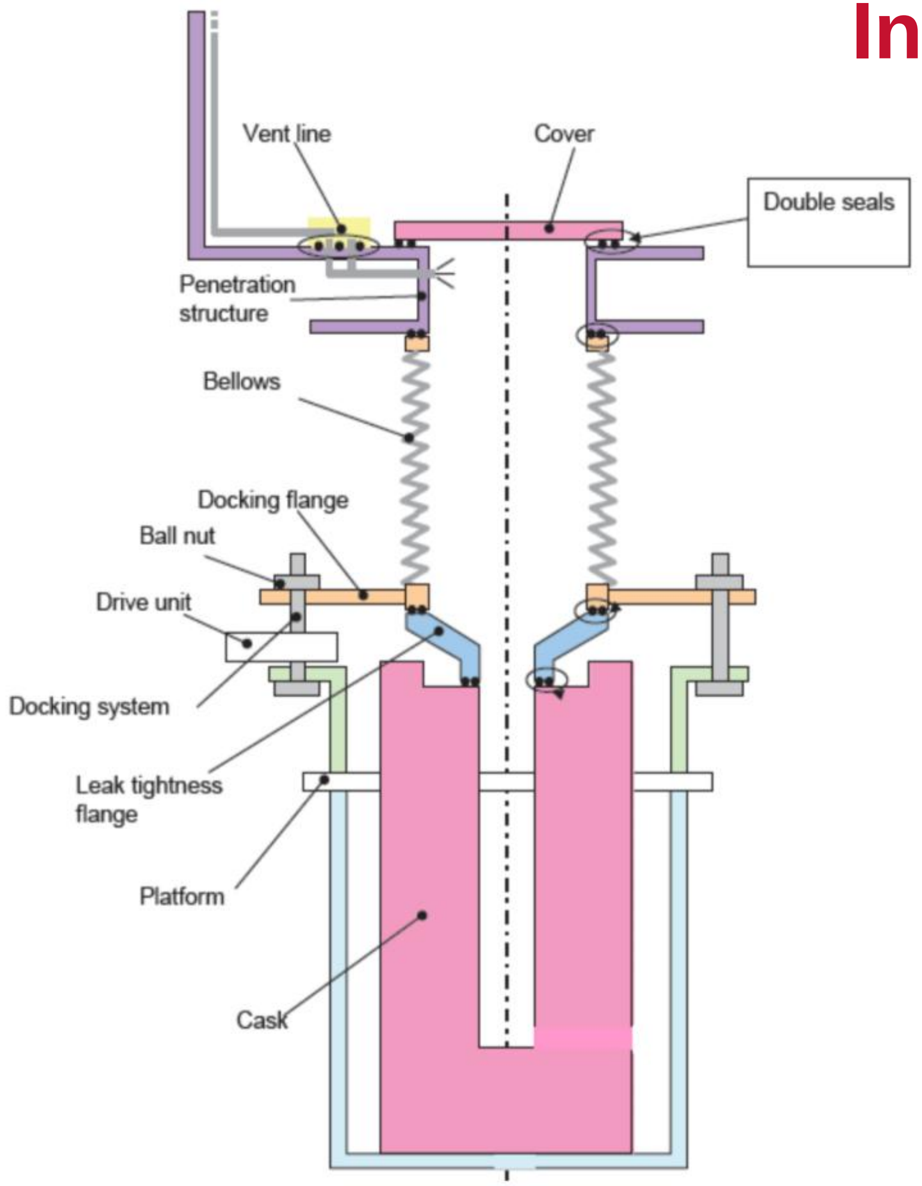
Platform
Trolley on articulated carriage
Travelling rails



Penetration Assembly

- The CLP penetration assembly provides a leaktight connection between the cask loading pit and the internal cavity of the cask. It consists of an upper cover at the bottom of the cask loading pit, the penetration, and a lower cover at the lower end of the penetration.
- The CLP penetration assembly connects the internal cavity of the spent fuel cask to the cask loading pit during loading operations so that spent fuel can be loaded into the cask.
- Safety-related function:
  - The CLP penetration assembly serves as part of the cask loading pit fluid boundary to prevent draining the SFP, including during and following a Safe Shutdown Earthquake (SSE).

Penetration Assembly – Leak Tight Interfaces



SFCTF Fluid and Pneumatic Systems

- SFCTF fluid and pneumatic systems are located on the SFCTM and in the Fuel Building
  - Used for filling, draining and drying the cask and the penetration.
  - Also provide compressed air for pneumatic devices and seal leakage detection.
- Safety-related function:
  - During cask loading, the fluid and pneumatic systems serve as part of the cask loading pit fluid boundary to prevent draining the SFP, including during and following a Safe Shutdown Earthquake (SSE).

Spent Fuel Cask

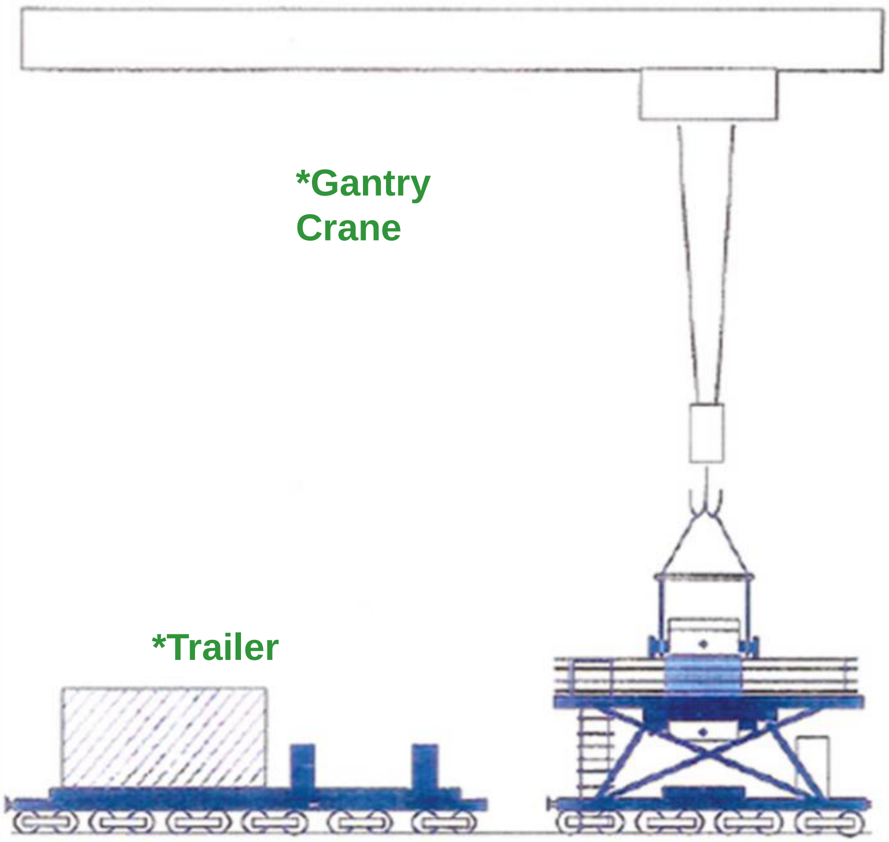
- Not within the scope of design certification.
- The COL applicant will provide a spent fuel cask design acceptable for use with the SFCTF prior to initial fuel loading operations.

SFCTF Operations

Pavan Thallapragada

Placement of the Cask on the SFCTM

Lifting Station
(Outside Fuel Building)

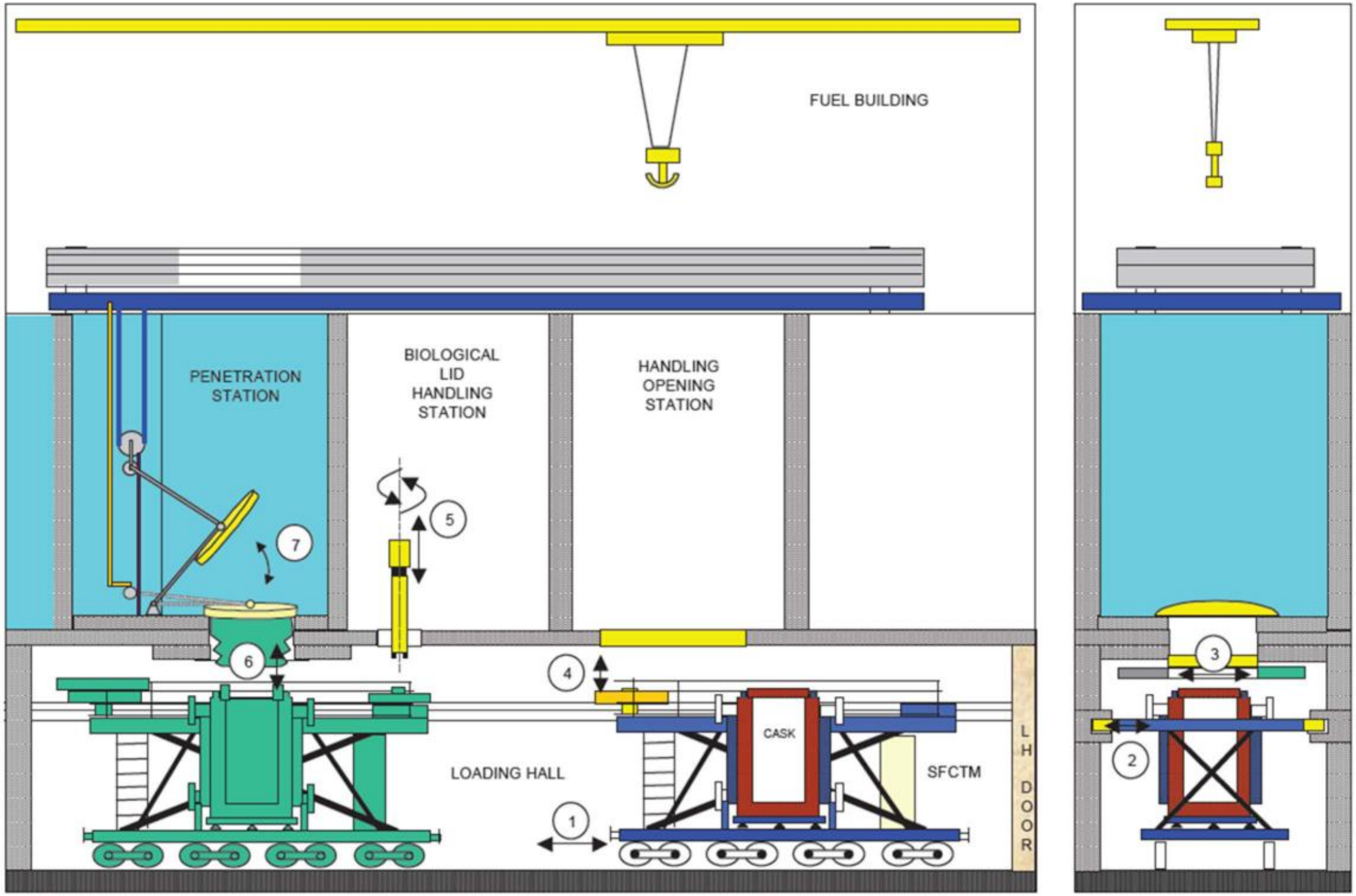


SFCTM

*Not in Design Certification Scope

Moving of SFCTM to Fuel Building Loading Hall

General View of SFCTF Stations in the Fuel Building



SFCTF Operating Advantages and History

- The U.S. EPR SFCTF design concept differs from cask loading facilities in U.S. operating fleet; however, the design has evolved from similar facilities in Europe.
- The design was developed in Europe to achieve the following advantages:
  - Preclude a cask-drop accident during lifting that could damage the building, stored fuel, or safety-related equipment.
  - Limit ionizing radiation exposure to plant personnel during cask loading.
  - Limit contamination of exterior cask surfaces.
  - Reduce cask loading time.
  - Reduce effluent and low-level radioactive waste during the cask loading operation.
- Similar SFCTF installed in several P4 and N4 series plants in France and Tihange 2 and 3 in Belgium.
  - It is estimated that about 1,000 loading operations have been successfully performed at French nuclear power plants.

Sections 9.1.1 and 9.1.2 Overview of Fuel Racks

Ian McInnes

Overview of Fuel Racks

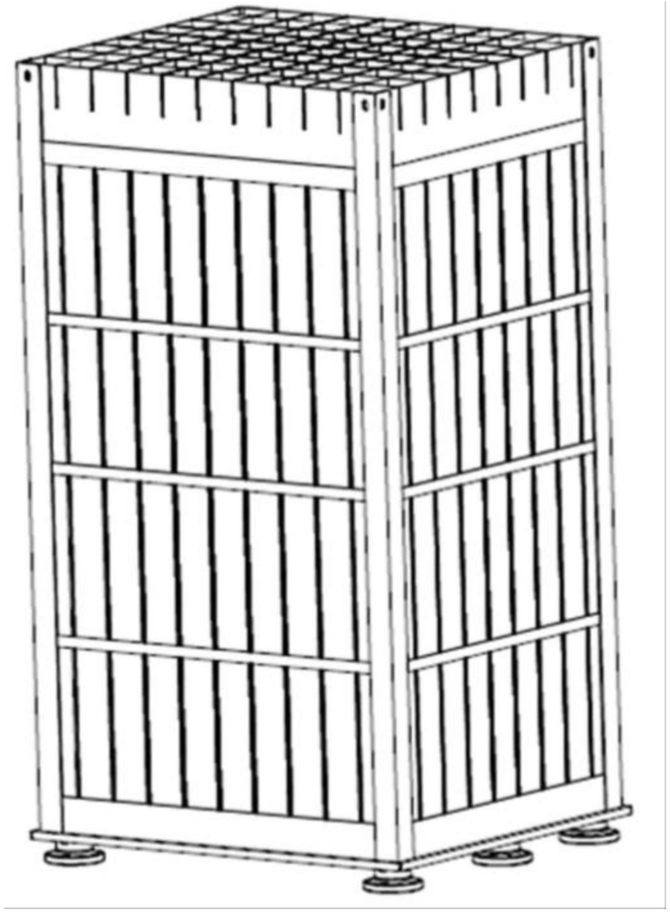
- Fuel rack design basis
- Neutron absorber materials
- Analytical methodology

Design Basis of Fuel Racks

- Fuel rack modules are based on existing 10 CFR Part 71 transportation and 10 CFR Part 72 dry storage technology
- TN has been designing and building fuel storage components for 40+ years
- TN experience includes the fabrication, loading and operation of 740+ dry storage canisters (over 27,000 fuel assemblies)
- Operational experience includes wet and dry loading of fuel directly applicable to the SFP and new fuel storage racks

Fuel Rack Design

- Fuel rack modules have rectangular modular construction
- Loads carried by welded stainless steel frame
- Fuel compartments are extruded aluminum tubes
- Poison material is an aluminum metal matrix composite (MMC), which has been in use in wet and dry fuel storage for >5 years

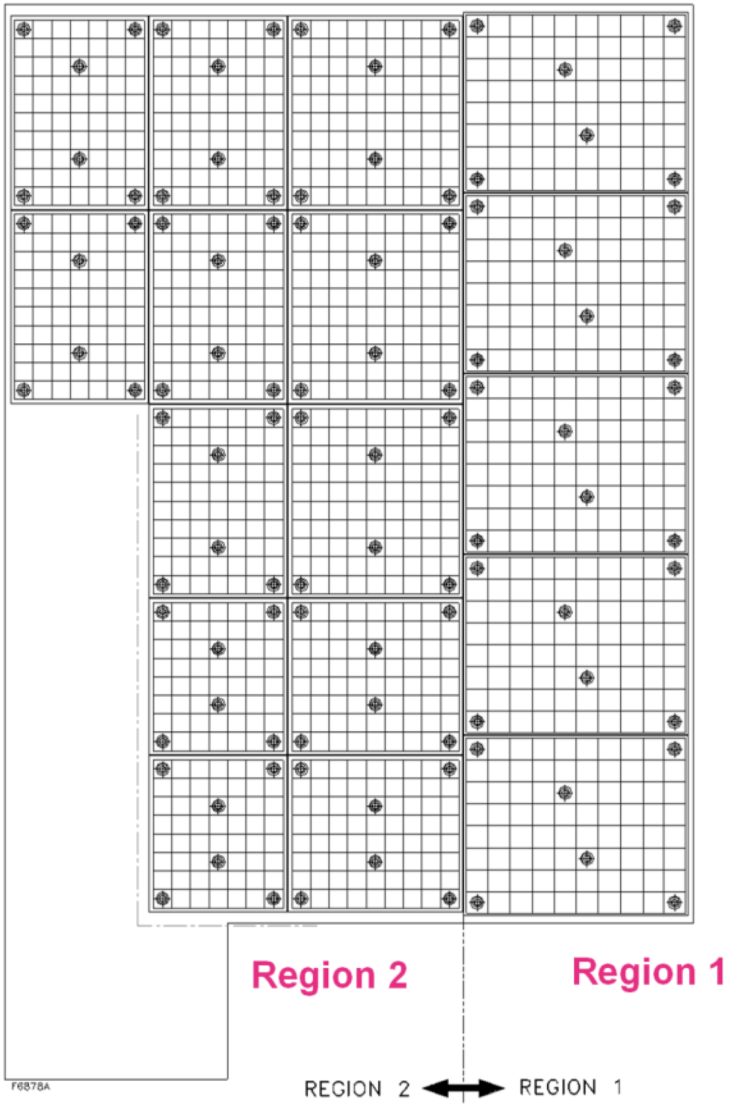


Fuel Rack Design

- Region 1 cells are formed by MMC neutron absorber material assembled in an egg-crate arrangement to form flux traps contained by an external steel frame and internal straps.
- Region 2 cells are formed by flat sheets of MMC sandwiched between fuel tubes and contained within a steel frame.
- Rack design is modular with adjustable feet, optimized to maximize capacity in SFP and New Fuel Storage Facility (NFSF).
  - In the SFP, rack modules are free standing and not anchored to adjacent modules, pool walls or floor.
  - In NFSF, rack module details are the same as Region 1, except they are anchored/restrained laterally at the top and bottom to the new fuel vault walls.

SFP Region 1 and 2 Racks

- SFP configuration has 5 Region 1 and 12 Region 2 rack modules.
- Racks provide a 10 year storage capacity plus a full core off-load reserve.
- NFSF contains 2 Region 1 Type modules.



Neutron Absorber Materials

- MMC is used as the neutron absorbing material for the racks.
- MMC consists of boron carbide in aluminum or aluminum alloy matrix with no polymer or organic components.
- TN obtained NRC approval of TN-68 cask for storage (10 CFR 72) and transportation (10 CFR 71) in 2000/2001, which uses MMC as a fixed poison.

Surveillance Program for Neutron Absorber Materials

- A coupon surveillance program is proposed to monitor MMC performance over life of racks to verify MMC integrity
  - Coupons are taken from the same production lot as that used for the construction of racks
  - Prior to immersion in the SFP, coupons are characterized by measuring thickness and B-10 areal density for comparison with subsequent measurements
  - At least one archive specimen is retained but not immersed in the SFP for later comparison with the irradiated coupons
  - The coupons are located adjacent to hottest fuel assembly in either an empty fuel compartment in Region 2 or in a space between rack modules
  - At approximately 2, 4, 6, 8, 10, 15, 20, 25, 30, 40, 50 and 60 years from commissioning, at least one coupon is removed, measured, visually examined, and B-10 areal density measured to monitor any changes in physical properties of the MMC

Safety Analyses Performed for the Rack Design

- Criticality Analyses
- Structural/Seismic Analyses
- Thermal Hydraulic Analyses

Criticality Analysis Criteria

- For the rack modules, including the new fuel dry storage racks, sub-criticality is maintained using a combination of flux traps, favorable geometry and fixed poison loading.
- Credit for fuel assembly irradiation (burnup credit), and credit for soluble boron loading in the SFP, are included in the criticality analysis.

Burnup Credit Methodology

- Methodology meets the requirements of the latest staff guidance per Interim Staff Guidance (ISG) DSS-ISG-2010-01, Revision 0
  - Depletion and criticality code bias and uncertainty are accounted for separately
  - Benchmarking of depletion codes to isotopic assay measurements was performed to justify the use of isotopic concentrations in burn-up credit analysis
  - Criticality code benchmarks also include burned assembly configurations from NUREG/CR-6979
- A variety of mis-load configurations are evaluated to determine soluble boron requirements

Criticality Analysis: Computer Codes

- Criticality calculations conservatively credit 90% of specified minimum B-10 areal density, and inspection statistics during acceptance testing provide minimum B-10 content with 95% probability at 95% confidence
- Criticality analysis employs the following Codes:
  - SCALE-4.4 computer code package for burnup credit analysis
  - 44 Group ENDF/B-V Cross Section Library
  - SAS2H/ORIGEN-S modules for Depletion Analyses
  - CSAS25 Module with KENO V(a) for Criticality Analyses
  - USLSTATS code for upper subcritical limit calculations

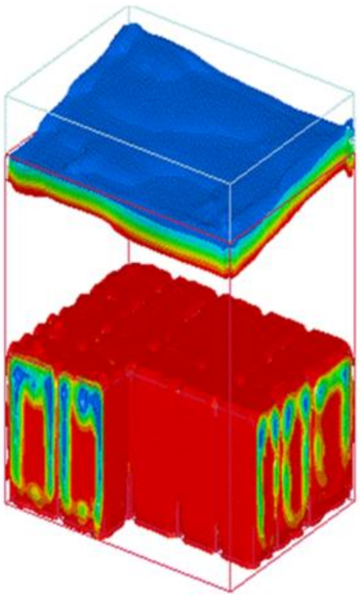
Structural/Seismic Analysis Criteria

- Racks are designed to Seismic Category I requirements and meet the stress limits of ASME BPVC Section III, Division I, Subsection NF-Supports, Class 3.
- Design, fabrication, and examination of racks are performed in accordance with guidance from NF-3000 (Design), NF-4000 (fabrication) and NF-5000 (examination) of ASME BPVC, Section III, Division I, Subsection NF-Supports, Class 3.
- Seismic modeling approach represents a significant advance over simplified lumped mass type approaches as it removes many of necessary assumptions/ approximations and explicitly captures 3D effects, fluid coupling, and multi-rack interaction effects.

Seismic Analysis

- Seismic Analysis Model uses LS-DYNA Code
  - Seismic input spectra are based on generic U.S. EPR inputs, broadened by +/-20% and amplified by 15%.
  - Five (5) sets of time histories were generated from the seismic spectra in accordance with regulatory requirements in Section 3.7.1 of NUREG 0800.
  - Full pool finite element model (FEM) includes 17 individual rack modules and the entire pool water volume is explicitly modeled.

LS-DYNA full Pool Model



Snapshot of Pool Sloshing

Whole Pool Multi-Rack LS-DYNA Model

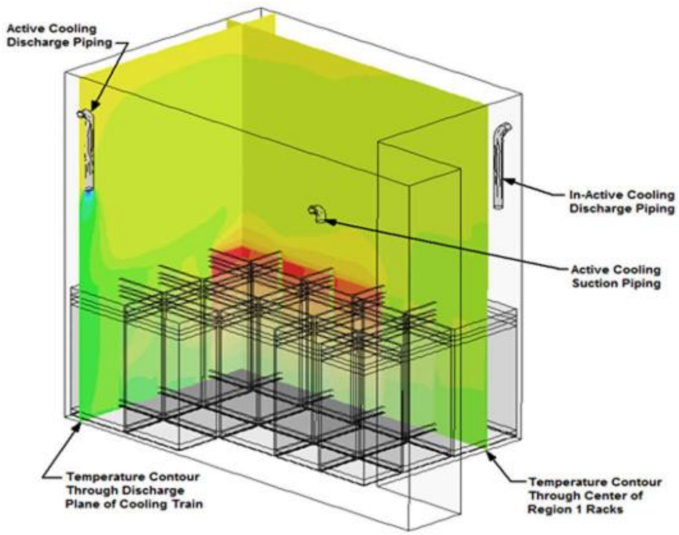
- The whole pool multi-rack model accounts for the following phenomena:
  - Hydrodynamic coupling between adjacent rack modules and between the racks and the pool structure
  - Structural nonlinearities due to rack sliding and rocking and impacting each other, global rack-to-rack and rack-to-pool interaction effects
  - Effect of partially loaded racks
- The water in the gaps between neighboring rack modules, between racks and adjacent pool walls, and above the racks is explicitly modeled to evaluate the effect of fluid pressures on the racks.
- Non linear multiple time history dynamic analyses is performed for different coefficients of friction between rack feet and pool floor.
- Results from whole pool model are used for stress evaluation using separate detailed FEM for the governing rack modules.

Thermal Hydraulic Analysis Criteria

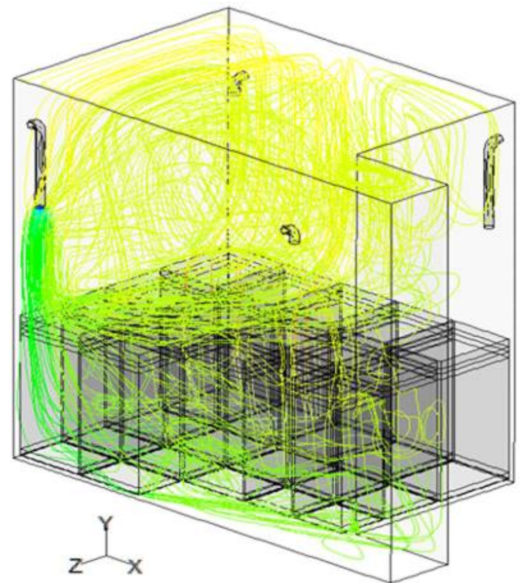
- Maximum SFP bulk water temperature of 120°F for partial and full core offloads with normal active cooling trains available.
- Maintain minimum water depth above fuel assembly of 23 feet under all conditions.
- Maximum SFP bulk water temperature of 140°F for partial and full core offloads assuming loss of one active cooling train.
- Maintain peak fuel cladding temperature below local saturation temperature (240°F).

Thermal Hydraulic Analysis Model

- Full pool model developed using NRC accepted CFD FLUENT Code
  - Detailed model uses over 2.2 million meshes.
  - Pressure drops and fluid structure interactions accounted for.
  - Analysis covers full and partially loaded rack including full core offload.



Temperature Profile



Velocity Distribution

Section 9.1.3
Fuel Pool Cooling and Purification System (FPCPS)

George Ifebuzo

Design Overview of the FPCPS

- The FPCPS consists of two separate and independent sub-systems:
  - Fuel Pool Cooling System (FPCS)
  - Fuel Pool Purification System (FPPS)
- The required safety-related function is to cool and cover the spent fuel assemblies with water during all storage conditions.
- FPCPS conforms with guidance and requirements provided in SRP 9.1.3 and RG 1.13 for safety-related spent fuel cooling system design.
- Designed such that the SFP cannot be inadvertently drained below 10 feet above the top of the active fuel.

Design Overview of the FPCS

- Removes decay heat from the SFP and maintains SFP ≤ 140°F (full core offload with single failure).
- Consists of two SFP cooling trains installed on opposite sides of the Fuel Building – separation limits physical effects of an internal hazard to one train
  - Each train consists of 2 pumps (in parallel) and 1 heat exchanger
  - Powered by a separate electrical division of 480V emergency AC power system (Divisions 1 & 4)
  - Designed with alternate feed provision (Divisions 2 & 3)
  - Backed by Emergency Diesel Generators (EDGs)

Design Overview of the FPPS

- Provides containment isolation of the reactor pool purification supply and return lines (safety-related function).
- Provides filtration and surface skimming of RB pools, FB pools and IRWST to remove radioactive materials, corrosion products and impurities.
- Provides water transfer capability for the RB pools, FB pools, and the IRWST.
- Purification loop consists of two parallel purification pumps, one ion-exchanger, and two filters.

Spent Fuel Pool Makeup

- SFP Makeup System
  - Makeup water source (~50,000 gallons) contained in transfer compartment or cask loading pit (both Seismic Category I)
  - SFP makeup pump backed by EDGs
- Supplemental SFP makeup capability
  - Demineralized water distribution system provides normal makeup to compensate for evaporation
  - Fire water distribution system (600,000 gallons) provides makeup via FB hose station
    - Supply hose station
    - 100% diesel-driven pump provides water flow during SBO conditions
  - IRWST (500,000 gallons) provides borated water makeup (Seismic Category I water source)
  - SFP spray cooling flow provided by two EDG backed sump pumps
  - Makeup water flow from external water source

Sections 9.1.2, 9.1.3 and 9.1.4 Prevention and Mitigation of Fuel Building and Reactor Building Pool Drain Down

Dennis Newton

Drain Down Prevention and Mitigation

Drain Down Prevention Features

- **FB and RB Pool liners and support structures are Seismic Category I**
  - Includes RPV Refueling Cavity Ring
- **FB and RB Pool drain pipes and their isolation valves are manual, Quality Group C and Seismic Category I**
  - FB Pool spent fuel storage compartment has no drain pipe
  - Drain lines greater than 2 inch have two isolation valves
- **FB Pool FPCPS supply and return pipes**
  - Located at least 20 feet above the top of fuel
  - Have siphon breakers
- **SFCTF Penetration Assembly has double seals and double bellows**
  - Bellows protected from mechanical damage
- **FB Pool compartment gateways isolated by both a swivel and a slot gate**
  - Bottom of gateways is 2.5 feet above top of fuel
  - Swivel and slot gate are Seismic Category I
- **SFCTF Penetration Assembly piping/valves are Quality Group C and Seismic Category I**
  - To first normally closed valve
  - To second normally open valve

Drain Down Prevention and Mitigation

Drain Down Detection Features

- **Leakage monitoring/testing between double leakage barriers**
  - (e.g., between SFCTF Penetration Assembly seals and bellows)
- **Level sensors provided in all FB and RB Pool compartments**
  - FB Pool spent fuel storage compartment has Class 1E level instrumentation, which alarms in Main Control Room
- **Drain isolation valves have position indication in Control Room**
- **Leakage from FB Pool liner is collected and monitored**

Drain Down Prevention and Mitigation

- **Mitigation – SFCTF Penetration Assembly Double Seal Failure**
  - **Seals are located between Penetration Assembly and the Spent Fuel Cask**
  - **Assumptions**
    - Both seals assumed to fail (two passive failures)
    - Cask loading pit gateway open to the FB Pool spent fuel storage compartment
    - Fuel assembly in cask loading pit compartment
    - No makeup water provided
      - However, make-up water at 400 gpm is available via the IRWST and the SFP purification pump
  - **Leak flow rate is approximately 390 gpm**
  - **Fuel assembly can be moved to FB Pool spent fuel storage compartment and cask loading pit swivel gate closed within 30 minutes**
    - Level decrease is about 1 foot in 30 minutes
  - **If leak is not isolated, maximum FB Pool spent fuel compartment drain down is to bottom of gateway and takes 8 hours**
    - Bottom of gateway is 2.5 feet above top of fuel assemblies

Drain Down Prevention and Mitigation

▶Mitigation – Cask Loading Pit Pipe Failure

- **6 inch drain and 2 inch penetration assembly pipe cracks**
- **Same as double seal failure event except**
  - leak rate approximately 75 gpm (combined leak rate)
  - drain down to bottom of gateway and takes >24 hours

Drain Down Prevention and Mitigation

▶ Mitigation – Inadvertent Opening RB Pool Drain Valves

- **Assumes two 6 inch drain valves and 8 inch drain header valve inadvertently opened**
- **Assumes no makeup water, however,**
  - MHSI pump can provide 600 gpm
  - LPI pump can provide 2200 gpm
  - FPCP pump can provide 400 gpm
  - Suction from IRWST
- **Drain water flows to the IRWST**
- **Drain rate about 5000 gpm**
- **RB Pool level drops about 7.5 feet in 30 minutes**
- **Fuel assembly can be returned to core, fuel transfer pit or a drain valve closed within 30 minutes**
- **If RB Pool allowed to completely drain**
  - Approx. 13 ft. of water remains above the fuel in reactor vessel
  - Approx. 12 ft. of water remains above any horizontal fuel assembly in transfer pit

Section 9.1.5
Overhead Heavy Load Handling System

Rick Parler

EPR™ by AREVA

AREVA

Overhead Heavy Load Handling System

- A heavy load is defined as a load the weight of which is greater than the combined weight of a single spent fuel assembly and its handling tool.
- For the U.S. EPR, the weight of a heavy load is ≥ 1730 lbs.
- Heavy load handling requirements and guidance:
  - NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants”
  - NUREG-0554, “Single-Failure-Proof Cranes for Nuclear Power Plants”
  - ASME NOG-1, “Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)”
  - ASME NUM-1, “Rules for Construction of Cranes, Monorails, and Hoists (With Bridge or Trolley or Hoist of the Underhung Type)”

Overhead Heavy Load Handling System

- Cranes that handle heavy loads are designed as Type I or Type II
  - Type I
    - Designed to handle a critical load
    - Designed to remain in place and support the critical load during and after a seismic event
    - Does not have to be operational after the event
    - Incorporates single-failure-proof features
  - Type II
    - Not used to handle a critical load
    - Designed to remain in place with or without the load during a seismic event
    - Need not support the load or remain operational after the event
    - Single-failure-proof features are not required

Overhead Heavy Load Handling System

- Type I – Single-failure-proof design
  - Hoist load path components designed such that any credible failure of a single component will not result in the loss of capability to stop and hold the critical load
  - Critical load – any load whose uncontrolled movement or release could adversely affect safety-related systems required for unit safety or could result in potential offsite exposures in excess of established limits
  - U.S. EPR has 4 single failure proof cranes:
    - Reactor Building polar crane
    - Fuel Building auxiliary crane
    - Fuel Building upper penetration cover hoist
    - Fuel cask biological lid handling hoist

Overhead Heavy Load Handling System

- Type I – Single-failure-proof design
  - Critical items for single-failure-proof design are those components located between the load and the source of energy holding the load
    - Hook
    - Wire rope
    - Load blocks
    - Gear train
    - Brakes
  - Design for single-failure-proof is accomplished by use of dual/redundant components and/or doubling the design factors

Overhead Heavy Load Handling System

- Type II Cranes
  - Used for lifts over equipment not required to perform a safety function (outage conditions)
  - Makes use of stops and interlocks preventing load handling over safety related equipment
  - Equipment / components are evaluated for the effects of load drop

COL Information Items

- A COL applicant will provide site-specific information on the heavy load handling program, including a commitment to procedures for heavy load lifts in the vicinity of irradiated fuel or safe shutdown equipment, and crane operator training and qualification.

Acronyms and Abbreviations

ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society Mechanical Engineers
BPVC	Boiler and Pressure Vessel Code
CFD	Computational Fluid Dynamics
CLP	Cask Loading Pit
COL or COLA	Combined Operating License (Applicant)
EDG	Emergency Diesel Generator
FB	Fuel Building
FEM	Finite Element Method
FPCPS	Fuel Pool Cooling and Purification System
FPCS	Fuel Pool Cooling System
FPPS	Fuel Pool Purification System
IRWST	In-Containment Refueling Water Storage Tank
ISG	Interim Staff Guidance
LPI	Low Pressure Injection

Acronyms and Abbreviations

MHSI	Medium Head Safety Injection
MMC	Metal Matrix Composite
NFSF	New Fuel Storage Facility
RB	Reactor Building
SBO	Station Blackout
SFCTF	Spent Fuel Cask Transfer Facility
SFCTM	Spent Fuel Cask Transfer Machine
SFP	Spent Fuel Pool
SRP	Standard Review Plan (NUREG-0800)
SSE	Safe Shutdown Earthquake

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

Presentation to the ACRS Subcommittee

AREVA EPR Design Certification Application Review

Safety Evaluation Report with Open Items

Chapter 9.1: Fuel Storage and Handling

February 22, 2012

Staff Review Team

- **Technical Staff**
  - **Tech Reviewer Name: Chris Van Wert**
    Branch Name: Reactor Systems
  - **Tech Reviewer Name:** Amrit Patel
    Branch Name: Reactor Systems
  - **Tech Reviewer Name: Raul Hernandez**
    Branch Name: Balance of Plant
  - **Tech Reviewer Name: Gordon Curran**
    Branch Name: Balance of Plant
  - **Tech Reviewer Name: Jim Xu**
    Branch Name: Structural Engineering
- **Project Managers**
  - Lead PM Name: Getachew Tesfaye
  - Chapter PM Name: Peter Hearn

Overview of DCA

SRP Section/Application Section		No. of Questions	Status Number of OI
9.1.1	Criticality Safety of New and Spent Fuel Storage and Handling	63	10
9.1.2	New and Spent Fuel Storage	41	2
9.1.3	Fuel Pool Cooling and Purification System	15	2
9.1.4	Fuel Handling System	39	19
9.1.5	Overhead Heavy Load Handling System	24	1
Totals		182	34

Ch 9.1 OPEN ITEMS

1. RAI 513, Question 09.01.01-53: The applicant needs to provide additional information regarding the neglect of uncertainty quantities including, but not limited to, fuel enrichment and fuel rod pitch.
2. RAI 538, Question 09.01.01-63: The applicant needs to correct an error indentified in Footnote (2) of TN-Rack 0101, Table 5-26 which shows a value of 0.5 when 0.05 is intended.
3. RAI 513, Question 09.01.01-56: Additional information is needed to demonstrate that the method for identifying the limiting 36-node burnup-dependent profile can actually produce the most limiting profiles.
4. RAI 513, Question 09.01.01-54: Assurance is needed that the uncertainty will be calculated and that it will be conservatively applied with respect to assembly loading in the SFP.
5. RAI 513, Question 09.01.01-57: Justification should be provided to demonstrate that no significant rack dimensional changes would occur as a result of the horizontal drop accident.

Ch 9.1 OPEN ITEMS

6. RAI 513, Question 09.01.01-58: Issue #5 remains an open item until further clarification is provided regarding placement of fuel assemblies next to fuel storage racks during normal operations.
7. RAI 513, Question 09.01.01-59: The staff notes that there appears to be enough distance to ensure that system reactivity is unaffected by having an assembly in the new fuel elevator for this accident condition, but the applicant needs to either verify that this scenario is not possible or provide an analysis that demonstrates that the minimum soluble boron requirement of 1100 ppm is unaffected.
8. RAI 513, Question 09.01.01-60: Although 1800 pcm provides substantial margin, additional staff review has led the staff to question whether the assumption of five percent initially enriched fuel is limiting for the all-cell portion of Region 2 during an accident. A lower burnup would have a less top peaked fission density which could interact more strongly with the fresh fuel assembly and therefore additional analysis should be performed at lower burnups along the spent fuel loading curve to verify that the 1100 ppm minimum soluble boron limit remains appropriate.

Ch 9.1 OPEN ITEMS

9. RAI 513, Question 09.01.01-61: The applicant does not explain the methodology for maintaining and controlling a minimum of 37 percent B-10 enrichment in the boric acid storage tank.
10. RAI 513, Question 09.01.01-62: The applicant is required to justify the verification of the proper B-10 enrichment for this operation.
11. RAI 526, Question 09.01.02-40: The staff requested that the applicant update FSAR Tier 2, Section 9.1.2 to include the justification of how the seismic classification of the SFCTF is credited to prevent a SFP draindown.
12. RAI 526, Question 09.01.02-41: The staff requested that the applicant justify the absence of a Technical Specification or a license condition that would require at least two of the seismic barriers to be in place while there is no cask attached to the SFCTFS.

Ch 9.1 OPEN ITEMS

13. RAI 526, Question 09.01.03-14: The staff requested that the applicant update FSAR Tier 2, Section 9.1.3 to address the impact on the SFP of an SSE while the SFCTF is in operation.
14. RAI 526, Question 09.01.03-15: The staff requested that the applicant clarify FSAR Tier 2, Section 9.1.3 to indicate the seismic criteria of all the piping and valves that connect with the SFP, and to indicate the elevation of any non-seismic pipe and of its anti-siphon device.
15. RAI 525, Question 09.01.04-21 The staff requested that the applicant clearly define which components are designed to NOG-1 as a single failure proof hoist.
16. RAI 525, Question 09.01.04-29: the staff requested that the applicant provide the following:
    a. Description of overall dimensions, structural elements (beams, girders, trusses, plates, etc.) and their connections for the SFCTM and the penetration assembly, including sketches.
    b. Description of the anti-seismic locking devices including their connections with the SFCTM and the structural walls (provide sketches).
    c. Overall dimensions and structural description of the loading hall (concrete walls and slabs) including sketches.

Ch 9.1 OPEN ITEMS

17. RAI 525, Question 09.01.04-30: The staff requested that the applicant provide the following:
    a. Description of how specific provisions of ASME NOG-1-2004 are applied to the structural design of the SFCTM.
    b. Description of how the Seismic Category I requirements for the SFCTM would be met through the Code provisions.
18. RAI 525, Question 09.01.04-31: The staff requested that the applicant provide the following:
    a. Description of how specific provisions of ANSI/ANS-57.2-1983 are applied to the design of the fuel assembly; if other codes and standards are referenced for technical requirements, provide a description of the extent to which other codes and standards are applied to the structural design/analysis of the penetration assembly.
    b. Description of how the Seismic Category I requirements for the penetration assembly to maintain the leak-tight fluid boundary during and following an SSE would be met through the provisions ANSI/ANS-57.2-1983.
    c. Description of how the standard is used to design the various seals to ensure the leaktight fluid boundary of the penetration assembly during and following an SSE, as well as an accident drop of fuel assembly.

Ch 9.1 OPEN ITEMS

19. RAI 525, Question 09.01.04-34: The staff requested that the applicant provide the following:
    a. Description of the design/analysis procedures and results used for the SFCTM and penetration assembly.
    b. Description of the computer models used to establish that the design of the SFCTM and the penetration assembly meet the seismic Category I requirements.
    c. Description of how various connections are modeled such as the lateral supports to the SFCTM with concrete walls through the anti-seismic locking devices and the vertical support at the base, as well as the interfaces between the SFCTM and the penetration assembly to ensure the leak tightness during an SSE event.
    d. Description of the design/analysis procedures and results used for the loading hall and cast loading pit structures.
20. RAI 525, Question 09.01.04-35: The staff requested that the applicant provide the description of the analysis/design procedures used for the design of the anchors to ensure adequate structural support for the SFCTM when subject to the SSE loads

Ch 9.1 OPEN ITEMS

21. RAI 525, Question 09.01.04-36: The staff requested that the applicant provide the description of applicable acceptance limits in terms of allowable stresses, strains, deformation and other design criteria for the SFCTM, penetration assembly components, seals, and loading hall and cask loading pit structures.
22. RAI 525, Question 09.01.04-37: The staff requested that the applicant provide the following:
    a. Description of materials used for the SFCTM, penetration assembly components, seals, and loading hall and cask loading pit structures.
    b. Description of quality control procedures in place to ensure adequate designs.
    c. Description of special construction techniques, if used.
23. RAI 525, Question 09.01.04-38: The staff requested that the applicant provide the following:
    a. Whether theses safety devices and seals are seismically qualified, and to what codes and standards these will be qualified against.
    b. Whether any tests will be performed to demonstrate the safety performance of the SFCTF during the normal operation and under SSE loads.

Ch 9.1 OPEN ITEMS

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24. RAI 525, Question 09.01.04-21, The staff requested that the applicant define in the FSAR which components and portions of the NOG-1 code are "applicable" or credited as single failure proof.
25. RAI 525, Question 09.01.04-22: The staff requested that the applicant describe any mechanical stops or electric interlocks included with the equipment to prevent movement in an unsafe manner in the FSAR. In addition, the staff requested that the applicant describe how Table 09.01.04-15-6 items provided in the response will be monitored and controlled (i.e., physical limitations, procedurally, etc.) and justify not including this table in the FSAR.
26. RAI 525, Question 09.01.04-23: The staff requested that the applicant identify what abnormal conditions would require an operator to enter the cask loading hall during cask loading operation.

Ch 9.1 OPEN ITEMS

27. RAI 525, Question 09.01.04-24: The staff requested that the applicant justify how it intends to credit manual actions of potentially failed equipment to the recovery from the SSE with suspended fuel assembly; also justify the safe use of the FHM, which is Seismic Category II, after the SSE.

28. RAI 525, Question 09.01.04-25, the staff requested that the applicant review all components for consistency between classifications in FSAR Tier 1 and FSAR Tier 2 to ensure consistency. The staff also requested that the applicant provide ITAAC for the SFCTF and address the inconsistency

29. RAI 525, Question 09.01.04-26: The staff requested that the applicant address the guidelines of SRP Section 9.1.5.III.3 for safe movement of cask and heavy loads and movement of heavy loads during the SFCTF operation.

Ch 9.1 OPEN ITEMS

30. RAI 534, Question 09.01.04-39: GDC 61 states in part that the design of the fuel storage and handling systems shall have suitable shielding for radiation protection and appropriate containment, confinement, and filtering systems. Sufficient shielding provides protection for workers from the spent fuel so that regulatory limits are not exceeded and overexposures do not occur.

   a. Provide additional information identifying which SFCTF fluid system valves are closed to stop water loss.

   b. Provide more information on the path the contaminated water takes, whether this water receives treatment before discharging to the environment, and how this minimizes contamination.

   c. The applicant provided several examples of design features that demonstrate compliance with the requirements of 10 CFR 20.1406 for the SFCTF. Revise chapter 12 of the FSAR to include these features.

   d. Because welding is required to ensure leak-tightness of the cask, and because the welding work itself can contribute significant occupational dose to the cask loading process, revise the FSAR to describe where and how welding occurs during the cask closing operations. In addition, clarify which lid or cover is welded versus which one may be bolted, and whether the welding or bolting of lids/covers is manual, automatic or remotely operated from the SFCTF.

   e. Provide in the FSAR the location of radiation monitors around the SFCTF (in the loading hall).

   f. Table 9.1.4-15-6 has as an interlock the requirement that the iodine extracting ventilation be operable prior to using the SFCTF. Revise the FSAR to include this information, with a description of how this requirement will be implemented.

Ch 9.1 OPEN ITEMS

31. RAI 513, Question 09.01.04-20: the staff requested AREVA to address operating experience considerations associated with refueling cavity seals :

   a. the staff requests the applicant to justify in the FSAR the verification and monitoring of this TS without alarmed level instrumentation in the reactor cavity, and the absence of reactor cavity water level instrumentation that provides level indication and alarm for abnormal conditions (low level and rate of change) both locally and in the main control room.

   b. The staff requests the applicant to include in FSAR Section 9.1.4.3 a description of the essential elements of the procedures or to make this a commitment for a COL information item. The essential elements should consider directing the COL applicants to establish and implement procedures responding to pool drain down events, performing periodic maintenance and inspection of the cavity ring and other seals in accordance with vendor recommendations, and monitoring cavity leakage.

   c. The staff requests the applicant to explain in the FSAR the protective measures and design features credited to ensure the movement of core components do not damage the reactor cavity ring. In addition, for illustrative purposes, this figured should be added to the FSAR.

   d. Because there is no cover plate for protection of the cavity ring and no leak detection of the cavity ring, the staff requests the applicant to provide the analysis that demonstrates a dropped fuel assembly will not result in a leak greater than makeup capability.

Ch 9.1 OPEN ITEMS

32. RAI 525, Question 09.01.04-27: The staff requested that the applicant clearly state what testing will be performed prior to use of the SFCTF.

33. RAI 525, Question 09.01.04-28: The staff requested that the applicant revise the COL information item and interface requirements. The COL information item should instruct the COL applicant to identify an NRC approved cask and demonstrate that the cask can be safely connected to the certified SFCTF and remove spent fuel from the SFP prior to initial fuel load and plant startup.

34. RAI 530, Question 09.01.05-24: The staff requested that the applicant provide in the FSAR the weight of each of the major heavy loads lifted by the FB auxiliary crane, the heavy loads normally handled, the weights of the loads, and the hoist capacities of the SFCTF.

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Protecting People and the Environment

Presentation to the ACRS Subcommittee

Section 9.1.1
Amrit Patel
Reactor Systems Branch

Regulatory Requirements for Section 9.1.1

10CFR50.68(b) in lieu of 10CFR50.68(a)

- **10CFR50.68(b)(2)** – fresh fuel storage (NFSV)
  - k-eff < 0.95 at 95/95 when flooded w/ unborated water
- **10CFR50.68(b)(3)** – optimum moderation (NFSV)
  - k-eff < 0.98 at 95/95 when filled w/ with low-density hydrogenous fluid
- **10CFR50.68(b)(4)** – soluble boron credit (fuel pool)
  - If credit for soluble boron taken,
    - k-eff < 0.95 at 95/95 when flooded w/ borated water
    - k-eff < 1 at 95/95 when flooded w/ unborated water

Technical Review Overview

- Normal & accident conditions for fuel storage
- Burnup credit
- Fuel handling considerations
- Selection of design basis assembly
- Storage rack design
- Uncertainty analysis
- Computer code applicability
- Criticality code validation

Burnup Credit Review

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- Depletion analysis:
  - Operating parameters
  - Limiting axial profile determination
    - Screening method used
    - Fuel nodalization for depletion calculation
  - Depletion uncertainty
- Criticality code validation:
  - International Handbook of Evaluated Criticality Safety Benchmark Experiments (IHECSBE) and Commercial Reactor Critical (CRC) data
  - Staff requested addition of Haut Taux de Combustion (HTC) data
- NUREG guidance:
  - NUREG/CR-6801 (Axial profile)
  - NUREG/CR-6979 (HTC data)
  - NUREG/CR-6665 (Depletion modeling parameters)
  - NUREG/CR-6951 (Use of CRC data)

Staff Confirmatory Runs

- SCALE/TSUNAMI-IP – Criticality experiment applicability to U.S. EPR design
  - Correlation coefficient calculations
- USLSTATS – Criticality code validation
  - Verification of calculated bias and bias uncertainty
- SCALE/STARBUCS – 1-D nodal depletion
  - Full burnup and enrichment loading curve verification
- SCALE/TRITON – 2-D nodal depletion
  - Burnup and enrichment loading curve verification

Open Items of Interest
Section 9.1.1 – Criticality Safety of New and Spent Fuel Storage and Handling

Limiting burnup profiles

The burnup profile assumed in the criticality analysis is a major factor in determining the reactivity state of the fuel in the SFP. The applicant uses a procedure to create a composite burnup profile through a screening process that was not clear to the staff.

Staff Evaluation

- The reactivity contribution from the axial ends of the fuel increases with fuel burnup since they are depleted to a lesser extent during operation. The staff is concerned that the applicant's screening process may not result in the identification of limiting burnup profiles with respect to the important axial ends. When determining limiting burnup profiles, weighting toward the axial ends should be considered.

Open Item

- RAI 513, Question 09.01.01-56 asks for additional information demonstrating that the method for identifying limiting burnup-dependent profiles, can actually produce the most limiting profiles.

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Presentation to the ACRS Subcommittee

Section 9.1.2 and 9.1.3

Raul Hernandez
Balance of Plant Branch

9.1.2 New and Spent Fuel Storage

- NFSF – 18’ deep dry storage facility with capacity for 120 fuel assemblies
- SFSF – 47’ 3” deep wet storage facility with capacity for 1247 assemblies
- FB protects the NFSF and the SFSF against natural phenomena and internal or external missiles
- Seismic Category I emergency water makeup system and backup water source

9.1.2 New and Spent Fuel Storage

- SFSF liner leak detection system
- Seismic design prevents pool draindown
  - SFP walls,
  - SFP liner,
  - fuel transfer canal,
  - Gates between the SFCTF and the SFSF

9.1.2 Open Items

- Open Item 9.1.2 – 41
  - Staff requested the applicant to justify why there is no regulatory control over the gates credited to prevent SFSF draindown

9.1.3 Fuel Pool Cooling and Purification System

- FPCPS consists of the following separate and independent subsystems:
  - Fuel pool cooling system (FPCS)
  - Fuel pool purification system (FPPS)
- FPCPS safety related functions:
  - SFP decay heat removal
  - Prevention of pool draindown below the required level for shielding and FPCS operation
  - SFP makeup to compensate for normal SFP evaporation for up to seven days
  - Seismic Category I back-up water source for SFP makeup.
  - Provides isolation of non-safety related piping from the Safety related portions

9.1.3 Open Items

- Open Item 9.1.3-15
  - The staff requested that the applicant clarify FSAR Tier 2, Section 9.1.3 to indicate the elevation of any non-seismic SFSF connection and of the anti-siphon devices

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Presentation to the ACRS Subcommittee

Section 9.1.4 and 9.1.5

Gordon Curran

Balance of Plant Branch

Fuel Handling System

The fuel handling system (FHS) provides for handling of fuel assemblies from the time new fuel assemblies are received at the plant site until the spent fuel assemblies are stored in the spent fuel pool and removed through the spent fuel cask transfer facility.

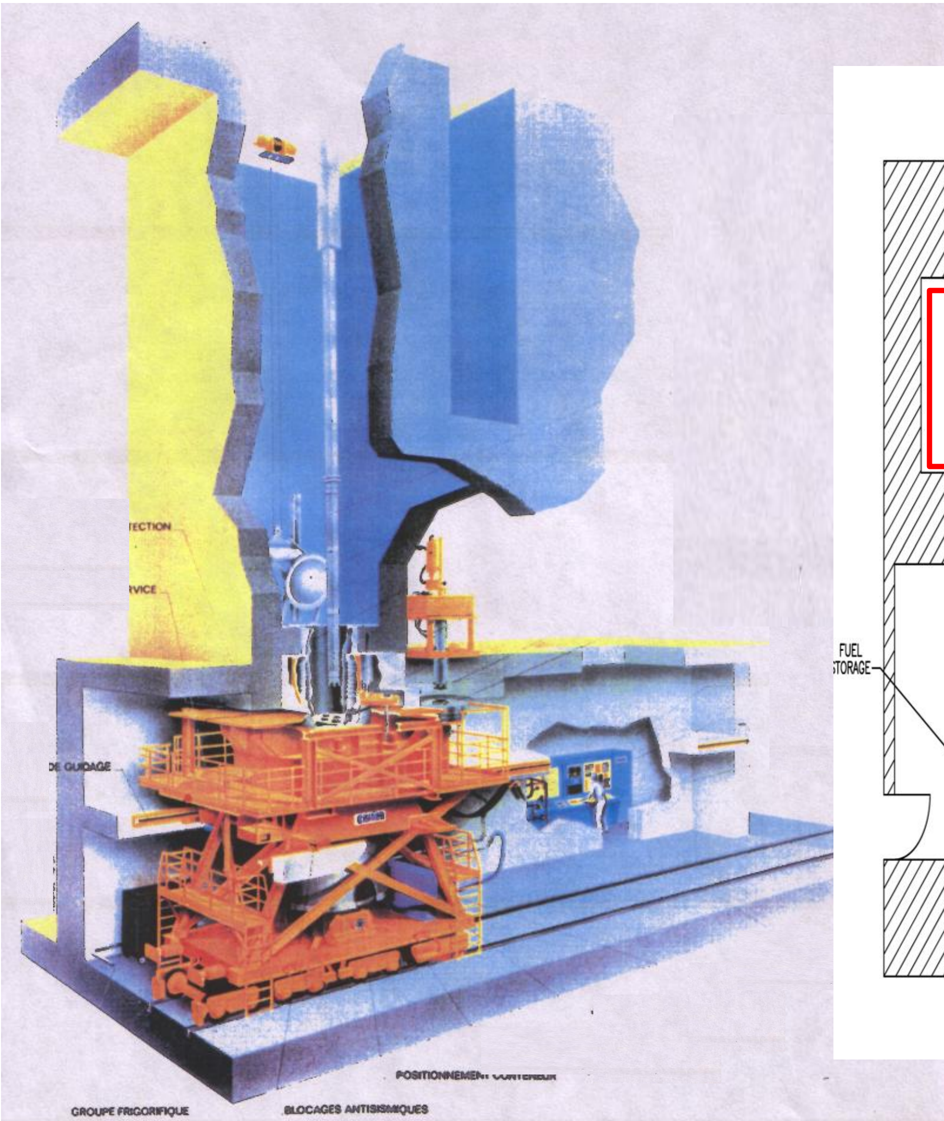
Fuel handling system (FHS)

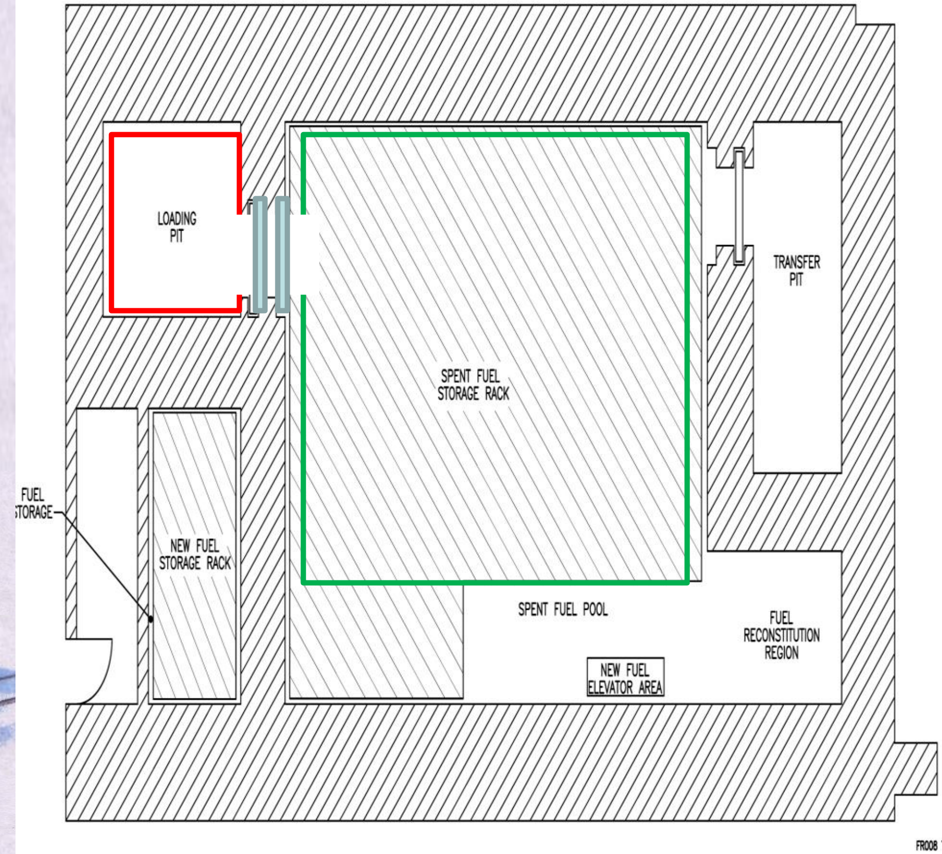
- Typical design: The main pieces of equipment used for fuel handling operations are the refueling machine, fuel transfer tube facility, new fuel elevator, spent fuel machine, and fuel storage racks

Spent Fuel Cask transfer facility (SFCTF)

- Unique Design to US: The main pieces of equipment in the SFCTF are the spent fuel cask transfer machine (SFCTM) for movement of the spent fuel cask within the loading hall of the Fuel Building and a penetration assembly for connection of the spent fuel cask to the cask loading pit

Spent Fuel cask transfer facility (SFCTF)





Technical Topics of Interest
Section 9.1.4 – Fuel handling System

United States Nuclear Regulatory Commission
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Key review challenges of unique SFCTF:

- Natural Phenomena protection
- Draindown prevention
- Test program

Technical Topics of Interest
Section 9.1.4 – Fuel handling System
Natural Phenomena protection

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Protecting People and the Environment

Natural Phenomena protection features of SFCTF (GDC 2):

- Operates with FB and protected from natural phenomena (except earthquakes)
- Seismic Category I components (SFCTM, penetration assembly)
- SFCTM rails, lateral guides and anti-seismic device
- Penetration assembly is connected with irreversible screws
- Hoists and trolley include single failure proof features
- Interlocks and controls

Open Items

- Define which interlocks provided, single failure proof features, capacities and special tools

Technical Topics of Interest
Section 9.1.4 – Fuel handling System
Draindown prevention

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<u>Draindown prevention (GDC 2, 61)</u>

Staff review:

- Fluid retaining components are Seismic Category I
- Exposed fluid retaining surfaces are design to withstand the impact of a drop assembly
- SSCs credited to support draindown prevention are design as Seismic Category I
- Redundant seals with leak detection at interfaces

Open Item 9.1.4-21 and 22

- Describe mechanical stops or electric interlocks

Technical Topics of Interest
Section 9.1.4 – Fuel handling System Test program

U.S.NRC
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Protecting People and the Environment

Test Program concern for SFCTF:

The staff needs assurance that the facility has the capability to remove spent fuel once fuel is loaded. Initial cask loading operations may occur many years after plant startup.

- Initial test program
- Col items
- Operating procedures and training
- ITAAC

Open Items

- Define ITP, ITAAC, COL Item and commit to operating procedures

Technical Topics of Interest
Section 9.1.4 – Fuel handling System Structural Integrity

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Key Open Item RAI 525, Question 09.01.04-29

The spent fuel cask transfer facility (SFCTF) includes two pieces of mechanical equipment which are 1) spent fuel transfer machine (SFCTM) and penetration assembly, to ensure safe transfer of spent fuel assemblies from the spent fuel pool into the spent fuel cask. US EPR FSAR Revision 4 Interim, Section 9.1.4.2 (August 31, 2011, Response to RAI 385) provides detailed description of the functional features of the SFCTF and stated that both pieces of the SFCTF equipment be designed as Seismic Category I. However, insufficient information is provided regarding the structural aspects of the SFCTF design. To facilitate the structural review of the SFCTF design, the applicant is requested to provided the following :

a. Description of overall dimensions, structural elements (beams, girders, trusses, plates, etc.) and their connections for the SFCTM and the penetration assembly, including sketches.
b. Description of the anti-seismic locking devices including their connections with the SFCTM and the structural walls (provide sketches).

Staff Findings

- The Staff conducted a review and evaluation of the U.S. EPR FSAR, which generated 182 Questions, with 42 remaining as Open Items. Through the use of public meetings, audits and conference calls the open items have been defined and the staff and AREVA have arrived at a common understanding of the requirements that must be satisfied. Presently the staff concludes that resolution of the 34 open items is manageable within the planned schedule. Upon resolving the open items, the Chapter 9.1 U.S. EPR FSAR will provide sufficient information to assist the COL applicant in constructing a U.S. EPR that satisfies the requirements of 10 CFR Part 52.

- Questions?

Presentation to ACRS U.S. EPR Subcommittee Ch. 14 - Verification Programs

Charles W. Tally

Regional Deputy for Project Integration and Design Support

Rockville, Md. February 23, 2012

EPR™ by AREVA

AREVA

Chapter 14 Contents

- Section 14.1 – Specific Information to be addressed for the Initial Plant Test Program
- Section 14.2 – Initial Plant Test Program For Safety Analysis Reports
- Section 14.3 – Inspections, Tests, Analyses and Acceptance Criteria, and Tier 1

Section 14.2 – Overview

- **Section 14.2 – Initial Test Program (ITP) For Safety Analysis Reports**
  - **U.S. EPR ITP is based on regulatory guidance contained in Regulatory Guide (RG) 1.68 Revision 3.**
  - **Includes testing of unique EPR design features.**
  - **Includes transient tests that demonstrate the ability to handle significant plant perturbations.**
  - **Conduct of test program is responsibility of COL Applicant**

Section 14.2 - Definitions

- **Construction Testing Phase**
  - **NOT within scope of ITP in FSAR Section 14.2.**
  - **U.S. EPR final calibration of instrumentation has been relocated from construction testing phase, testing phase described in RG 1.68, to preoperational test phase due to digital interfaces.**
- **Preoperational Testing Phase**
  - **Begins after completion of construction testing and completes prior to fuel load.**
- **Startup Testing Phase**
  - **Begins after completion of preoperational testing and completes with moisture carryover or ultimate heat sink testing (whichever occurs last).**

Section 14.2 – Preoperational Testing Objectives

- Demonstrate structures, systems, and components (SSC) functionality prior to fuel load.
- Exercise and evaluate technical specification surveillance procedures.
- Exercise and evaluate emergency operating procedures.
- Provide permanent plant operating staff experience and “on-the-job” training.

Section 14.2 – Preoperational Testing Scope

- NSSS Support Systems
- Front Line Safety Systems
- Engineered Components
- Civil Components and Systems
- Distributed Utilities
- General Supply Systems
- Power Conversion Systems
- Heating Ventilation and Air Conditioning Systems
- Auxiliary Systems
- Electrical Systems
- I&C Systems
- I&C Functions
- Hot Functional Tests (HFT)
- Individual tests are described in FSAR Section 14.2.12 (173 tests)

Section 14.2 - Startup Testing Objectives

- Achieve an orderly and safe initial fuel load and initial criticality.
- Perform initial heatup and low power physics testing (LPPT).
- Perform orderly safe power ascension.
- Complete testing of SSC functionality that can not be tested without reactor power.

Section 14.2 – Startup Testing Scope

- Initial fuel loading and pre-critical tests
- Initial criticality and low power tests
- Power ascension tests (per RG 1.68)
  - 5% reactor power plateau
  - ≥10% reactor power plateau
  - 25% reactor power plateau
  - 50% reactor power plateau
  - 75% reactor power plateau
  - ≥98% reactor power plateau
- Individual tests are described in FSAR Section 14.2.12 (49 tests)

Section 14.2 – Unique Features Testing

- Control rod drive mechanism (CRDM)
- Control rod position indication
- Fixed self-powered neutron detectors (SPNDs), fabricated from Cobalt-59
- Movable incore neutron measurement "aeroball" system used to calibrate the SPNDs
- Measurement of U.S. EPR "heavy neutron reflector" reactor internals vibration (RG 1.20)
- Natural circulation of the RCS
- Reactor coolant pump standstill seal, designed to isolate the RCP seal in response to SBO event
- Pressurizer surge line test to verify that thermal stratification is within design limits
- Partial trip feature to immediately reduce reactor power to ≤50% reactor power and turbine bypass/condenser capacity ≥50% reactor power

Section 14.2 – Transient Testing

- Pre-Core Safety Injection Initiated at HZP
- Natural Circulation
- Total Loss of Offsite Power (LOOP)
- Load Swings
- Remote Shutdown Station Checkout
- Loss of Feedwater Pump
- Trip of Generator Main Breaker
- Load Follow
- Turbine-Generator Load Rejection
- LOOP with Plant Auxiliary Loads Supplied in Island Mode

Section 14.2 – Transient Testing (Continued)

Test #177 - Pre-Core Safety Injection Initiated at HZP

- **Verifies automatic RCS depressurization using main steam relief train and establishing intermediate head safety injection during HFT.**
  - Rapid depressurization of steam generators (SGs) is accomplished by rapid cooldown using main steam relief train.
  - RCS is cooled and depressurized simultaneously with the SGs.
  - Medium head safety injection system injects into RCS and is controlled without filling the pressurizer solid.

Test #196 – Natural Circulation

- **Verifies that plant establishes natural circulation in the steam generators that is sufficient to remove decay heat.**
  - Performed at ≤5% reactor power.
  - Initiates a loss of power to all RCPs.
  - Injects boron until shutdown margin is achieved.
  - Verifies boron mixing occurred during natural circulation.
  - Plant response is monitored for at least 30 minutes without restoring power to RCPs.

Section 14.2 – Transient Testing (Continued)

▶ Test #198 – Total Loss of Offsite Power

- **Verifies ability to stabilize plant at HZP conditions following loss of power to non-safety-related busses.**
  - Performed at 10% reactor power.
  - Initiates a turbine-generator trip combined with a simultaneous loss of power to all RCPs (initiates reactor trip).
  - Plant response , especially emergency feedwater, is monitored for at least 30 minutes without restoring power to RCPs.

▶ Test #200 – Load Swings

- **Verifies plant automatic control response to positive and negative step load changes.**
  - Performed at 25%, 50%, 75%, and ≥98% reactor power.
  - Step turbine load changes are performed with plant controls in automatic, as close to instantaneous as possible, that are as challenging as possible without violating fuel warranty limits.

Section 14.2 – Transient Testing (Continued)

Test #211 - Remote Shutdown Station Checkout

- **Verify ability to perform reactor trip and control a plant cooldown from the remote shutdown station using emergency feedwater.**
  - Performed at 25% reactor power.
  - Plant controls are transferred from the MCR to the remote shutdown station, where reactor trip is initiated from outside of MCR.
  - Plant is initially cooled down to hot shutdown and subsequently cooled down to cold standby.

Test #217 – Loss of Feedwater Pump

- **Verify plant response to loss of one of three operating feedwater pumps.**
  - Performed at 75% reactor power.
  - Verifies start of standby feedwater pump and response of automatic feedwater controls during the transient.
  - Steam generator levels should remain within normal operating bands during the transient.

Section 14.2 – Transient Testing (Continued)

Test #219 – Trip of Generator Main Breaker

- **Verify ability of feedwater systems to remove decay heat after reactor trip and loss of all RCPs.**
  - RG 1.68 expected response can be obtained by simultaneously tripping all RCPs (initiates a reactor and turbine-generator trip).
  - Performed at ≥98% reactor power.

Test #220 – Load Follow

- **Verifies plant automatic control response to positive and negative gradual load changes without operator intervention.**
  - Performed at 25%, 50%, 75%, and ≥98% reactor power plateaus.
  - Step turbine load changes are performed with plant controls in automatic.
  - Power reduction of 10% during one hour period without operator intervention.
  - Power stabilized for two hours without operator intervention.
  - Power increase of 10% during one hour period without operator intervention.

Section 14.2 – Transient Testing (Continued)

▶ Test #221 – Turbine-Generator Load Rejection

- **Verifies that the U.S. EPR can power non-safety loads, including RCPs, if the turbine-generator output breakers open and offsite power remains energized.**
  - Performed at ≥98% reactor power.
  - Turbine-Generator trip occurs due to loss of all load.
  - RCPs remain in-service
  - Reactor remains critical.
  - Reactor experiences a partial trip and automatic power reduction to ≤50% reactor power.
  - Main steam that is not used by the turbine-generator is automatically dumped into the main condenser to match Tavg – Reactor Power limits.
  - Reactor operators restore rod sequence and overlap to Technical Specification limits.
  - Reactor power is automatically reduced to 25%.
  - Main steam is automatically dumped into the main condenser to match Tavg – Reactor Power limits.
  - Reactor operators reduce power manually to prepare for turbine-generator synchronization or HZP maintenance conditions.

Section 14.2 – Transient Testing (Continued)

Test #227 – Loss of Offsite Power with Plant Auxiliary Loads Supplied in "Island Mode"

- **Verifies that the U.S. EPR can power safety and non-safety loads in "island mode" if offsite power is lost, and be able to operate in this mode until the offsite grid is reenergized.**
  - Performed at ≥98% reactor power.
  - Reactor remains critical.
  - RCPs remain in-service with power supplied by the U.S. EPR turbine-generator.
  - Reactor experiences a partial trip and immediate power reduction to ≤50% reactor power.
  - Reactor operators restore rod sequence and overlap to technical specification limits.
  - Reactor power is automatically reduced to 25%.
  - Main steam that is not used by the turbine-generator is automatically dumped into the main condenser to match Tavg – Reactor Power limits.

Section 14.2 – Conduct of Test Program

- **A COL applicant referencing the U.S. EPR FSAR will provide:**
  - **A description of ITP administration**
    - Organizational structure
    - Position requirements
  - **Test program schedule and sequence**
  - **Program to ensure that test results are adequately reviewed**
  - **Program that maintains completed test records**
  - **Test procedures, developed from FSAR test abstracts and design limits**
    - Site-specific design
    - Reference design

Chapter 14.3 Outline

- 14.3 Overview
- 14.3.1 Introduction
- 14.3.2 System Based Design Descriptions and ITAAC
- 14.3.3 Non-system Based Design Descriptions and ITAAC
- 14.3.4 Interface Requirements
- 14.3.5 Site Parameters
- 14.3.6 Design Acceptance Criteria

Section 14.3 Overview

- Section 14.3 of Tier 2 provides the selection criteria and methods used to develop Tier 1
- Tier 1 contains two types of material
  - Certified Design Material (CDM), and
  - Inspection, Tests, Analyses and Acceptance Criteria (ITAAC).
- Tier 1 material is derived from Tier 2 material

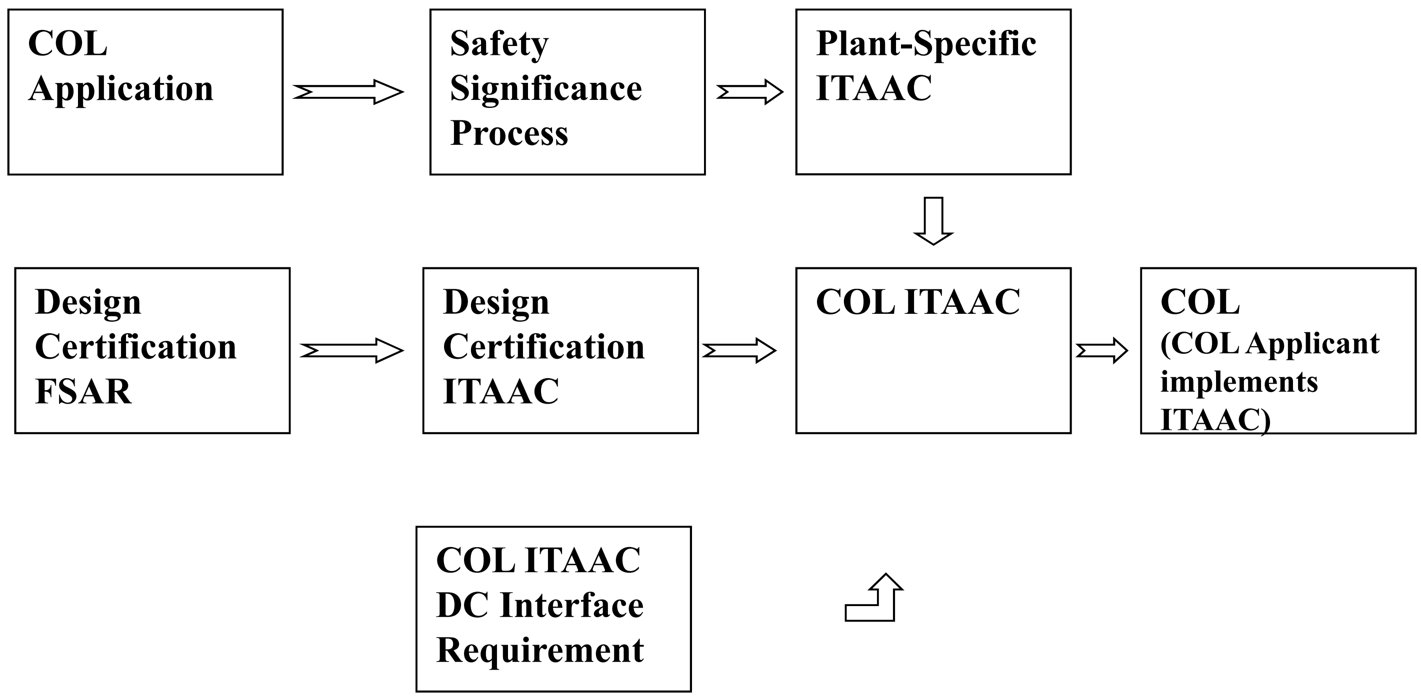
Section 14.3 Overview

- Consistent with SRP 14.3 Tier 1 has five chapters
  - Introduction
  - System-based design descriptions and ITAAC
  - Non-system-based design descriptions and ITAAC
  - Interface requirements
  - Site parameters

Section 14.3 Overview-
Relationship to COL

- **Relationship to COL ITAAC**
  - **Design Certification (DC) provides interface requirements determined to be safety significant (to support certified portion)**
  - **COL provides ITAAC for emergency planning and site-specific portions of the facility**

Section 14.3 Overview- Relationship to COL



Tier 2 Section 14.3.1 Introduction

- **Describes the content of Tier 1 section 1.0**
  - **Definitions**
  - **General Provisions**
  - **Figures Legend**
  - **List of Abbreviations and Acronyms**

Tier 2 Section 14.3.2 System-Based Design Descriptions and ITAAC

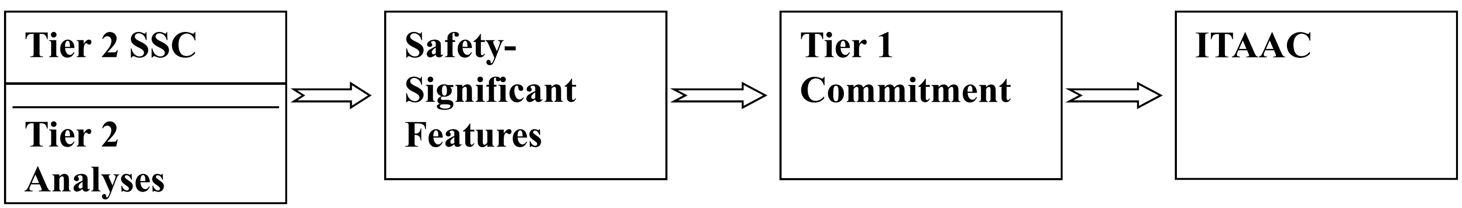
- **Section 14.3.2 is consistent with SRP 14.3**
- **Tier 1 material is derived from Tier 2 material**
- **Describes the content and format of Tier 1 Certified Design Material (CDM)**
- **Describes the content and format of the Tier 1 ITAAC**

Organization of Tier 1 – Chapter 2

- 2.1 Structures
- 2.2 Nuclear Island Systems
- 2.3 Severe Accident Systems
- 2.4 Instrumentation and Control Systems
- 2.5 Electrical Power
- 2.6 HVAC Systems
- 2.7 Support Systems
- 2.8 Steam and Power Conversion Systems
- 2.9 Radioactive Waste Management Systems
- 2.10 Other Systems

14.3.2- Selection Process

- The selection processes are consistent with SRP 14.3
- Two processes used
  - System/Structure/Component (SSC) inclusion based on safety classification
  - Inclusion based on analysis review



14.3.2 - Selection Process (cont'd)

- **SSCs are reviewed based on classification and function**
  - **Include features that are directly required to provide the safety-significant function**
  - **Include primary safety injection flow path piping and equipment required to provide that function**
  - **Exclude manual valves that are not credited or features provided solely for equipment protection (e.g., system pressure relief valves, vent and drain piping and valves)**

14.3.2 - Selection Process (cont'd)

- **Analyses are reviewed to identify key performance features and parameters that should be verified**
- **List of analyses addressed is consistent with SRP 14.3**
  - **Design Basis Accident Analyses (Chapter 15)**
  - **Radiation Protection Analyses (Chapter 12)**
  - **Fire Protection Analyses (Chapter 9.5)**
  - **Flooding Analyses (Chapter 3)**
  - **Anticipated Transient Without Scram (ATWS) (Chapter 15)**
  - **Probabilistic Risk Analysis and Severe Accident (Chapter 19)**
  - **Unresolved Safety Issues, Generic Safety Issues & TMI Action Items (Chapter 1)**

ITAAC – Features Verification

- Systems/Structures/Components (SSC) features provided to meet various functional requirements are discussed in Tier 2.
- Tier 1 verifies the existence of the feature without regard to its purpose described in Tier 2.

14.3.2 - ITAAC Verify Plant Features

Systems Example

- Functions Approach (T2): Low Head Safety Injection (LHSI) provides core cooling for large break loss of coolant accident
- Features Approach (T1): LHSI piping runs from the IRWST, to the reactor coolant system via a pump and heat exchanger
- Features Approach (T1): LHSI supplies water at x gpm to RCS

Structures Example

- Functions Approach (T2): The wall between rooms X and Y provides radiation protection (and/or flooding and/or structural support and/or ..)
- Features Approach (T1): The wall between rooms X and Y is 18” thick.

14.3.2 –System Design Description

- The system design description is the certified design material
- Certified design material is in effect for the life of the facility

14.3.2 - ITAAC

- ITAAC are consistent with the certified design material
- Must be satisfied with closure justification submitted to NRC and approved to support 52.103g finding prior to loading fuel
- ITAAC expire following the 52.103g finding

14.3.2 – ITAAC Format and Content

- ITAAC content and format are consistent with SRP 14.3

Commitment	Inspections, Tests, Analyses (ITA)	Acceptance Criteria
The wording in the SDD that describes the feature to be verified.	The specific method the licensee will use to verify that the feature described has been provided.	A description of the acceptance criteria to be satisfied by the ITA.

Tier 2 Section 14.3.3 Non-System-Based Design Descriptions and ITAAC

- Tier 1 Chapter 3 addresses non-system-based topics
- SRP 14.3 provides a suggested list of topics for Chapter 3
  - Reliability Assurance Program
  - Initial Test Program
  - Human Factors Engineering
  - Pipe Break Hazards
- Additional Chapter 3 topics developed during the course of the review
  - Security
  - Containment Isolation
  - Plant Cabling
  - Accident Monitoring Instrumentation
  - Seismic SSC Interaction
- The CDM and ITAAC In Chapter 3 follow same approach as system- based CDM and ITAAC in Chapter 2 of Tier 1.

Tier 2 Section 14.3.4 Interface Requirements

- Tier 1 Chapter 4 addresses interface requirements
- Safety-significant items to be met by site-specific plant features to satisfy commitments in the certified design
  - Not to be confused with ITAAC developed by the COL applicant that support the COL
- Provides the requirement or a reference to where the requirement exists
  - For example - 4.11 Power Transmission (Main Generator, Main Transformer, Protection & Synchronization) is provided in Section 2.5.6 of Tier 1

Tier 2 Section 14.3.5 Site Parameters

- Tier 1 Chapter 5 addresses safety-significant site parameters
- List of parameters developed based on precedent of prior certified designs and SRP 2.0 (Referenced in SRP 14.3)
  - Examples: Rainfall, snow loads, temperatures, soil properties
- Safety- significant site parameters are to be satisfied by the COL Application, therefore no ITAAC are required.

Tier 2 Section 14.3.6
Design Acceptance Criteria

- Section 14.3.6 provides additional explanation on the use of Design Acceptance Criteria (DAC) in Tier 1 for the U.S. EPR
- Design Acceptance Criteria – Definition
  - "A set of prescribed limits, parameters, procedures, and attributes upon which the NRC relies, in a limited number of technical areas, in making a final safety determination to support a design certification."
- Design Acceptance Criteria – Closure processes
  - Amendment to DC
  - COL Application
  - After COL is issued with DAC. Closeout follows same process as ITAAC.

U.S. EPR DAC

- Due to the state of completion of the U.S. EPR design, DAC exist in only two areas as opposed to the four areas listed in SRP 14.3
- SRP 14.3 indicates that DAC may be appropriate on the subjects of: piping design, human factors, digital I&C design, and radiation shielding
- U.S. EPR DAC exist for only two areas: piping design, and human factors engineering

Acronyms

ATWS	Anticipated Transient Without Scram
CDM	Certified Design Material
COL	Combined License
CRDM	Control Rod Drive Mechanism
DAC	Design Acceptance Criteria
DC	Design Certification
FSAR	Final Safety Analysis Report
I&C	Instrumentation and Controls
IRWST	In-Containment Refueling Water Storage Tank
ITA	Inspections, Tests and Analyses
ITAAC	Inspections, Tests, Analyses and Acceptance Criteria
ITP	Initial Test Program
HFT	Hot Functional Tests
HZP	Hot Zero Power

Acronyms (cont'd)

LHSI	Low Head Safety Injection
LOOP	Loss of Offsite Power
LPPT	Low Power Physics Testing
MCR	Main Control Room
NSSS	Nuclear Steam Supply System
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RG	Regulatory Guide
SPND	Self Powered Neutron Detector
SG	Steam Generator
SBO	Station Blackout
SRP	Standard Review Plan (NUREG-0800)
SSC	Structures, Systems and Components
TMI	Three Mile Island

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Protecting People and the Environment

Presentation to the ACRS Subcommittee

AREVA EPR Design Certification Application Review

Safety Evaluation Report with Open Items

Chapter 14: Verification Programs

February 22-23, 2012

Staff Review Team

- **Technical Staff**
  - **Tech Reviewer Name: Andrea Keim**
    Branch Name: Quality Assurance
  - **Tech Reviewer Name:** Manas Chakravorty
    Branch Name: Structural Engineering
  - **Tech Reviewer Name:** Yiu Law
    Branch Name: Engineering Mechanics
  - **Tech Reviewer Name:** John Budzynski
    Branch Name: Reactor Systems
  - **Tech Reviewer Name:** Daniel Mills
    Branch Name: Instrumentation, Controls and Electrical Engineering
  - **Tech Reviewer Name:** Peter Kang
    Branch Name: Instrumentation, Controls and Electrical Engineering
  - **Tech Reviewer Name:** Tarico Sweat
    Branch Name: Balance of Plant

(Staff Review Team Continued)

- **Tech Reviewer Name:** Jean-Claude Dehmel
  Branch Name: Radiation Protection
- **Tech Reviewer Name:** James Bongarra
  Branch Name: Operator Licensing
- **Tech Reviewer Name:** Anne-Marie Grady
  Branch Name: Containment and Ventilation

- **Project Managers**
  - Lead PM Name: Getachew Tesfaye
  - Chapter PM Name: David Jaffe with Tanya Ford

Overview of DCA

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SRP Section/Application Section		No. of Questions	Status Number of OI
14.1	Specific Information for IPT	2	0
14.2	Initial Plant Test Program	163	7
14.3	Inspections, Tests, Analyses, and Acceptance Criteria	-	-
14.3.1	Selection Criteria	3	1
14.3.2	Structural and Systems Engineering	61	9
14.3.3	Piping Systems and Components	51	4

(Overview of DCA Continued)

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SRP Section/Application Section		No. of Questions	Number of OI
14.3.4	Reactor Systems	4	0
14.3.5	Instrumentation and Controls	42	5
14.3.6	Electrical Systems	34	0
14.3.7	Plant Systems	38	0
14.3.8	Radiation Protection	3	2
14.3.9	Human Factors Engineering	19	3

(Overview of DCA Continued)

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SRP Section/Application Section		No. of Questions	Status Number of OI
14.3.10	Emergency Planning (Plant-specific)	-	-
14.3.11	Containment Systems	5	1
14.3.12	Physical Security Hardware	58	1
	TOTAL	475	33

Presentations

Presenter	Section
Andrea Keim	14.2
Tanya Ford	14.3.1
Manas Chakravorty	14.3.2
Yiu Law	14.3.3
John Budzynski	14.3.4
Daniel Mills	14.3.5
Peter Kang	14.3.6
Tarico Sweat	14.3.7
Jean-Claude Dehmel	14.3.8
James Bongarra	14.3.9
Ann-Marie Grady	14.3.11

Red----Presentation

Black----Available

14.2 – Initial Plant Test Program Significant Open Item

RAI 527, Question 14.02-163, based on a review of FSAR, Tier 2, Revision 3, Section 14.2.12 and the FSAR mark-up provided in responses to RAI 386, Questions 14.02-151, 14.02-152, 14.02-156, 14.02-158, and 14.02-159, the staff identified a number of inconsistencies in the descriptions of test methods and acceptance criteria for radiation monitoring systems listed in FSAR Tier 2, Sections 14.2.12, 12.3, 11.5.3, 11.5.4, 11.2, 9.4.3, and 9.2.4. The staff's review indicates that the test methods and acceptance criteria do not refer to each system's specific radiation monitor tag numbers in confirming the proper operation of automatic control functions (e.g., isolation or diversion) upon detecting high radioactivity activity levels and departures in process or discharge flow rates, or proper operation of backflow preventers for systems that are not equipped with radiation monitoring instrumentation.

14.3.1 – Selection Criteria Significant Open Items

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RAI 182

- In RAI 182, Question 14.03-10, the staff raised various concerns regarding ITAAC including:
  - Inconsistencies with ITAAC wording and interpretations
  - Technical adequacy of ITAAC
  - Definitions used in ITAAC wording
  - ITAAC inspectability issues
- The staff reviewed the applicant's response to RAI 182 and determined the response insufficient in addressing all of the staff's concerns.
- Follow-up RAI 469, Question 14.03-16 was issued to resolve the remaining concerns that had not been addressed.

(Significant Open Items Continued)

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RAI 469

- In RAI 469, Question 14.03-16, the staff requested the applicant to address the remaining ITAAC issues identified by the staff including:
  - Specificity in ITAAC wording
  - Improper use and omission of “as-built” terminology in ITAAC
  - ITAAC inspectability issues
- The staff is still in the process of reviewing the applicant’s draft response to RAI 469 and has provided some feedback to the applicant regarding its response.

(Significant Open Items Continued)

RAI 469 (cont.)

- **Examples of feedback provided to the applicant included:**
  - ***Lack of specificity*** – There are several instances where the ITAAC requirement simply states that an analysis be performed. However, there's no specificity as to whether this analysis is based on the design or construction of the plant. By saying analysis only and not providing which type, leaves ambiguity in when the analysis is to be performed. AREVA needs to specify this level of detail throughout all of the ITAAC where an analysis is required
  - ***Inspections of analyses*** – If an analysis is to be based on as-built conditions, there also needs to be an inspection associated with this ITAAC to verify that the work was completed according to the applicable specifications.

(Significant Open Items Continued)

RAI 469 (cont.)

- ***ASME Code related ITAAC*** – All ASME Code ITAAC should be consistent throughout all of the ITAAC sections. Therefore, even if an ASME Code related ITAAC appears in different ITAAC Chapters, the wording should be consistent in each reference throughout ITAAC.
- ***Omission of "as-built" terminology*** – In several instances the term "as-built" was removed from the ITAAC wording when in some instances it should not have been. If the requirement is to be performed after construction has been completed, then this terminology should be added back to the ITAAC wording for specificity.

(Significant Open Items Continued)

RAI 469 (cont.)

- ***Severe Accident ITAAC*** - AREVA quotes from SRP Section 14.3 that "only the existence of the feature needs to be verified by ITAAC." This argument relates to the Section 14.3 guidance that the level of design detail need only be commensurate with the significance of the safety functions. However, the SRP also suggests that a "graded approach" be used; specifically how to address "specific non-safety-related criteria for inclusion in Tier 1 such as severe accident, ATWS, and fire protection." The staff believes that additional severe accident ITAAC need to be included for selected safety significant, but non-safety-related equipment (e.g., the Hydrogen Monitoring System which measures the hydrogen concentration in containment during and after the accident).

- **RAI 469, Question 14.03-16, is being tracked as an open item to resolve the staff's remaining ITAAC concerns.**

14.3.2 - Structural and Systems Engineering Significant Open Items

- RAI 386, Question No. 14.03.02-45: Requested that the applicant address whether all barriers providing protection against the dynamic effects of missiles and pipe breaks had been identified in FSAR Tier 1, Section 2.1 and requested that the applicant include the key dimensions for these barriers. The applicant's response resulted in follow-up RAI 527, Question 14.03.02-57 which noted that barrier dimensions had not been provided and requested that analysis, inspection and acceptance criteria (ITAAC) for internal missiles barriers be included in FSAR Tier 1, Section 2.1 ITAAC tables.
- RAI 386, Question No. 14.03.02-51: Requested that the applicant address the ASME III, Division 2 Code requirements regarding the need to measure strains during the structural integrity test of prototype containments. The applicant's response stated that the containment was not a prototype, but did not provide the basis for its position. This resulted in follow-up RAI 527, Question 14.03.02-59 which asked that specific comparisons between tested prototypes and the EPR containment be provided to support the applicant's position that the EPR containment did not require strain measurements.

14.3.5 - Instrumentation and Controls Significant Open Items

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- RAI 506, Question 14.03.05-27: Requested that the applicant to address how ITAAC describes the Safety Information and Control System (SICS) safety functions and how the safety functions are verified.

- RAI 506, Question 14.03.05-30: Requested that the applicant address how ITAAC verifies the safety functions of the Priority and Actuator Control System (PACS.)

- RAI 506, Question 14.03.05-39: Requested that the applicant explain why single-failure protection ITAAC were not included for some safety-related systems.

- RAI 506, Question 14.03.05-41: Requested that the applicant address how ITAAC describes the self test functionality of the Safety Automation System (SAS) and how this functionality is verified.