Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
610th Meeting

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Wednesday, December 4, 2013

Work Order No.: NRC-473 Pages 1-70

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

DISCLAIMER

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

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, as reported herein, is a record of the discussions recorded at the meeting.

This transcript has not been reviewed, corrected, and edited, and it may contain inaccuracies.

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

610TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

WEDNESDAY

DECEMBER 4, 2013

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 1:30 p.m., J. Sam Armijo, Chairman, presiding.

COMMITTEE MEMBERS:

J. SAM ARMIJO, Chairman

JOHN W. STETKAR, Vice Chairman

HAROLD B. RAY, Member-at-Large

RONALD G. BALLINGER, Member

SANJOY BANERJEE, Member

DENNIS C. BLEY, Member

CHARLES H. BROWN, JR. Member

MICHAEL L. CORRADINI, Member

DANA A. POWERS, Member

JOY REMPE, Member

PETER RICCARDELLA, Member

MICHAEL T. RYAN, Member

STEPHEN P. SCHULTZ, Member

GORDON R. SKILLMAN, Member

ACRS CONSULTANT:

WILLIAM J. SHACK

DESIGNATED FEDERAL OFFICIAL:

CHRISTOPHER L. BROWN

ALSO PRESENT:

EDWIN M. HACKETT, Executive Director, ACRS

MIKE CALL, NMSS

PATRICK CASTLEMAN, OCM

GREG CASTO, NRR

AMY CUBBAGE, OCM

HOSSEIN ESMAILI, RES

KATHY HALVEY GIBSON, RES

DON HELTON, RES

JOHN HULL, OGC

STEVEN JONES, NRR

IAN JUNG, OEDO

MARVIN LEWIS*
TIM MCGINTY, NRR
JOSE PIRES, RES
BILL RECKLEY, NRR
FRED SCHOFER, NRR
DAVE SKEEN, NRR
ROB TAYLOR, NRR
KEVIN WITT, NRR

*Present via telephone

T-A-B-L-E O-F C-O-N-T-E-N-T-S

I. OPENING REMARKS BY THE ACRS CHAIRMAN

Chairman Armijo 5

II. JAPAN LESSONS LEARNED TIER 3 ISSUE:

1. Opening remarks

Chairman Armijo 6

2. Staff opening remarks and introduction

Tim McGinty 6

III JAPAN LESSONS LEARNED TIER 3 ISSUE:

EXPEDITED TRANSFER OF SPENT FUEL TO DRY CASK STORAGE

Kevin Witt 7

Steve Jones 15

IV PUBLIC COMMENT

Marvin Lewis 68

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

(1:30 p.m.)

CHAIRMAN ARMIJO: The meeting will now come to order. This is the first day of the 610th meeting of the Advisory Committee on reactor safe guards.

During today's meeting the committee will consider the following. Japan Lessons Learned Tier 3 issue, expedited transfer of spent fuel to dry cask storage.

Second, draft report on the bi-annual ACRS review of the NRC safety research program. And third, preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Christopher Brown is the designated Federal Official for the initial portion of the meeting.

We have received no written comments or requests to make oral statements from the members of the public regarding today's sessions.

There will be a phone bridge line. To preclude interruption of the meeting, the phone will be placed in a listen in mode during the presentations and committee discussion.

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

So we'll start with the first topic and the purpose of the meeting, briefing is to receive, the purpose of the meeting is to receive a briefing from the Office of Nuclear Reactor Regulation on the staff evaluation and recommendation for Japan Lessons Learned Tier 3 issue on expedited transfer spent fuel.

Our materials metal urging reactor fuel subcommittee reviewed this matter on June 9th, September 19th and November 19th of 2013. Our full committee also reviewed this matter on October the 2nd, 2013.

We will now proceed with the meeting and I call upon Tim McGinty of the NRR to give a brief introduction and introduce the presenters. Tim.

MR. MCGINTY: Thank you. Good afternoon, my name is Tim McGinty and am the direct of the division of safety systems in the Office of Nuclear Regulation at the NRC.

I would like to thank the Chairman and the members of the ACRS for the opportunity to hear the

staff's presentation of the near Term Task Force Tier 3 action to recommend whether further regulatory action is recommended or additional study would be warranted regarding the expedited transfer of spent fuel from wet to dry storage.

To determine whether regulatory action might be warranted, we followed our regulatory decision making procedures to determine whether there is a substantial safety enhancement. Additionally, to provide information to the Commission, the staff performed additional cost-benefit analysis as well as additional sensitivity studies of cases beyond the current regulatory framework.

Based on the feedback that you provided in prior subcommittee meetings, the staff has made improvements to their analysis and updated COMSECY-13-0030. Which was initially sent to the Commission on November 12th.

For our meeting with you today, Kevin Witt will be covering the Tier 3 plan background and evaluation process, Steve Jones will be covering the Tier 3 analysis and Fred Schofer will supporting the discussions on the cost-benefit analysis. And with that I turn it over to Kevin Witt please.

MR. WITT: Thank you, Tim. As Tim

mentioned my name is Kevin Witt, I'm a project manager and the Japan lessons learned projector director in the Officer of Nuclear Reactor Regulation.

I was responsible for coordinating staff activities on this issue. I'll be going through a bit of the background and then I'll turn it over to Steve.

For the agenda today we're going to go really quickly through a background on this issue. You probably heard it before, we've presented this to you a number of times so we're going to try to focus more on the technical aspects of this analysis.

We're also going to give a brief recap of the spent fuel pool study which was reviewed by the ACRS at their July meeting. And just to give you a little bit of history with how we used that.

And then we're going to talk about the analysis we did, we're calling it the regulatory analysis on this issue. We'll talk about the assumptions we made and the results then we'll talk about the conclusion.

A little bit of background, after Fukushima happened the Japan Lessons Steering Committee decided to initiate a lessons learned item on this issue of whether expedited transfer of spent fuel, whether regulatory action might be needed on

this issue.

And as first step in that issue to determine how to progress on that, we initiated a study on that that was conducted by the Office of Nuclear Regulatory research. And that evaluated the difference, it's the spent fuel pool study.

That was provided at the Commission in October. It evaluated the differences and consequences between high-density and low-density spent fuel pools at a reference plant, specific reference plant.

And then on the Tier 3 plan what we did was, we tried to determine what the best way to figure out whether regulatory action is needed on this issue. And so there's a broad history of research on this topic of spent fuel safety.

And we so kind of formulated a plan to take all that information into consideration and process it through our regulatory framework utilizing the regulatory analysis guidelines. And that's in NUREG Brochure 0058. And that's the enclosure to the Tier 3 COMSECY which was just sent up to the Commission on this issue.

We provided an update to the Commission on this plan on how we propose to pursue it. That was

provided in May of 2013 and we just sent that up to the Commission, the final paper in November.

The Tier 3 plan, the objective of what we were doing with this first phase, what we're calling the first phase of this plan, was to determine whether we needed additional study on this matter. And depending on how the analysis would turn out, we would come up with a decision on whether regulatory action might be warranted. And if that would be the case then we would proceed to Phase 2.

So Phase 1 was really a high level look at whether more study is needed on this issue. And that's what was provided to the Commission.

Now Phase 2, obviously our recommendation is to not go to that point, but if we did get to Phase 2 we would be doing additional analysis such as doing research on risks associated with an expedited transfer as well as conservatism that we've made in this analysis to try to put more, less on certainty in that analysis.

And then Phase 3 would be inclusion of all these other factors that are currently ongoing. Probably take a number of years for all that be completed. So that would be our plan.

We've had a number of stakeholder

interactions on this issue. We had two public meetings, August 22nd and September 18th of this year.

We received a number of letters from stakeholders about our analysis as well as the spent fuel pool study. We responded to those letters.

In addition we've also included responses to the comments we received in the documents in the spent fuel pool study. They included an appendix in the final study with responses to comments they received on the study as well as in this Tier 3 analysis, we included at the back of our analysis, we included responses to some of the questions or comments we received on how we did this.

As I mentioned, the spent fuel pool study that was just, there was a public comment period on that in July, June and July. And the final report was sent to the Commission in October.

Now on this Tier 3 analysis we did release a draft version of the analysis back in September. And really the content of the analysis, the way we did the analysis hasn't really changed from what we issued back in September to what we have now.

It's more about the format and the layout of how we explained the analysis. And we'll go through that in a little bit more detail.

We did have the ACRS full committee presentation on this in October. And we did take some feedback to that to improve the COMSECY which was reflected in the final version that was sent up to the Commission.

We also received a nonconcurrence from NRC staff on this that was attached to the back of the COMSECY. We have a response to that, we also have a slide on some of those issues that we'll talk about.

Now from the subcommittee meeting we did receive some questions and comments about the content of our analysis. We did make some corrections, I sent that to Christopher. I believe, that was sent to you all.

The final version of the COMSECY was updated. These are basically typographical errors. They did not change the analysis that we did. So this is just, gives an overview of what we have changed.

I think we captured all the things that you mentioned and made sure that everything else was correct. So we appreciate the feedback on that.

VICE CHAIRMAN STETKAR: Kevin, just to get it on the record, you didn't make all of the corrections in Table 2. And in particular you say for the high case, the liner fragility is set to a 100

percent and it's not.

And the changes that you made to Tables 44, 56 and 60 did indeed bring two of the base case evaluations into alignment with two others. But it kept two of them consistently now out of alignment with the other four.

So what I propose, just to avoid getting into excruciating detail in this meeting, is I'd like to sit down with the staff offline and try to understand what's going on in those, the 44, 56, 64 detail tables. Because I still can't figure out a couple of them.

Table 2, it's just you missed one of the, on the right hand column where you say for the high estimate 100 percent fragility is used for all the cases, that's not true. You use 25 percent fragility for the high cases, for two, three and four.

MR. WITT: Okay.

VICE CHAIRMAN STETKAR: So you still got a little bit of typos to look at.

MR. WITT: Okay.

VICE CHAIRMAN STETKAR: You really off two or three things.

MR. WITT: I apologize for that. We'll certainly make sure that everything is correct and

afterwards we'll be happy to talk to you.

VICE CHAIRMAN STETKAR: Okay, thanks.

MR. WITT: About those things. Okay, just to talk a little bit about how we went through this process.

As I mentioned, the first step of this process was the spent fuel pool study. And that was a consequence study for a specific plant, a reference plant, based on the Peach Bottom spent fuel pool. And of course specific scenario that was a seismic event that impacted the spent fuel there. Spent fuel pool.

From that study we took the consequences and we did an example of how that would fit into our regulatory framework. So we added in Appendix D to the spent fuel pool study which took the consequences from the spent fuel pool accident and applied it to the framework to see whether there would be a substantial increase in safety.

And we expanded it out a little bit. We included some other initiating events that had analysis in the spent fuel pool study.

And then from there, that really laid the basis for how we did the Tier 3. We took the same process and we extended that out even more and we applied that same analysis to all the plants.

We tried to capture them in different groupings and we'll talk about that a little bit later. That's all for the study.

MR. JONES: Good afternoon, my name is Steve Jones, I'm the technically lead for spent fuel storage and handling in division of safety divisions. I'd like to briefly recap the results of the spent fuel pool study that you heard about a few months back from the Office of Research.

Just covering some of the highlights with respect to this study. One, the spent fuel pools, it does support a robust spent fuel pool construction and that the study confirmed that the, at least for the reference plant, that the pool at the low likelihood of leakage.

And in the study they made a conservative assumption really of a 90 percent of the time the pool would not leak.

CHAIRMAN ARMIJO: Steve, I just want to bring up a point. Bill Shack and I had breakfast today and we talked about the spent fuel pool study and it actually did, the analysis, the detailed analysis was not limited to the 0.7 g PGA earthquake.

It also did an analysis of the 1.2. And could you remind us of what the liner leakage

probability was for that analysis?

MR. JONES: I'd have to look for --

VICE CHAIRMAN STETKAR: I have it. For June?

MR. WITT: I don't believe that we did a structural analysis for the 1.2 g earthquake.

VICE CHAIRMAN STETKAR: Right.

CHAIRMAN ARMIJO: Is that --

MR. WITT: We did it for the 0.7 g. What we did in the regulatory analysis was we included the 1.2 g consideration in the regulatory analysis and we assumed 100 percent liner --

CHAIRMAN ARMIJO: Okay --

VICE CHAIRMAN STETKAR: For only the BWR --

MR. WITT: For the Peach Bottom.

VICE CHAIRMAN STETKAR: -- for only Peach Bottom.

CHAIRMAN ARMIJO: Only Peach Bottom?

MR. WITT: Correct.

VICE CHAIRMAN STETKAR: For the others you assume 0.5.

MR. WITT: Right.

VICE CHAIRMAN STETKAR: Just for the base case.

CHAIRMAN ARMIJO: Just maybe I misunderstood.

CONSULTANT SHACK: This is Bill Shack. What I was explaining to Sam is, if you looked at the Vermont Yankee and you looked at that fragility and you used the same law of normal distribution, you would get a, you would not get a hundred percent for the failure at the 1.2 g earthquake.

VICE CHAIRMAN STETKAR: Right.

CONSULTANT SHACK: You'd get closer to 0.5.

CHAIRMAN ARMIJO: Okay.

CONSULTANT SHACK: So although they didn't do the calculation, if you assumed it, followed the law of normal similar to the Vermont Yankee one then we would conclude that you roughly have a factor of 2.

CHAIRMAN ARMIJO: Okay, I misheard. Yes. Okay, thank you.

MR. JONES: Okay, and then if leakage were to occur that would fully drain the pool, the study concluded that spent fuel in the pool would air-coolable within two months after discharge from the fuel for at least 72 hours.

And in both case, both the high-density and low-density storage cases, the frequency of a

release was identical. Essentially all cases that lead to a release from a low-density, for a high-density pool configuration also lead to a release for a low-density. However the magnitude of the release was different.

Next slide. And then in general these statements support that the previous spent fuel pool study's conclusions were valid. And I think we'll move onto the next slide.

Okay, what changed in Appendix D to the spent fuel pool study, it examined or included initiating events that were not specifically analyzed in the main body of the report. Including a more severe earthquake, the cask drop event, and other initiators such as loss of power or loss of coolant inventory.

Then the Tier 3 regulatory analysis included all these additional initiating events and examined groups of pools representing the entire operating fleet in the Eastern and Central U.S. and new reactors under construction. The API-1000 plants in South Carolina and Georgia.

The security --

CONSULTANT SHACK: Steve, this is Bill Shack, can I ask a question again --

MR. JONES: Yes.

CONSULTANT SHACK: -- about this? If I look at the regulatory analysis for the spent fuel pool study in Appendix D, and it's Table 108 so I'm looking beyond 500 miles and $4,000 per person-rem, I get in the high case of benefit of like minus $25 million.

If I look at the high analysis in the Tier 3 regulatory analysis for the Group 1 plants for the high analysis, I get a plus $500 million. I think the difference in the assumption is that the, in the Peach Bottom one you did not assume mitigation for one and not the other and you did in the Tier 3.

Is that the difference or, what makes this enormous difference from minus $25 million to plus $500 million?

MR. SCHOFER: As far as the mitigation, the mitigation assumption was the same for Appendix D. So --

CONSULTANT SHACK: So the low one always had mitigation and the high one didn't?

MR. SCHOFER: That is correct.

MR. WITT: Well, and what we did in the Tier 3 analysis was we tried to pick the highest cases, generally, for the assumption. So we didn't

always use the Peach Bottom assumptions in that analysis. For instance --

CONSULTANT SHACK: That would seem to indicate that you're grouping them is still too course. I mean if you're going to minus $25 million to plus $500 million, that's, you know, steering an awful lot of information.

MR. SCHOFER: I mean, you know, a major difference between the two analyses is, for the reference plant all we had to do was address the high and low for that particular plant. When I went to the grouping to address all the pools, there's more variability from pool to pool to pool, even within a group.

And so when, you know, you have the high estimate cases, those high estimate values --

CONSULTANT SHACK: Then you can't argue that the high estimate case is conservative. I mean you're arguing that it covers a lot of variabilities. So if I did a real case for one of those, you know, would I end up with something that looked like $500 million?

MR. WITT: Well I think that, how we've characterized the high cases is that we view it as more of a bounding type analysis and we viewed the

basis --

VICE CHAIRMAN STETKAR: Please don't use the word bounding. They are not bound, people interpret bounding as it cannot be any worse than that. And that is not true.

They are high estimate cases. They don't use bounding values for all parameters. So you're high estimates cases are not conservatively bounding. They are simply high estimate cases.

CHAIRMAN ARMIJO: Everywhere where they are not --

VICE CHAIRMAN STETKAR: They are not bounding.

CHAIRMAN ARMIJO: Everywhere where the table says 100 percent, that is bounding.

VICE CHAIRMAN STETKAR: That is a bounding value of the fragility.

CHAIRMAN ARMIJO: Right.

VICE CHAIRMAN STETKAR: Period. That is correct. Other values that are used in those high estimate cases are not.

CHAIRMAN ARMIJO: Sure. Right.

CONSULTANT SHACK: But there are bounding values in the Appendix D analysis too where you used a hundred percent for the 1.2 g earthquake --

MR. WITT: Correct.

CONSULTANT SHACK: -- and you still came up with minus $25 million versus the $500 million. I'm still looking for the --

CHAIRMAN ARMIJO: Where's the pony?

CONSULTANT SHACK: Yes, I just, I need somehow to sort that out a little bit.

CHAIRMAN ARMIJO: I think, have demographics changed at all?

MR. WITT: Demographics went down.

VICE CHAIRMAN STETKAR: You'll have to get back to him.

MR. WITT: Well, I'll get back to you on that. Still have a lot of questions, but not that, okay.

All right, I do want to point out once more that the security events are handled separately. We did consider the regulatory changes specifically those implemented under 10 CFR 50.54(hh) and those are included in the regulatory baseline.

The regulatory analysis really comes in two parts. First, the safety goal screening that evaluates the effect of early transfer of fuel with respect to this commission safety goal policy statement.

And specifically we used the quantitative health objectives to evaluate whether or not or to what degree the safety goals were satisfied. Also there's a cost-benefit analysis.

This was designed to really look at the maximum potential benefit for the particular cases evaluated. And it analyses those benefits in terms of representative groups of spent fuel pools.

Next slide please. The safety goal screening used, basically done in three steps. One was determining a release frequency. We used the highest release frequency among the high estimate cases. In that case it was Group 4.

And then applied a conditional probability of a fatal cancer from the spent fuel pool study derived for a large release at the Peach Bottom site, specifically, and that considered a linear no-threshold model with protective actions implemented.

And from that determined that the individual latent cancer fatality risk was less than one percent of the quantitative health objective goal. Any questions? Next slide I guess.

So based on that result we concluded there was a marginal safety benefit. We also considered the quantitative health objective related to top

fatalities and determine that there was no risk of early fatalities due to the nature of the release from the spent fuel pool accident.

A potential benefit here was a very, again, a very small fraction of the latent cancer goal. I do want to highlight that the cancer risk however is relatively insensitive to the magnitude of the release due to the predominantly, due to the effective protective actions but also the slow evolution of the accident.

Because we're so far from the quantitative health objective goal, the safety benefit was low enough that it easily did not pass the safety goal screening to proceed on to a bio-impact analysis. Although we did continue to provide information to the, addition information for this particular study.

CHAIRMAN ARMIJO: Have you ever just stopped the analysis with the evaluation of meeting the QHO criteria?

Simply said, you know, we're spinning our wheels spending money and the answer isn't going to get any better. Do you have history of doing that in this staff?

MR. SCHOFER: When we did a safety goal screening, you know, typically we're evaluating

reactors for core damage frequency or, you know, if we're well below the 10-5 --

CHAIRMAN ARMIJO: So for that case you've done it enough that you feel that you can just stop right there?

MR. SCHOFER: And prior NUREGs that evaluated the spent fuel pools, you know, did look at the QHOs and never did a detailed cost evaluation.

CHAIRMAN ARMIJO: Okay, it's been done before then? You've actually stopped at the QHO.

MR. JONES: Sorry. The cost-benefit analysis was conducted with an effort to maximize the calculated benefit predominately through selection of the release fractions from the spent fuel pool and also treatment of mitigation.

Probably jump back on this slide. I'm sorry, I jumped ahead one slide on the presentation in front of you.

Okay, for the cost-benefit analysis we selected one alternative. That was expedited transfer.

So all fuel if more than four years decay was assumed to be moved to dry cask and the remaining fuel be stored in a low-density configuration in the existing racks. That is 1x4 with each recently

discharged assemblies surrounded by four empty slots on each face.

And the established spent fuel pool groups, there's four groups that are specifically considered in this analysis. The first group was the BWRs with elevated pools.

Second group was PWRs and BWR Marked IIIs where they are separate buildings for the spent fuel pool from the reactor. And the pools are generally at or near plant grade.

The third group was the, represented the new reactors. The AP-1000 plants under construction.

And the fourth group is a set of plants that share a spent fuel pool and therefore would have higher decay heat loadings. And also a greater fraction of the time potentially with high decay heat loads represent in the pool.

The major assumptions used in the cost-benefit analysis were provided in Table 2 of the analysis. Some of these included the spent fuel pool event frequencies and accident progression assumptions, the economic modeling and also the timing with respect to when dry casks were loaded and therefore how the, I'm sorry, how the discount rates were applied to determine the cost for those actions.

They also established the base case so we consider representative of the bulk of the plants and somewhat conservative with respect to what we consider the average plant and perform sensitivity and studies.

CHAIRMAN ARMIJO: Steve, I just want to make sure I have this straight. The decision not to credit mitigation capabilities that would result from orders EA-12-049 and EA-12-051, you consider that an assumption or different than an assumption or what is it? Is it just a decision or an assumption that the equipment, even if it was there, wouldn't work?

MR. SCHOFER: It certainly was not that.

CHAIRMAN ARMIJO: Well so we just did a decision not apply, but you didn't, that equipment was not credited for either alternative, right? The base case.

I mean the Alternative 1 or Alternative 2, so. It was an evenhanded, we're not going to credit that for either alternative?

MR. WITT: We have a slide on that, Slide 20. We can talk about it now if you want?

CHAIRMAN ARMIJO: Just say yes or no. Did you --

MR. WITT: Well they're analysis did not credit mitigation for the baseline case. But we do

have a slide that talks about what would happen if you did credit for both cases or if you did not credit for both cases.

CHAIRMAN ARMIJO: That's new then?

MR. WITT: That's new information that we're presenting to you.

CHAIRMAN ARMIJO: Oh, okay. All right.

MR. SCHOFER: To answer your question directly, it was an assumption that was made to develop the maximum delta between the two cases to demonstrate that whether we could show the low-density alternative to be cost-beneficial.

CHAIRMAN ARMIJO: Yes, I understand, I understand.

MR. SCHOFER: But it was just an assumption made because of other results that came out of Appendix D.

CHAIRMAN ARMIJO: Okay.

MR. JONES: Okay, we are talking about these assumptions. We did assume for the regulatory baseline case relatively high release fractions.

We used for the BWRs the elevated pools. Since there was somewhat less uncertainty with that value, the spent fuel pool study value of about 40 percent.

For the pools at or near grade, or the remainder actually of the groups, we assumed a higher value that was used in NUREG-1738 of 75 percent. And then when considering the low-density spent fuel configuration, the alternative, the value used was three percent for all groups. That was representative of the low-density releases from the spent fuel pool study.

And with consideration of mitigation, that release fraction has both a lower frequency and a much lower magnitude. Obviously greater than one order of magnitude lower release for the alternative case.

Next slide please. For the base case analysis, as I mentioned before, we did believe that's the correct case to use to decide whether or not to pursue additional studies to refer the refine of our assumptions.

The base case includes some conservative but not bounding values for the following items. One was the initiating event frequencies.

The seismic event frequency was derived from USGS 2008 information. And we used predominately the Peach Bottom seismic hazard for all the base cases actually. And that is near the upper end of the estimated frequencies for plants in the Central and

Eastern United States.

Okay. The liner fragilities were based on the spent fuel pool study for the elevated pools and used previous study information for the remainder of the pools. Weather is really a lot more uncertainty with respect to the specific plant configuration.

Cesium inventories were based on the actual amount of spent fuel present. The cooling periods and the fuel burn up that's typical for the plants in the group.

The releases were calculated using a MACCS2 code in the Peach Bottom meteorology information. However the population density was assumed for the Surry plant which is representative of the mean of all the U.S. plants therefore it's somewhat lower than Peach Bottom.

And for the industry implementation cost it was based predominately on Electric Power Research Institute information. Next slide.

One major assumption that was intended to address stakeholder comments regarding the ability to accurately represent partially drain down states or the fact that racks may interfere with natural circulation cooling of the fuel and the actual distribution of the fuel. Most of the cases include,

most of the initiating events include a bounding assumption that heat removal would be inadequate due to natural circulation effects.

This is, we consider this conservative because the spent fuel pool study indicated that there's substantial potential for air-cooling when the pool is drained or the decay heat is low. And we made an exception in that case for the Mark I and II BWRs covered by the spent fuel pool study because again, there was less uncertainty with that information.

And for that case we used eight percent representative of the fraction of the operating cycle where the heat in the hottest assemblies was too high to support adequate natural circulation cooling there.

Okay, next slide please. These assumptions resulted in this table for the initiating, for release frequency determination. This does not consider any mitigation effects.

For Bin 3, for Bin 1 in particular. I do want to point out again the inadequate pooling eighth percent. That substantially reduces the contribution from the Bin 3 earthquake to the overall results there.

And for Bin 4, for the at-grade pools which represent Groups 2 through 4, there's a 50

percent assumption of pool liner fragility which somewhat reduces the contribution of Bin 4 to that overall total. Nevertheless, for both plants about 90 percent of the overall release frequency is based on the seismic initiators. And that's consistent with past studies and other information.

VICE CHAIRMAN STETKAR: Steve?

MR. JONES: Yes.

VICE CHAIRMAN STETKAR: I hate to pick at numbers but this table, this report is so full of numbers that --

MR. JONES: Right.

VICE CHAIRMAN STETKAR: These numbers that you're showing on this slide are not the same as the numbers that are in Table 43 in the report. Many of them are but some of them are not.

MR. JONES: Should they be?

VICE CHAIRMAN STETKAR: Yes they should.

MR. JONES: They should be the same.

VICE CHAIRMAN STETKAR: Yes, okay.

MR. JONES: I guess that was what I was struggling with.

VICE CHAIRMAN STETKAR: One of the things that I look on this slide, for example, if I look at the, you know, what are, there's a five percent pool

liner fragility, let's see, maybe some of, yes, maybe they are. I'm sorry. I'm sorry maybe they are.

MR. JONES: Okay.

VICE CHAIRMAN STETKAR: 4.9, they're organized a little differently but --

MR. JONES: Yes, they are organized a little different, I'm sorry.

VICE CHAIRMAN STETKAR: Yes, I'm sorry you're right. I retract all of that. These are.

MR. JONES: Okay.

VICE CHAIRMAN STETKAR: These are. The base case, these, I'm sorry.

MR. JONES: Yes.

VICE CHAIRMAN STETKAR: Never mind.

MR. JONES: Okay.

(Simultaneous speaking)

MEMBER CORRADINI: How far back do you want to retract on the statement?

VICE CHAIRMAN STETKAR: No, that's not --

(Simultaneous speaking)

MEMBER CORRADINI: I just want to be clear.

MR. JONES: Okay, I hope I got that one.

VICE CHAIRMAN STETKAR: It happens.

MR. JONES: Using those frequencies and

applying the release fractions and cesium inventories identified for the different groups and then the overall consequence results from the MACCS2 analysis, the cost-benefit analysis presents the resulting economic and health consequences.

And predominately the base case is looking at benefits within 50 miles considering the current regulatory guidelines of $2,000 per person-rem. And then all cases for the, for all groups within the base case, the cost outweigh the benefits for that particular analysis.

Sensitivity analysis were performed to consider the potential increase in the dollar per person-rem factor to $4,000 and also extended the analysis to consider consequences beyond 50 miles. In that case, again for Groups 1 and 2, the cost outweigh the benefits for those plants.

However, for the Groups 3 and 4, the benefits marginally outweigh the cost. And that's due in part, for Group 3 predominately due to the longer period of operation expected. And for Group 4, there's somewhat higher consequences resulting from the fact that two reactors are discharging to a single pool.

CHAIRMAN ARMIJO: Steve?

MR. JONES: Yes.

CHAIRMAN ARMIJO: You know, beyond 50 miles, where do you stop? You know, you wind up over the ocean or I mean, a few months ago there was a Stanford study that basically covered the earth with fallout from Fukushima. And of course they got a huge population and they use the LNT and they got all sorts of latent cancer fatalities.

In this analysis, where is, what's, you know, greater than 50, does it take me around the world or does it stop at the Atlantic Coast? Exactly how did you do that?

MR. JONES: I guess I'd have to --

MR. WITT: If I could offer my thought on it? I understood that the way that, out of consequences beyond 50 miles are generally impacted as by people repopulating the area. And so depending on where they're repopulating I think is where the consequences may rely.

CHAIRMAN ARMIJO: But people are repopulating the area within 50 miles also.

MR. JONES: Correct.

CHAIRMAN ARMIJO: So I'm just trying to find, you know, the population, number of people exposed gets bigger the further out you go and then at

some point you run out of people. Maybe over the ocean or something. How do you do that?

MR. JONES: Don may be able to address the truncation that was --

MR. HELTON: Hi, this is Don Helton of the Office of Nuclear Regulatory Research. We'd have to get back to you with a very precise answer but you should be thinking in terms of out to 500, either 500 or 1,000 miles.

So in the direction of the Atlantic Ocean for a site like Peach Bottom, you would reach the Atlantic Ocean and the other three directions you would not have. And for other sites obviously different situations. But that's the mental notion you should have.

CHAIRMAN ARMIJO: So as far as out as there are people?

MR. HELTON: No, it would be 500. Like I said, if it was pre-coded calculation, we'd have to check to whether, partially due to calculations as to whether it was done to 500 or 1,000.

CHAIRMAN ARMIJO: Okay.

MR. HELTON: But I think also, I think it's 500. But so the point being, no, it's not as far out as it could go, it's to that distance.

CHAIRMAN ARMIJO: Okay.

VICE CHAIRMAN STETKAR: We're roughly picking up about a factor of six and a half to seven depending on the group in terms of addition, you know, latent cancer fatalities, avoided person-rem or something like that.

MR. SCHOFER: Averted dose.

VICE CHAIRMAN STETKAR: Averted dose, thank you, Fred.

CHAIRMAN ARMIJO: Okay, I just want to know where it ended.

MR. JONES: Okay, based on these results the staff does not recommend that additional studies be pursued to further refine the assumptions that went into this based on the relative cost here and the benefits that could be achieved. Next slide please.

They want to hit specifically on mitigation sensitivities. That was a major component of our subcommittee discussions.

And then as we mentioned before, we made a conservative assumption going in that the base case would assume effective mitigation only for the alternative of low-density storage and ineffective mitigation for the baseline to maximize the delta among the four different, basically four different

cases that were considered in this spent fuel pool study. And that's really what provided the information that allows us to differentiate between low and high-density storage cases.

For the, if we assumed ineffective mitigation for both, that would slightly reduce the calculated benefits because you would have somewhat greater consequences from the low-density storage case. However, because we are already, as I mentioned earlier I guess, there's a greater than factor of ten difference in the magnitude of the release fraction that's assumed between the low-density and high-density cases.

And overall that dominates and therefore there would not be a substantial change in the, met benefits and the resulting conclusion.

CHAIRMAN ARMIJO: Do you have numbers, like the release fractions, when you, this case?

MR. JONES: The release fractions we'd, would remain silent.

CHAIRMAN ARMIJO: Excuse me?

MR. JONES: The release fractions remain silent.

CHAIRMAN ARMIJO: Right.

MR. JONES: The release fractions constant

for all the events that are determined to lead to release. And on Slide 15 we showed that the, for the elevated pools, Group 1 plants, the assumption was a 40 percent release fraction for the high-density storage and three percent for the low-density.

MR. SCHOFER: Yes, what changes is the release frequency if you have successful mitigation you're changing release frequency and then the delta between the two.

CHAIRMAN ARMIJO: Okay. What were the values for release frequency with and without mitigation before the --

MR. JONES: Right. The release frequencies as I've mentioned before, from the Spent Fuel Pool Study, both the low density and high density cases assumed to have the same release frequency prior to assuming any effective mitigation.

If you assume mitigation you basically reduce the frequency shown here at the bottom by a factor of 20 for the respective groups. The top number, so it would be about one times ten to the minus seven for the elevated pool case and a little bit less than that for Groups 2, 3, and 4, for the low density case.

And then for the high density case it is

the fraction shown here, or did I, I didn't do that right.

(Simultaneous speaking)

MR. JONES: I'm sorry. It's about --

CHAIRMAN ARMIJO: Is that a backup chart or do we have --

MR. JONES: Well if you take 2.7, roughly, 2.7 times ten to the minus seven for the Group 1 case assuming mitigation and it would be 1.8, roughly, times ten to the minus seven for the Groups 2, 3, and 4.

CHAIRMAN ARMIJO: For Alternative 1?

MR. JONES: For the low density storage case, assuming effective mitigation.

CHAIRMAN ARMIJO: Alternative 2?

MR. JONES: I'm just --

CHAIRMAN ARMIJO: And when you --

MR. JONES: -- dividing the numbers on the bottom by 20.

CHAIRMAN ARMIJO: All right. Well I'm lost, but maybe when --

MEMBER RICCARDELLA: Let me ask a question. On Slide 20 on your second bullet you said that "assuming ineffective mitigation would not change the conclusion."

What conclusion are we talking about? Are we talking about the conclusion that there's no benefit or are we talking about the conclusion regarding that specific case that says one, you know, you had some cases that came through, but, yes, the low density option is preferable, does it change that conclusion for that case?

MR. JONES: All the conclusions, the conclusion we're referring to is the overall result of the Cost Benefit Analysis --

MEMBER RICCARDELLA: Okay.

MR. JONES: -- and all the conclusions on Slide 19 remain the same. The change is too small to affect any of those numbers.

CHAIRMAN ARMIJO: I think Pete was asking whether it changes the benefits?

MEMBER RICCARDELLA: Yes.

MR. JONES: It does change the benefits.

CHAIRMAN ARMIJO: And that's really where we're at, you know, if it changes the benefit substantially then we'd like to know by how much.

MR. SCHOFER: It reduces the delta benefit and the conclusion he's talking about, it remains not cost beneficial, so at the bottom the net is negative. So when he says the conclusion doesn't change, it

remains negative and it goes a little bit more negative because the net benefit is smaller.

CONSULTANT SHACK: What happens to the $500 billion benefit in a high case?

CHAIRMAN ARMIJO: Yes. Those are the things that, you know, really worries --

MR. WITT: Well, for the high case, it wouldn't have changed for ineffective because that's already --

MR. JONES: That doesn't have mitigation --

MR. SCHOFER: If you assume effective mitigation for both cases to the same amount - significant, you know, it reduces your benefits significantly --

CHAIRMAN ARMIJO: Which is more consistent with your conclusion.

MR. SCHOFER: -- one or millions to --

MEMBER RICCARDELLA: That's what bothers us. It's consistent with your conclusion whereas when you do this effective mitigation for the Alternative 2 and no effective mitigation for Alternative 1, you wind up in some of the high cases of sensitivity studies with enormous or very attractive benefits for an alternative that you then say it's not worth

pursuing.

So it's a big problem that, you know, you're kind of contradicting yourself.

CHAIRMAN ARMIJO: That's the crux of our concern.

MR. JONES: That is the --

MEMBER RICCARDELLA: Yes. That's not the overall conclusion, it's that when you run some cases with apples and oranges, you come out with results that don't support your overall conclusion.

CHAIRMAN ARMIJO: That's a big concern not necessarily that, you know, a specialist who do cost benefit analysis and know the rules of the game and that this is really the basis for the decision.

It may be okay, but, you know, the general public out there --

MEMBER RICCARDELLA: They're going to want to understand this.

CHAIRMAN ARMIJO: -- and they're going to say, gee, these guys show really big benefits. Well, and then they chose to ignore them. You know, I'll tell you if I, the people that I talk to really look at these things and they say, you guys are ignoring your own analysis.

MEMBER RAY: Yes, it's the people who do

understand it who have an agenda and use it in the way that you're supposed --

(Laughter)

MEMBER RAY: Plus they have biggest risk, Sam, is that people will use the information out of context to advance an agenda.

CHAIRMAN ARMIJO: I agree with you, Harold, but there are people who don't understand at all.

(Simultaneous speaking)

CHAIRMAN ARMIJO: People being in good faith look at the tables, would look at a bar chart that shows low case, base case, high case, and then sensitivity study.

And the Alternative 2 look wonderful in the high case and incredibly good in the sensitivity study, and then we say but don't pay attention to that.

Just there's a, if nothing else, a communication problem, but it just is very difficult to understand. I know you were trying not to undermine, not to hide any benefit that might be inherent in the alternative, that was a good thing.

But if you try too hard you can justify anything and I think you tried too hard and so when --

Crediting mitigation for both cases and comparing them apples and apples is the right way to go.

I believe that would support your conclusion much more and it's also logical. So --

MEMBER BANERJEE: Would it support your conclusion more? So what would be, if you did an apples to apples calculation how would the benefits be impacted for the high case?

MR. JONES: I think the main issue there is determining what, you know, what success fraction you would give for mitigation implementation.

MALE PARTICIPANT: Just make it apples to apples.

MEMBER RICCARDELLA: Or use a bunch of different success ratios, but use the same for both options.

MR. SCHOFER: If you use the same success rate as the low case you get roughly a factor of 20 decrease in benefits.

MR. JONES: Your higher case is the one.

(Simultaneous speaking)

MEMBER BANERJEE: It's the high case which we are interested in. How would it -- oh, that was for the high case.

VICE CHAIRMAN STETKAR: He meant to say

for the load, if they used the same success rate, 95 percent successful mitigation, for the high density loading case you get a factor of 20 reduction.

I mean it's 5 percent failure.

MEMBER BANERJEE: Let's, yes, but that's okay. Reverse and say if you had no mitigation in --

MR. SCHOFER: In either case.

MEMBER BANERJEE: -- either case, yes. I mean that's the more --

MR. SCHOFER: You get like a 10 percent reduction.

MEMBER BANERJEE: Only a 10 percent?

MR. SCHOFER: Yes.

MEMBER BANERJEE: That's what I think if you do an apples to apples, what is the benefit in the worst scenarios, that's really what, and you're saying it's not that much, 10 percent or times ten?

MEMBER SCHULTZ: It would not change the conclusion, that's the important --

MR. SCHOFER: 10 percent.

CHAIRMAN ARMIJO: But it changes the numbers in the benefits, but it wouldn't change the --

MEMBER BANERJEE: How would it change the numbers?

CHAIRMAN ARMIJO: -- conclusion of that

specific case.

MEMBER RICCARDELLA: Right. That's what we're really asking.

MEMBER BANERJEE: But that hits you immediately when you read this. The high case has a big benefit, looks like anyway.

MEMBER RICCARDELLA: I don't know what big is, but a few hundred million or whatever.

VICE CHAIRMAN STETKAR: It seems like a --

MR. JONES: There's no doubt, I guess there's a big, there's a difference in consequences, but when you assume effective, when mitigation is effective it dramatically reduces those or basically eliminates the difference between the two cases.

MEMBER BANERJEE: But if mitigation was not effective in both cases, does the difference stay uneffective or -- is it substantiative?

MR. JONES: Yes, that's about a 10 percent change in the benefits, but that doesn't change any of conclusions really, but -

CHAIRMAN ARMIJO: I understand what you're saying in comparison cost, cost benefit comparison.

MR. JONES: So the problem is determining where between zero and 95 percent effective.

CHAIRMAN ARMIJO: Well I don't think it

matters as long as it's even-handed. Unless you have reason to believe that in the low density loading your mitigation is likely to be much more effective than in the high density loading and what would drive that?

Certainly not the liner vagility, certainly not the fact whether a pump would work or instrumentation would work, they're independent of a density of loading.

Certainly not the heat loads because if they, you know, you still have plenty of heat load with a low density loading. So it all adds up, but, you know, they would be about the same.

MEMBER RICCARDELLA: Is there a difference in time to respond?

VICE CHAIRMAN STETKAR: That's about the only factor that I could think of is some small difference in the time for human response.

But it's -

CHAIRMAN ARMIJO: But it's not out -

VICE CHAIRMAN STETKAR: I mean as long as you're out into hours it doesn't, differences don't make much difference.

MEMBER SCHULTZ: There's ample time to effect mitigation --

VICE CHAIRMAN STETKAR: Yes.

MEMBER SCHULTZ: -- in both cases.

CHAIRMAN ARMIJO: Well you understand our view, but I'm just coming back from a standpoint. As specialists you understand this technology and you understand the issues, you understand the practice, and you can read these charts and you can say obviously there's not benefit here.

We don't recommend it. But for people who are less experienced, it looks like there's a huge benefit, okay, and you're ignoring it. So it's, sorry, that's the way it goes.

MEMBER BALLINGER: And, of course, sort of, horses out the barn with a lot of this. Is there a reason not to include another section --

VICE CHAIRMAN STETKAR: Yes.

MEMBER BALLINGER: -- in the document that says, okay, if you compare apples to apples, well these are the results that you get.

MR. WITT: Well, what the objective of our paper was is to determine whether we need more research or not and I don't think by including that you would change that conclusion at all, but --

MEMBER BALLINGER: I'll agree with you, but put your neighbors hat on.

MR. RECKLEY: This is Bill Reckley, and

part of the difficulty that you'll have is that this discussion is likely to come up whenever we're dealing with very large consequence, low frequency type of events.

And we understand exactly what you're saying, share the concern that it could be misrepresented. The same could be said even if we didn't have the discussions of the cost benefit.

Whenever you are doing an analysis which needs to be done to support a calculation like this where you're calculating those large consequences, there is a concern that those consequences are going to be brought out without the context of the frequency in some of the other discussions we're having.

So I think we do share your view, but as what Kevin was saying, really to, the purpose of this was to make these simplifying assumptions to then determine whether we needed to spend more resources and more time to go and answer a question like, is the mitigation of a high density pool one out of 20, one out of 15?

Yes, we said it was zero which is, you know, one extreme. We still come out saying it's not cost beneficial to us, meaning it's not worth studying whether it's one out 15, one out 17, or one out of 19,

to refine the process.

So we do understand the concern. I think at this point, as someone else has said, this Report, both the previous draft, this one, the Spent Fuel Pool Study, all of this material is out there and to the degree it's going to be misunderstood or even misrepresented that, the barn door has been left open.

CHAIRMAN ARMIJO: I didn't worry about misrepresentation because that's, it's the same people that will do that, but I'm talking about people who in good faith look at the Report and get, as minimum, they get confused and at worst they say, they're just ignoring their own analysis because they're determined to come to that conclusion.

That's what I'm worried about and I see what you've done and I understand what you've done, but it's not going to play well in Peoria.

MEMBER SCHULTZ: I know we're moving forward to discuss this in many different ways, but it seems to me that for this particular situation we're in fact, as you said, Bill, that we're talking about low probability, high consequence events is the exact reason why you shouldn't take one of the scenarios and penalize it by a factor of 20, the frequency by a factor of 20.

And, therefore, be presenting that you have one case that you've increased the frequency by a factor of 20 for no reason except to see what the sensitivity would be and present those as the results of the analysis because of what we've been discussing in terms of the perception that it can create.

And it would be better to say emphatically that we can think of no reason, if you're going to do that, then you also have to say we can think of no reason why the mitigation between the high density and low density would be different, but just to see what would happen we're going to examine it.

Why would one do that, I don't know, but you ought to at least say that, we can think of no reason why the mitigation would be different, but our results have been calculated in that way, and when we do that we draw the same conclusion we do if we, we draw this conclusion that we should not study this any further.

So we have penalized it by a factor of 20. You have to describe what a factor of 20 means especially when you're talking about consequences to a large population of people.

You have to describe what that means and then you'll have an opportunity to make this case.

Even in that case we draw the same conclusion, but it's difficult to have presented it in a way that we have because of just that fact.

We're talking about low probability, high consequences and we've put ourselves in a position where we've calculated a difference that, as engineers, we don't think is real.

The difference is not real. We can't think of a reason why it would be this different, it's not one in 17 or one in 19, it's one to one and a half, or one to one and a quarter, I mean, they're about the same.

CHAIRMAN ARMIJO: Okay. Well I guess we've communicated our concern here, so I think it's probably best just to keep going unless members want to, let's just keep going.

MR. JONES: Okay. I did want to go over the overall safety perspectives of the staff. The spent fuel pools provide adequate protection and defense in depth.

I want to point out the base case release frequencies that we're using here are on the order of a few times in a million years, a very low frequency.

And they don't consider the effective deployment of mitigation capability if mitigation was

effective most times that would dramatically reduce that frequency to well below one in a million years.

Also, the spent fuel pools have defense in depth. The pools are designed to have a very low frequency of coolant loss and they are robust structures. The Spent Fuel Pool Study and past studies support that conclusion.

Also, actions taken since 2001 in particular, but haven't provided additional measures of protection against releases should the pool drain, including dispersing the fuel to enhance the capability for air cooling.

Provision of coolant makeup under cases where there's damage to the plant or other causes result in unavailability of the installed makeup systems, and plants have a provided capability to spray water on the pool to provide additional cooling under cases where all ability to cool the fuel has been lost.

CHAIRMAN ARMIJO: In those cases I want to make, another issue that came up in preparing for the meeting is, the fact that you didn't do, go further on these other alternatives as far as regulatory analysis or more analysis, was that something because you were constrained by an SRM or some other thing or you just

chose not to do it?

Because there's no question that, at least for the plants that can do it, that one by eight loading isn't very beneficial and can't be very costly, certainly not like expedited fuel transfer.

And so I'm trying to understand why you chose not to do it. Yes, it may still not be cost beneficial in the strict sense of the word, but it's awfully inexpensive and the benefits if you ever got into trouble would be enormous.

I'm just trying to understand why the staff didn't say, hey, there's simpler things we can do that can take the heart out of the problem and less costly things.

They may not apply to every plant in the United States, it may be only certain kinds of plants and certain kinds of pools, just didn't understand why that wasn't pursued.

MR. WITT: Well I think our view is that the benefits may not be as great either as obviously moving to low density storage, so even though the cost may be reduced, the benefits may be reduced as well.

CHAIRMAN ARMIJO: The benefits seem huge from the Spent Fuel Pool Study.

MR. JONES: I guess what I would address

is that not all pools have the capacity to actually reach a one by eight configuration with the existing --

CHAIRMAN ARMIJO: I understand that.

MR. JONES: -- storage capacity. I think we could look at this a --

(Simultaneous speaking)

MR. JONES: -- for voluntary initiative on the part of industry, however, we're in the same position where we look at probably greater benefits from discharging and achieving a low density storage and still not really seeing a substantial benefit in terms of measurements with respect to the quantitative health objectives and the cost benefit analysis imposing a requirement to do that than --

CHAIRMAN ARMIJO: Yes. I understand that point --

MR. SCHOFER: If I can just piggyback Steve, if we would be imposing we would have to meet the backfit criteria again, do a safety screen, verify that you have a substantial safety enhancement.

If you don't meet that screen then, you know, you can't do the backfit per se, and as the paper indicates that, you know, we have in there that we could discuss this with licensees who could

voluntarily evaluate this for their own particular plant and, you know, implement this if it's feasible.

MEMBER BANERJEE: But in all cases the mitigation had a large effect if I remember. That was the major way you could get benefits, right? And you're saying that's not feasible for all the plants or they don't have mitigation --

MR. SCHOFER: No, we're talking about the one by eight.

MEMBER BANERJEE: Oh.

CHAIRMAN ARMIJO: Plant loading or supplementary cooling capabilities --

MEMBER BANERJEE: I mean once you start draining the damn pools --

MR. WITT: This talks about enhancement and mitigation strategy. There were a couple cases in the Spent Fuel Pool Study where the mitigation capacities weren't sufficient to keep the fuel cool.

But it was only one or two scenarios, right?

MR. JONES: That they were --

(Simultaneous speaking)

MR. JONES: And that was very early and that was based on just the existing equipment that's currently at the site. The next order does call for

greater redundancy and components.

CHAIRMAN ARMIJO: So the expectation it should be that we have a very high confidence that we'll be able to mitigate these kinds of accidents and --

MEMBER CORRADINI: So can I get a clarification? So an answer to Sam's question about the one by eight, you said you have to do a backfit analysis.

What number would you use in the backfit analysis, the 2000 or the 4000?

MR. SCHOFER: We do the substantial safety enhancement screen first, which is the QHO -

MEMBER CORRADINI: Oh.

MR. SCHOFER: -- and if you don't meet that hurdle then you're done. I mean --

MEMBER CORRADINI: Okay.

MEMBER BANERJEE: So the main effect is that you just have less hot fuel in there? I mean it leaves less, but won't the cool fuel be even hotter at the end --

MR. SCHOFER: You have the same --

(Simultaneous speaking)

MR. SCHOFER: The hottest fuels fill in the pool. The cooler fuel has been moved onto the --

MEMBER BANERJEE: But what I'm saying is wouldn't the cool fuel also eventually burn?

MR. SCHOFER: Yes.

MEMBER BANERJEE: Well what difference does that --

MR. SCHOFER: It may not, depends on the --

CHAIRMAN ARMIJO: It may not reach the condition that required to start fire. You know, it may be the inherent benefit is in the event that you have no mitigation at all, there's an advantage in having less stuff to heat up and burn and release. But there's a number there and that's okay, but we do everything weird since we've learned from Fukushima is put in better mitigation instrumentation, things like that.

MEMBER BANERJEE: If you have a --

MR. JONES: I think that's what -

MEMBER BANERJEE: -- factual drain down and, you know, you have no air cooling possible, it's going to get too hot eventually and the stuff can, I won't say burn, let's say it goes through rapid chemical reaction.

MR. SCHOFER: All right. The Spent Fuel Pool Study looked at the one by eight and saw that the

one by eight looked similar to the low density.

MR. JONES: I think basically what we're dealing with is the further you spread apart the high heat sources the less likely, in certain sections the zirconium are to reach the initiation temperature required for either steam, you know, oxidation with steam or oxidation with air, depending on the circumstances.

MEMBER BANERJEE: But given enough time they will, right? In a --

CHAIRMAN ARMIJO: Presumably you're -

MR. JONES: Not necessarily, it depends.

CHAIRMAN ARMIJO: -- if you're doing something during that time.

MEMBER CORRADINI: The analysis says no.

MR. JONES: Hold on. The analysis -

MEMBER CORRADINI: You have to believe the analysis, but the analysis says under those conditions, no.

MR. JONES: The analysis did stop at 72 hours and I guess under marginal conditions there may still be some potential for, if no action is taken for that fuel to reach the initiation temperature.

MEMBER CORRADINI: I guess where I'm, I've been listening to this and we're talking about the

numbers, I guess I'm kind of, at least at this point, I'm with Sam.

If you're showing delay and you delay for days and you're not trying to mitigate, I don't, I'm lost. To me that's the obvious thing.

CHAIRMAN ARMIJO: Yes. That's unrealistic.

MEMBER CORRADINI: And the only reason I bring it up now is I've heard this argument before about partial drain down, but if I've got partial drain down dye extended, and as you said you've stopped the calculation, you could invent some condition at about the right elevation, in about the right time, that if you just sat there and watched it eventually it would cook.

But who in their right mind are going to sit there and watch it? It gives you extended for days to mitigate. That's where I guess when you were asking the question that's what made me want to say something, is that their analysis shows not conclusively that it never is going to start not reacting, but in so long of time --

MEMBER BANERJEE: But eventually it'll get there. It takes longer.

MEMBER CORRADINI: Well it's all, I'm sure

it's all a function of some quantitative number, but it's so late in time that if we take the one historical event, days later they came back and refilled.

So it's the mitigation, it's always the mitigation.

CHAIRMAN ARMIJO: Okay. Any other comments? Well I guess we should come to the conclusion chart, we haven't quite got there.

MR. JONES: Yes. We skipped over one slide, but --

CHAIRMAN ARMIJO: If we know what that is.

(Simultaneous speaking)

MR. JONES: There's one slide we skipped over I think on quantitative health objectives, and we did want to acknowledge that they were developed predominantly for reactor accidents and the main thing is that they're reflective of individual risk and that spent fuel accidents could result in impact to larger areas, I think as we discussed.

MEMBER RICCARDELLA: Why is this?

MR. JONES: Predominantly because there is no robust containment around the spent fuel pools and it is a high temperature event so the release could be somewhat more energetic than a reactor at least with

respect to the cesium and, therefore, go a little further.

And while the staff could develop alternative societal measures, I think the cost benefit analysis plus the comparison, the large margin to the QHOs, provides sufficient basis to not pursue further analysis.

And that really gets to our conclusion which is again the spent fuel pool accident results we found less than, well less than 1 percent of the quantitative health objectives, the costs of expedited transfer generally outweigh the benefits we'd get for reduced storage density and, therefore, we don't recommend pursuing additional studies or pursuing any regulatory action for those issues.

MEMBER SKILLMAN: Steve, I do have a question on your second bullet. You do have within the study the recognition that there is risk associated with moving fuel, so I don't understand why that second bullet doesn't include a phrase that, not only the cost, but the risks have been considered?

Because the operator risk is not minimal. There is a huge amount of activity to accomplish what one might think this activity will give in terms of benefit. Seems that that needs to be communicated in

that second bullet, and it is in your study.

MR. JONES: Okay.

MR. WITT: In our analysis we assume that the expedited transfer was handled completely, safely so that there was no negative impact on the benefits or change, so --

MEMBER SKILLMAN: Well I understand that, but I've just got to tell you, I think that that's a flawed assumption. I think that, you know, if you're going to say, like Ron says, to the people next door there isn't any benefit, there needs to be at least a token, comment about what the impact is on the staff that might have to do this work because I think there's this latent idea, well, gee whiz, if we just move all the stuff offsite everything's going to be Kumbaya.

And I believe that that is a flawed assumption.

MR. RECKLEY: This is Bill Reckley again. And we'll acknowledge that, we didn't call it "flawed," we would simply say it was another simplifying, conservative assumption that bias the results and if this had come out a different way we would have modeled that and many other things more exactly in Phase II of our assessment.

But, yes, we know it's a know it's a non-physical thing and it was simply simplifying --

MEMBER SKILLMAN: Well, but you did get etched in your studies, it's in the studies.

CHAIRMAN ARMIJO: It's mentioned.

MR. WITT: There's a number of things, the qualitative aspects of this that kind of support our conclusion that nothing else needs to be done here. For instance, the costs associated with doing this, we've had that discussion before, that the costs could be significantly higher than what we assumed in here.

CHAIRMAN ARMIJO: Well we know for sure that NRC costs would not be zero, and that was in your whatever, your assumption in the cost for doing the Alternative 2 and I think it would be enormous.

I think it would be such an enormous distraction from the staff from things that are really more important for safety and it would also cost money, and that was not in the study, but you said it's simplifying and it doesn't make --

MR. WITT: Well we added in qualitatively to say that there's these other issues that we didn't include in the analysis but it would support our conclusion.

MEMBER REMPE: And one of those that we've

brought up in prior meetings is the fact that you attribute the costs, or the casks to the EPRI Study and we all have discussed numerous times about how the costs would increase.

Although I noticed in the COMSECY that it says "costs might be higher or lower," they don't really say, imply that they could be higher. So if you were presuming this again it might be good to mention, too, as another item.

CHAIRMAN ARMIJO: We all have our views on cost estimates and that it's a function of how many times we've been wrong in the cost estimates.

(Laughter)

MEMBER REMPE: Well --

CHAIRMAN ARMIJO: And I've had my share.

MEMBER RAY: Nobody can possibly can see that costs would be lower to accelerate because of the supply of --

MEMBER CORRADINI: I think that was Joy.

MEMBER RAY: Yes, that is her point.

MEMBER REMPE: Yes.

MEMBER RAY: It isn't a matter of well, it might be higher or it might be lower.

MEMBER REMPE: Which is what the COMSECY says --

MEMBER RAY: It's going to be higher, that's not true. It's going to higher.

MEMBER SCHULTZ: Yes. Well there's also the nuclear safety aspect here. Sam, you mentioned that it's going to divert, if we move in this direction it would divert attention of the NRC.

It will also divert attention of reactor staff. And that, both of those have a direct impact on reactor safety.

CHAIRMAN ARMIJO: Okay. Any other questions or comments from the staff? Well we're ahead of schedule and I suggest we'll take 15 minutes -- oh, yes, Dick?

MEMBER SKILLMAN: I think we ought to thank this team. You've been in front of us a couple times --

CHAIRMAN ARMIJO: Okay.

MEMBER REMPE: It's the same story.

CHAIRMAN ARMIJO: We're part of the team.

(Laughter)

(Simultaneous speaking)

MEMBER CORRADINI: I should've -- you are dismissed.

CHAIRMAN ARMIJO: Please don't take our difficult questioning and everything else, we really

appreciate the amount of work you did in a very short time and, again, you know what worries us and, so we'll go from there.

We're going to check to see if there's anybody on the line, on the bridge line. Does anyone in the audience wish to make a comment?

Okay. The bridge line's open. Is there anyone on the bridge line there?

MR. LEWIS: Yes there is. I am Marvin Lewis, L-E-W-I-S.

CHAIRMAN ARMIJO: Mr. Lewis, please go ahead.

MR. LEWIS: Well I was listening to you talking about these assumptions and the what have you. Not problematical, but I was just wondering why, discuss the costs of accidents have increased with time, even suggesting that as your frequency instead of using the frequency assumptions that you did?

I hope I'm making myself clear, over.

VICE CHAIRMAN STETKAR: Actually, no, Mr. Lewis. If you could, this is John Stetkar, and I'm kind of PRA frequency guy, so if you could elaborate a little bit your notion I'd certainly appreciate it to better understand your concern.

MR. LEWIS: Well take a look at, we had

Chalk River, we've had Three Mile Island, we've had this, we've had that, now we come to Fukushima which is much worse than anything we've had previously, including Chernobyl, as far as I can tell, and they're very, very costly.

See and it's one thing to mess up the backwoods of the Ukraine, it's another thing to mess up a few miles from Tokyo, it's very, very expensive and is so I figure, and that's what I'm pointing at.

I mean, yes, Three Mile Island, we had one reactor, Chalk River we had one reactor. Even Chernobyl, we had one reactor, now, we have three reactors. Is this the way accidents are going to be trending?

More and more reactors involved per accident? Also, take a look at the frequency, back at Chalk River we had one accident back in the backwoods, not too costly as we got into Chernobyl, again backwoods, at the Ukraine.

We get into Three Mile Island a few miles from Harrisburg and a little more costly. I forget, what 100 miles from Tokyo even more costly and more reactors involved.

VICE CHAIRMAN STETKAR: Thanks a lot. That helps.

MR. LEWIS: So accidents increase.

VICE CHAIRMAN STETKAR: Okay, we --

MR. LEWIS: Also the frequency increases. We had Chalk River, we had Three Mile Island -

VICE CHAIRMAN STETKAR: I think we understand your point, Mr. Lewis. Thanks for elaborating that clarifies it I think quite a bit. Thank you.

CHAIRMAN ARMIJO: Is there anyone else on the bridge line that cares to make a comment? Okay, hearing none, I think what we're going to do is take a break for 15 minutes and reconvene at 3:10 p.m. and we'll start on our discussion on the biannual ACRS Report.

(Whereupon, the meeting in the above-entitled matter was concluded at 2:55 p.m.)

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Japan Lessons Learned Tier 3 Issue: Expedited Transfer of Spent Fuel to Dry Cask Storage

Kevin Witt, NRR/JLD/PSB
Steven Jones, NRR/DSS/SBPB
Fred Schofer, NRR/DPR/PRMB

ACRS Full Committee Briefing
December 4, 2013

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Agenda

- Background
- Tier 3 Evaluation Process
- Regulatory Analysis Modeling, Assumptions, and Results
- Conclusion

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Background

- Spent Fuel Pool Study initiated in July 2011
  - Evaluates difference in consequences between high and low density SFP loadings at a reference plant
- Tier 3 Project Plan:
  - Determine whether the NRC should consider expedited transfer of spent fuel to dry casks
  - Utilizes information from past SFP studies and SFPS
  - Follows normal regulatory process utilizing Regulatory Analysis Guidelines (NUREG/BR-0058)
  - May 2013 Memo provided updated plan to Commission

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Tier 3 Plan

- Phase 1 – Evaluate whether additional studies are needed to determine if regulatory action might be warranted (COMSECY-13-0030, November 12, 2013)
- Phase 2 – If directed, perform additional analysis (i.e., additional research on expedited transfer risk and minimize conservatisms)
- Phase 3 – If directed, consider other factors (criticality, mitigating strategies, solar storms, economic consequences, new regulatory framework, etc.)

Stakeholder Interactions

- Two public meetings held (August 22 and September 18)
  - Questions involving both SFPS and Expedited Fuel Transfer
  - Responding to letters received from stakeholders
- Spent Fuel Pool Study
  - Draft issued for public comment - June 2013
  - Written comments addressed in final report - October 2013
- Expedited Transfer Memorandum and Regulatory Analysis
  - Draft issued for public review - September 2013
  - ACRS Full Committee Presentation – October 2013
  - Non-concurrence from NRC staff
  - In response to stakeholder feedback, the staff provided additional detail addressing specific issues and reformatted analysis for clarity

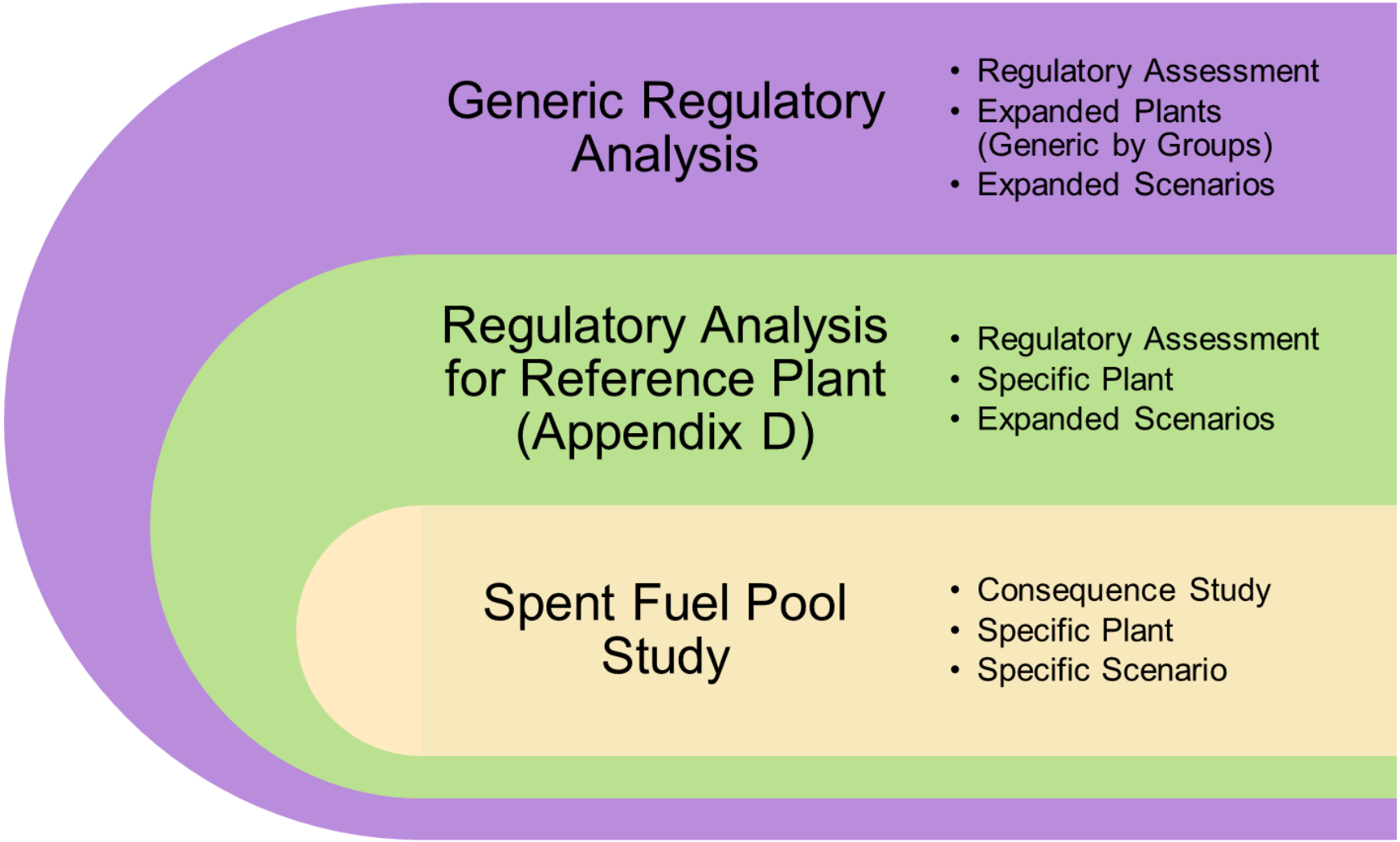
U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

COMSECY-13-0020 Revisions

- Table 2 – corrected liner fragility value
- Table 10 – corrected base case benefits
- Table 44 – corrected dose calculations for groups 2-4
- Table 56 – corrected dose calculations for group 1
- Table 60 – corrected dose calculations for groups 1-4
- Table 64 – corrected dose calculations for groups 2-4

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Overview



U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

SFP Study Results

- The pool in this study survives the severe earthquake with no liner leakage 90 percent of the time
- Even if a leak occurs, spent fuel is only hot enough to cause a radiological release within a few months after the fuel is moved into the pool; otherwise the spent fuel is air-coolable for at least 72 hours
- Both high- and low-density pool loads generate a release with similar (but very low) frequency; high-density loading can lead to a larger release

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

SFP Study Results (continued)

- Public health and environmental effect estimates are generally the same or smaller than earlier studies
- The SFPS, together with previous research, confirms spent fuel pools adequately protect public health and safety
- The regulatory analysis for the reference plant indicates that expedited spent fuel transfer does not substantially enhance safety

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

SFPS and Tier 3 Regulatory Analysis

- **Spent Fuel Pool Study (Appendix D) and Tier 3 Regulatory Analysis consider initiating events beyond the event in SFPS:**
  - more severe earthquake
  - cask drop
  - loss of power/loss of coolant inventory events
- **Tier 3 Regulatory Analysis covers all SFP designs used with operating reactors in the Eastern and Central U.S.**
  - PWRs and BWRs with Mark III containments (spent fuel stored in at-grade pool separate from reactor building)
  - Western plants to be revisited following seismic re-evaluations
  - New reactors (AP-1000)
- **Assessment of security events handled separately**
  - regulatory changes implemented (e.g., 10 CFR 50.54(hh))
  - effect of security changes reflected in regulatory baseline

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Tier 3 Evaluation Process

- Safety Goal Screening Evaluation
  - Based on the Commission Safety Goal Policy Statement
  - Used the Quantitative Health Objectives to evaluate achievement of the safety goals
- Cost/Benefit Analysis
  - Intended to identify maximum potential benefit
  - Analyzes costs and benefits for representative pool design groups

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Safety Goal Screening

Bounding Release Frequency

- Bounding frequency of SFP release about 1 in 29,000 years (3.46×10^{-5} per year)
- Regulatory Analysis Table 43, High Estimate for Group 4 (highest total release frequency)

Conditional Probability of Fatal Cancer

- Conditional probability of an individual developing a fatal latent cancer within a ten-mile radius calculated to be 4.4×10^{-4} given a large SFP release from high-density pool (SFPS Table 34)
- Linear–no-threshold model with protective actions implemented

Individual Latent Cancer Fatality Risk

- Conservative latent cancer fatality risk estimate to an average individual within ten miles of 1 in 66 million (1.52×10^{-8} per year)
- Less than one percent of the individual risk goal of less than one-tenth of one percent of the average chance of developing a fatal cancer in the U.S. (2×10^{-6} per year)

Safety Goal Screening Results

- Marginal safety benefit based on comparison with QHOs
  - No risk of fatalities due to nature of release
  - Potential benefit is a very small fraction (0.76%) of latent cancer goal
  - Cancer risk relatively insensitive to magnitude of release due to slow accident progression and effective protective actions (SFPS)

- Minor or limited safety benefit below threshold of safety goal screening

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Cost-Benefit Analysis Overview

- Evaluated one alternative - Expedited Transfer
  - Transfer fuel with more than 5 years decay to dry casks
  - Store remaining fuel in low-density configuration in existing racks
- Established SFP Groups
  - Four groups evaluated representing operating and new plants
- Major Assumptions (Regulatory Analysis Table 2)
  - Initiating SFP Event Frequencies and Accident Progression
  - Economic modeling (e.g., definition of representative plants, future spent fuel discharge projections)
  - Timing (e.g., dry cask storage loading, occupational dose)
- Established a base case
- Performed sensitivity studies

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Assumptions to Maximize Calculated Benefit

- Release fraction and mitigation effectiveness assumptions provide conservative estimate of potential benefit
- Regulatory Baseline – Maintain the Existing Spent Fuel Storage Requirements
  - High cesium release fractions (SFPS value of ~40% for Elevated Pools and NUREG-1738 value of 75% for other groups in base case)
  - Assumed ineffective mitigation for this alternative
- Expedited Transfer Alternative - Low-density Spent Fuel Pool Storage
  - Low cesium release fractions (SFPS value of 3% for all groups in base case)
  - Assumed effective mitigation for this alternative

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Base Case Analysis

- Staff considers base case appropriate for decision whether to pursue additional studies to refine assumptions
- Base case includes appropriately conservative assumptions, but not bounding values, for the following:
  - Initiating events (USGS 2008 information for Peach Bottom seismic hazard, and NUREG-1738 and NUREG-1353 for other initiators)
  - Seismic liner fragilities (based on results of SFPS and NUREG-1738)
  - Cesium inventories for each group (based on SFP capacity , amount of uranium, cooling periods, and fuel burnup for reactors in group)
  - Plume dispersion (used MAACS2 and Peach Bottom Meteorology)
  - Population density and economic activity (used data for Surry)
  - Industry implementation costs (used EPRI information)

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Base Case Analysis (Continued)

- Uncertainty regarding spent fuel pool conditions (i.e., pool water level, fuel distribution, and location of liner tears)
  - Generally make bounding assumption of inadequate heat removal if fuel is uncovered for base case
  - Conservative because SFPS and other studies indicate substantial potential for air cooling when pool is drained or decay heat is low
  - Exception for Mark I and II BWRs
    - SFPS reduces uncertainty for specific scenario evaluated
    - Used SFPS information of 8% inadequate cooling for 0.7g PGA earthquake

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Base Case Frequencies

Event	Base Case Frequency	Pool Liner Fragility	Inadequate Cooling	Release Frequency	Comments
Seismic Bin 3 (0.7g PGA)	Peach Bottom				
Elevated Pool	1.65×10^{-5}	10%	8%	1.35×10^{-7}	SFPS result
At-Grade Pool	1.65×10^{-5}	5%	100%	8.25×10^{-7}	
Seismic Bin 4 (1.2g PGA)	Peach Bottom				
Elevated Pool	4.90×10^{-6}	100%	100%	4.90×10^{-6}	
At-Grade Pool	4.90×10^{-6}	50%	100%	2.45×10^{-6}	
Cask Drop All Pools	2.0×10^{-7}	100%	100%	2.0×10^{-7}	Not always credible
Other Initiators					
Elevated Pool	2.37×10^{-7}	Not	100%	2.37×10^{-7}	
At-Grade Pool	2.67×10^{-7}	Applicable	100%	2.67×10^{-7}	
Total					About 90% seismic contribution
Elevated Pool				5.47×10^{-6}	
At-Grade Pool				3.74×10^{-6}	

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Cost-Benefit Analysis Results

- Base case costs outweigh benefits
  - Benefits based on $2000/person-rem within 50 miles
  - Changes in discount rate do not change conclusion
- Sensitivity Analyses ($4000/person-rem and analysis beyond 50 miles) produce marginal benefits
  - Sensitivity base case costs outweigh benefits for Groups 1 & 2
  - Sensitivity base case benefits marginally outweigh costs for Groups 3 & 4
- The staff considers the base case an appropriately conservative analysis for use as the primary basis for the staff's recommendation that additional studies not be pursued and Tier 3 issue be closed

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Mitigation Sensitivity

- Base case assumes effective mitigation for alternative and ineffective mitigation for baseline
  - Conservative assumption
- Assuming ineffective mitigation for both slightly reduces the benefits and would not change the conclusion
- Assuming effective mitigation for both significantly reduces benefits for all cases

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Safety Perspectives

- Spent Fuel Pools provide adequate protection and defense-in-depth
- Overall estimated frequency of damage to stored fuel is low
  - Base case release frequencies for existing pools are on the order of a few times in a million years
  - These frequencies exclude effective deployment of mitigation capability and generally exclude consideration of air cooling
- Spent Fuel Pool Maintains Defense-in-Depth
  - Defense-in-depth consists of layers of protection with reliability of each layer commensurate with the frequency of challenges
  - SFP designed to prevent coolant inventory loss under accident conditions, which results in a low frequency of coolant inventory loss
  - Fuel dispersal, coolant makeup, and spray capability have reliability commensurate with the low frequency of coolant inventory loss

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Use of QHOs for Screening

- Acknowledge that current safety goal screening, including QHOs, developed for reactor accidents
- Recognize that SFP accidents could result in larger areas and populations being affected than for reactor accidents
- Could develop alternative societal measures but with continued focus on public health and safety (SRM for SECY-12-0110)

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Other Alternatives

- Examples include:
  - Alternative loading patterns
  - Direct offload of fuel into more coolable patterns
  - Enhancement of mitigation strategies
- Staff has considered these possible changes but determined that they do not provide a substantial safety enhancement such that generic regulatory action would be warranted

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Conclusion

- Risks from SFP accidents are less than 1% of the Quantitative Health Objectives
- The costs of expedited transfer of spent fuel to dry cask storage outweigh the benefits
- Additional studies are not needed
- **No further regulatory action is recommended for the resolution of this issue and this Tier 3 item should be closed**

UniStar NUCLEAR ENERGY

UNISTAR NUCLEAR ENERGY

Presentation to ACRS Full Committee
U.S. EPR™
Calvert Cliffs Nuclear Power Plant Unit 3
FSAR Chapters 2.4, 2.5, 3, 9, 13 and 14
December 5, 2013

Introduction

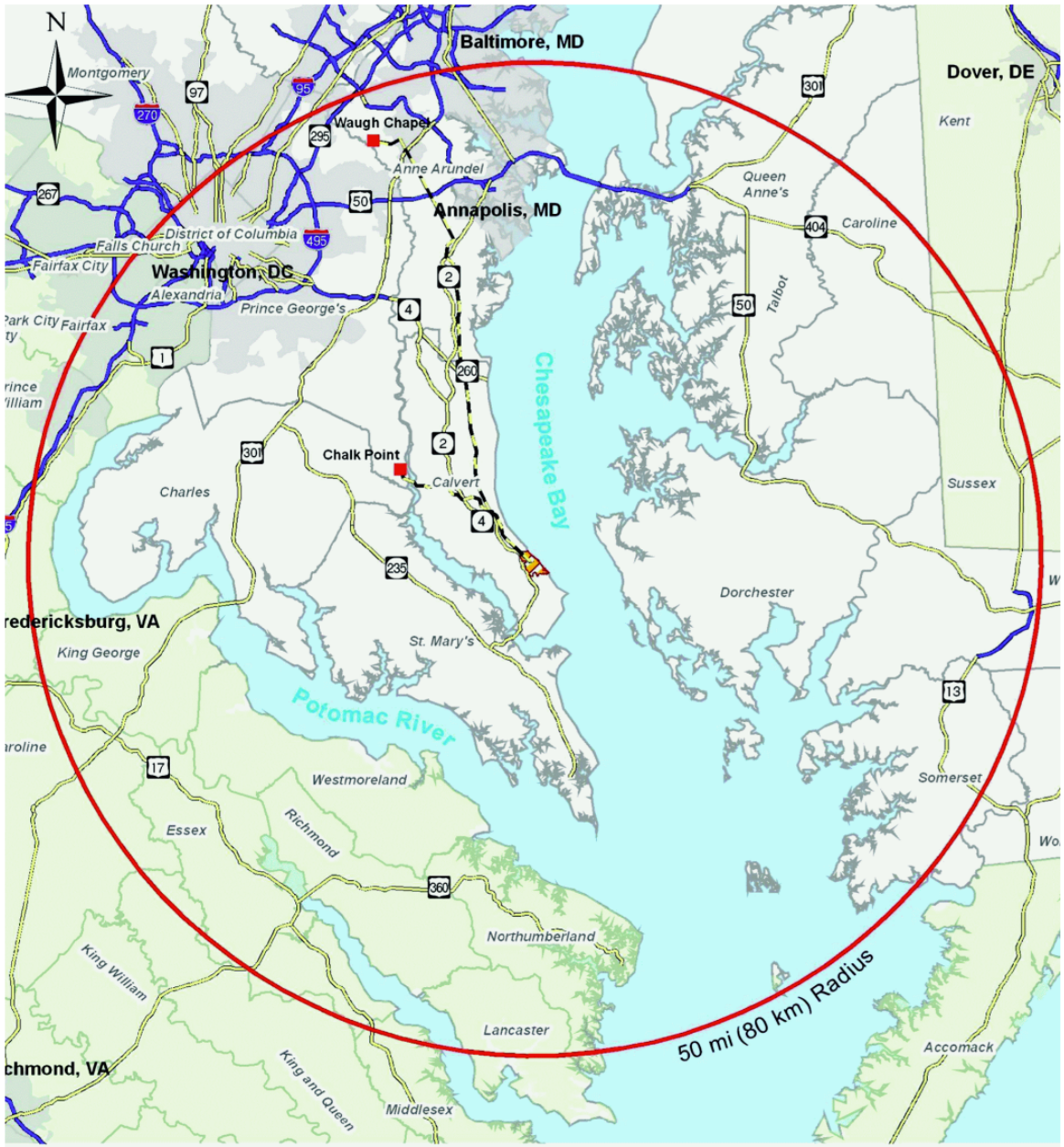
- Today Mark Finley, UniStar - President, CEO and CNO, will lead the Calvert Cliffs Unit 3 presentation.
- Presentation was prepared by UniStar and is supported by:
  - Robert Randall, UniStar –Engineering Manager
  - Antonio Fernandez, PhD, PE, UniStar – Structural/Seismic Engineering
  - Mark Hunter, UniStar – Director Operations and Maintenance
  - Onur Tastan, Rizzo Associates – Structural/Seismic Engineering
  - Todd Oswald, AREVA — U.S. EPR Technical Consultant Civil Structural
  - Ahmed “Jemie” Dababneh, PhD, Rizzo Associates –Technical Director
  - Shankar Rao, Bechtel – Project Engineer
  - Mustafa Samad, PhD, Bechtel – Sr. Engineering Specialist-Hydrology
  - Stephen Huddleston, AREVA – Engineering Manager, BOP Systems
  - Kelly Knight, PhD, Bechtel - Engineering Manager

Calvert Cliffs Unit 3
Chapters 2.4, 2.5, 3, 9, 13 and 14
Overview

Calvert Cliffs Unit 3 Summary				
Chapter	# Departures	#Exemptions	# SER Open Items	# SER Open Items Responses Submitted
2.4	0	0	2	1
2.5	4	4	8	8
3	0	0	36	36
9	3	0	4	4
13	0	0	6	6
14	0	0	37	37
Totals	7	4	93	92

Calvert Cliffs Unit 3
ACRS Full Committee Meeting
Introduction

- UNE is responsible for the design of Calvert Cliffs Unit 3 and develops the design primarily through contracts with Bechtel and AREVA.
- Reference Combined License Application (RCOLA) authored using 'Incorporate by Reference' (IBR) methodology.
- The focus of today's presentation will be a summary of the third set (4½) of FSAR Chapters that have been presented to the U.S. EPR ACRS Subcommittee.
- The first Calvert Cliffs Unit 3 ACRS Full Committee meeting, addressing the first set (9½) of FSAR Chapters, was conducted on April 7, 2011.
- The second Calvert Cliffs Unit 3 ACRS Full Committee meeting, addressing the second set (4) of FSAR Chapters, was conducted on April 12, 2012.
- For today's presentation only supplemental information, or site-specific information, departures or exemptions from the U.S. EPR FSAR are discussed.


N
Baltimore, MD
Dover, DE
Montgomery
Waugh Chapel
Anne Arundel
Annapolis, MD
Queen Anne's
Kent
Caroline
District of Columbia
Falls Church
Fairfax City
Washington, DC
Alexandria
Prince George's
Fairfax
Talbot
Chesapeake Bay
Chalk Point
Calvert
Charles
Sussex
Dorchester
Fredericksburg, VA
King George
St. Mary's
Potomac River
Somerset
Westmoreland
Essex
Richmond
Northumberland
King William
Lancaster
Accomack
King and Queen
Middlesex
50 mi (80 km) Radius

List of Chapters

- Chapter 2.4, Hydrologic Engineering
- Chapter 2.5, Geology, Seismology, and Geotechnical Engineering
- Chapter 3, Design of Structures, Components, Equipment, and Systems, (except Section 3.7, Seismic Design)
- Chapter 9, Auxiliary Systems
- Chapter 13, Conduct of Operations
- Chapter 14, Verification Programs

2.4 HYDROLOGIC ENGINEERING

2.4 Hydrologic Engineering
Hydrologic Description

- Hydrological Characteristics
  - The Calvert Cliffs Nuclear Power Plant (CCNPP) Unit 3 site is located on the Calvert peninsula within the Chesapeake Bay watershed, adjacent to and southeast of CCNPP Units 1 and 2.
  - The Chesapeake Bay constitutes the main water body influencing the siting of CCNPP Unit 3.
  - The Calvert peninsula is formed by the Chesapeake Bay to the east and the Patuxent River to the west.
  - Drainage in the vicinity of the CCNPP site includes several small streams and creeks, which fall within two sub-watersheds of the Chesapeake Bay with the drainage divide running nearly parallel to the shoreline.
  - All streams and creeks near the CCNPP Unit 3 site east of Maryland State Highway (MD) 2/4 are non-tidal.

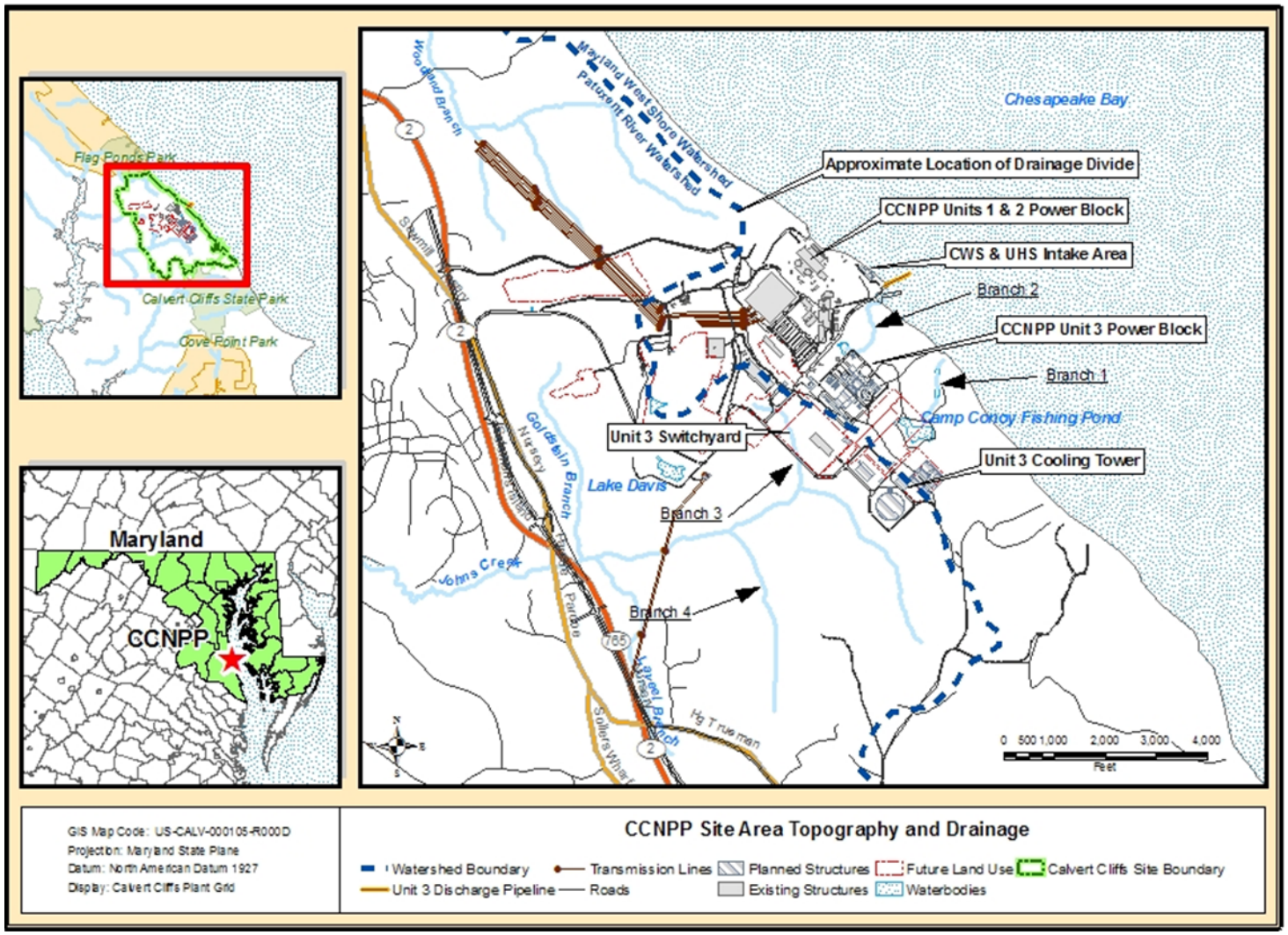
2.4 Hydrologic Engineering
Hydrologic Description

- Plant Siting
  - The CCNPP Unit 3 safety-related structures, systems and components (SSCs) will be located within the Maryland Western Shore Watershed at the Power Block area and at the Ultimate Heat Sink (UHS) Makeup Water Intake Structure (MWIS) area.
  - Access to safety-related structures, systems and components (SSCs) in the power block area will be located at or above Elevation 84.6 ft.
  - The deck of the UHS MWIS will be at approximately Elevation 11.5 ft with openings or entrances to the MWIS located at or above Elevation 36.5 ft.

2.4 Hydrologic Engineering
Hydrologic Description

Aerial View of CCNPP Unit 3 Site on the Calvert Peninsula

2.4 Hydrologic Engineering
Hydrologic Description
CCNPP Unit 3 Site Area

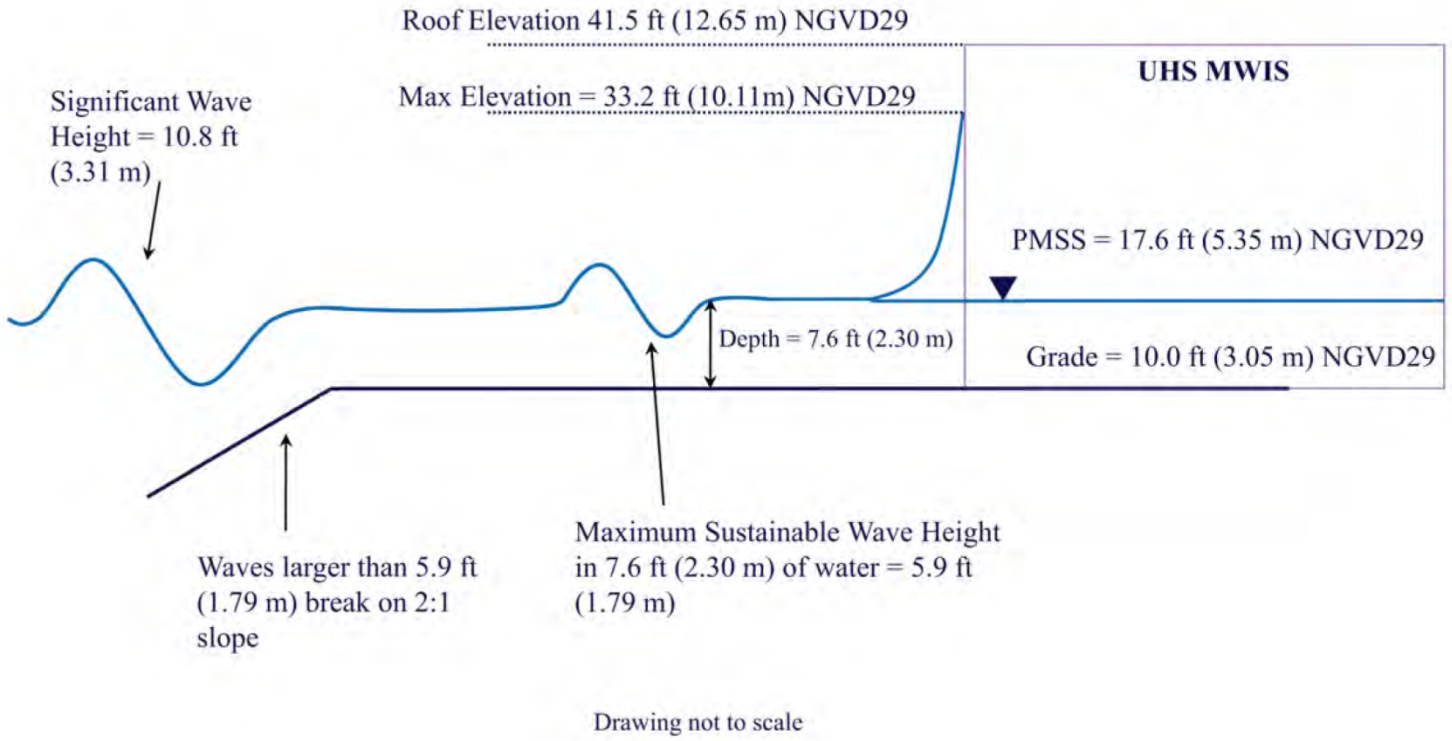


2.4 Hydrologic Engineering
Probable Maximum Surge and Seiche Flooding

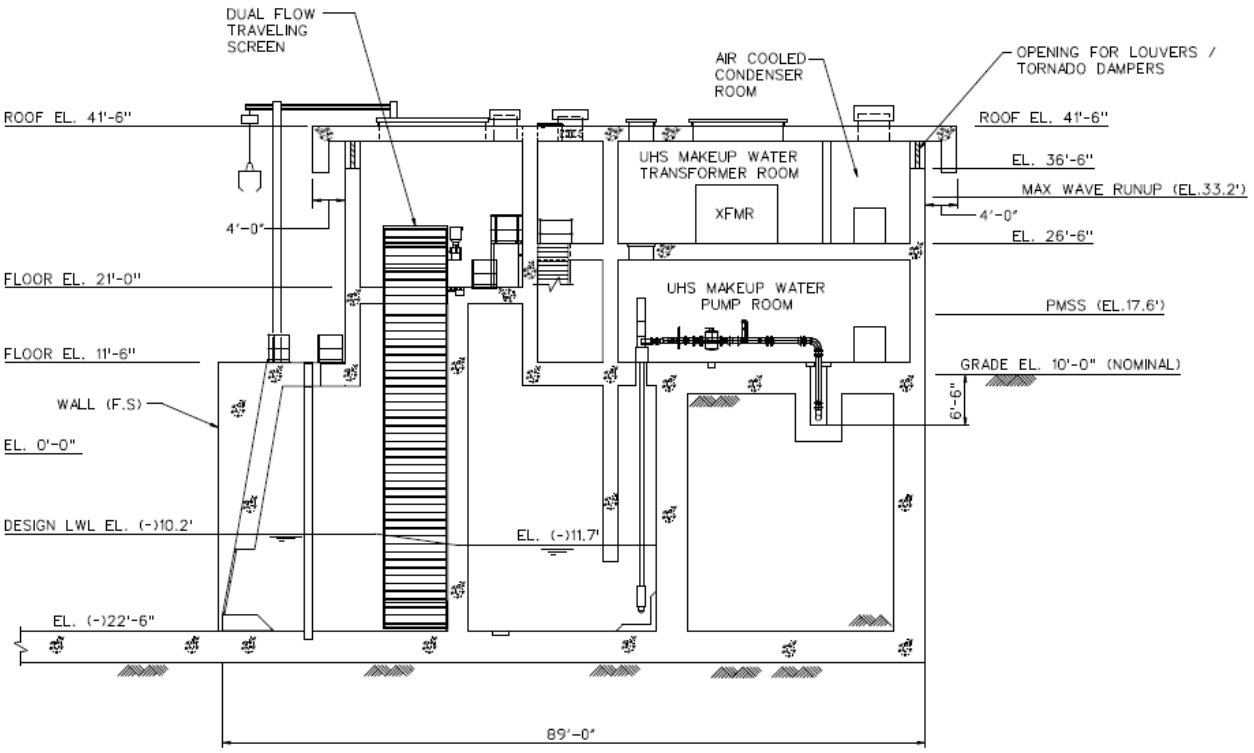
- Probable Maximum Storm Surge (PMSS) and Seiche Flooding
  - The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model predicted a maximum surge elevation at the site of 11.0 ft from a water level of 0.0 NGVD 29. The simulated surge height was then adjusted to take into account the 20% margin (SLOSH model uncertainties) suggested in Technical Report National Weather Service (NWS) 48 (Jelesnianski, 1992) and the antecedent water level of 4.4 ft NGVD 29. The final PMSS elevation thus obtained is 17.6 ft NGVD 29.
  - The maximum wave runup on the intake structure was computed to be 15.6 ft. This runup, combined with the PMSS, will reach an elevation of 33.2 ft NGVD 29 as shown on Figure 2.4-33.
  - Because the effects of seiche oscillation are eliminated by a change in sustained wind direction, any existing seiche oscillation in the Chesapeake Bay prior to the arrival of any hurricane will be eliminated by the strong and changing wind field of the hurricane. Hence, resonance of seiche oscillation with PMSS is precluded.

2.4 Hydrologic Engineering
Probable Maximum Surge and Seiche Flooding

Figure 2.4-33— {Schematic Diagram Wave Runup on the UHS Makeup Water Intake Structure (MWIS)}



2.4 Hydrologic Engineering
Probable Maximum Surge and Seiche Flooding
UHS MWIS Cross Section



UHS MAKEUP WATER INTAKE STRUCTURE
ELEVATION LOOKING EAST

2.4 Hydrologic Engineering
Probable Maximum Tsunami Flooding

- Probable Maximum Tsunami (PMT) Flooding
  - The PMT amplitude and drawdown at the CCNPP site were computed for the three potential tsunami sources using the maximum and minimum tsunami-induced water surface elevations.
  - The maximum simulated amplitude and drawdown at the CCNPP site were obtained from the postulated submarine landslide at the Virginia-North Carolina continental shelf off the coast of Norfolk, Virginia.
  - The PMT amplitude was estimated to be 1.71 ft above the antecedent water level. Combining with the antecedent water level of 4.34 ft and tsunami runup of 5.13 ft, the PMT high water level is estimated as 11.18 ft or rounded up to 11.5 ft.
  - The PMT drawdown was estimated to be 1.24 ft below the antecedent water level. Combining with the mean lower-low water antecedent water level, the PMT low water level is estimated as -1.23 ft or rounded down to -1.5 ft.
  - Because the maximum and the minimum water levels at the CCNPP site would be affected by storm surges, the maximum and minimum water levels from the PMT did not represent limiting flood or low water design bases for the CCNPP site.

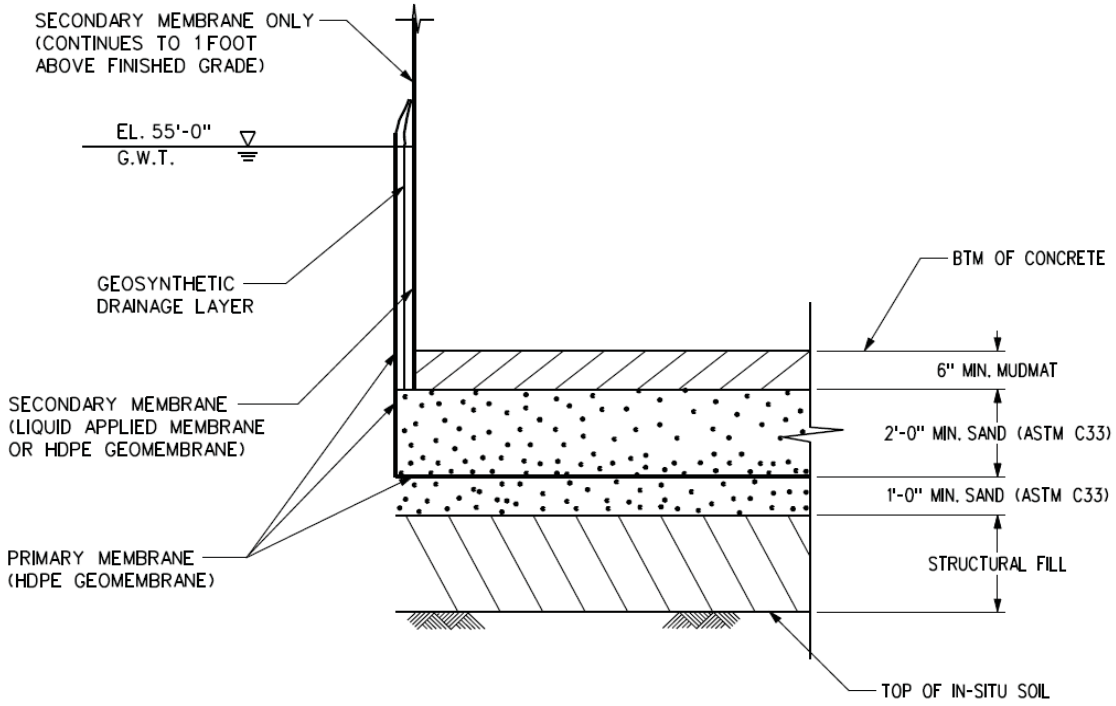
2.4 Hydrologic Engineering
Groundwater

- Groundwater in the surficial aquifer at the Calvert Cliffs Unit 3 site is aggressive (pH ~5.2).
  - This affects the portions of structures that are below the water table (at least 30' below power block grade) but not at MWIS.
  - Waterproofing system will protect the portions of the Nuclear Island (NI) and Essential Service Water Buildings (ESWBs) that are below the groundwater water table.
  - Water level will be monitored behind waterproofing system with the capability to dewater if necessary.
  - Dampproofing system will protect the Emergency Power Generating Buildings (EPGBs) that are above groundwater table.
- UHS Makeup water (from Chesapeake Bay) is brackish.
  - Concrete structures subject to brackish water (MWIS and ESWB) will use concrete with a maximum water-cementitious materials ratio of 0.4 and a minimum compressive strength of 5000 pounds per square inch (psi).

2.4 Hydrologic Engineering
Groundwater

Waterproofing system will protect the portions of the NI and Essential Service Water Buildings (ESWBs) below the groundwater table.

- Waterproofing system
  - Primary and secondary membranes
  - Groundwater monitor system
  - Vertical drainage system placed between primary and secondary systems to facilitate flow of leaked groundwater down to sump pumps



Chapter 2.4
Hydrologic Engineering
Summary

- Fifteen (15) COL Information Items, as specified by U.S. EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 2.4
- No ASLB Contentions
- No Departures or exemptions from the U.S. EPR
- Two (2) SER Open Items
- One SER Open Item Request for Additional Information (RAI) has been responded to, and the other is scheduled for early 2014.

2.5 GEOLOGY, SEISMOLOGY, AND GEOTECHNICAL ENGINEERING

2.5 Geology, Seismology, and Geotechnical Engineering Vibratory Ground Motion

- Vibratory Ground Motion
  - A detailed review of the vibratory ground motion assessment was carried out for the CCNPP Unit 3 site, resulting in the development of the CCNPP Unit 3 Ground Motion Response Spectra.
  - As the first step in this process, a Probabilistic Seismic Hazard Assessment (PSHA) for a hard rock condition was performed taking into account guidance in NRC Regulatory Guide 1.208.
    - ✓ The recently developed seismic source characterization (SSC) for the Central and Eastern United States (CEUS SSC) (EPRI/DOE/NRC, 2012)
    - ✓ The EPRI (2004, 2006) ground motion characterization (GMC) model.

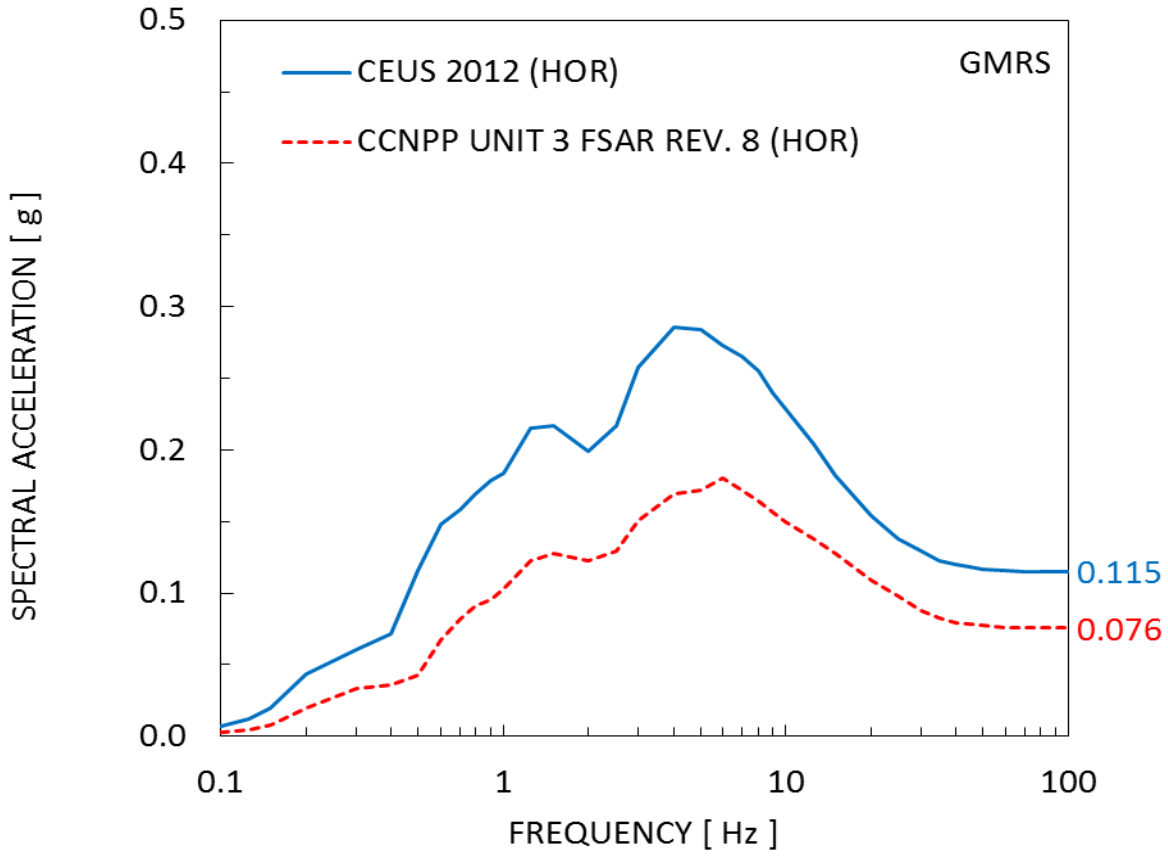
2.5 Geology, Seismology, and Geotechnical Engineering Vibratory Ground Motion

➢ Mineral Virginia Earthquake

- August 23, 2011, M 5.8 from the Central Virginia Seismic Zone (CVSZ)
- CEUS SSC catalog predates the Mineral Virginia Earthquake (MVE).
- UniStar has performed the necessary evaluations to verify that the CEUS 2012 SSC catalog adequately accounts for events such as the MVE.
- Mineral Virginia Earthquake and Aftershocks (SER-Open Item RAI 385)

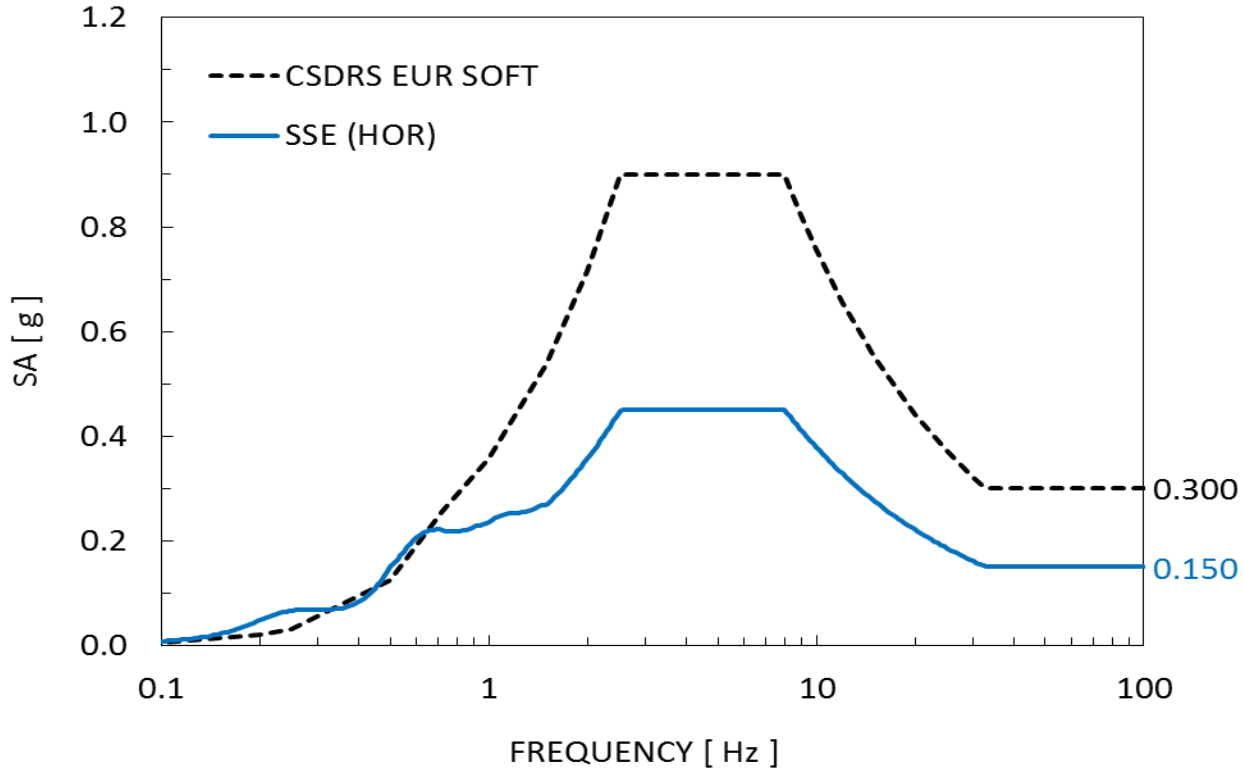
2.5 Geology, Seismology, and Geotechnical Engineering Vibratory Ground Motion

IMPACT OF 2012 CEUS SSC



2.5 Geology, Seismology, and Geotechnical Engineering Vibratory Ground Motion

Safe Shutdown Earthquake (SSE) & Certified Seismic Design Response Spectra (CSDRS)



The site specific soil structure interaction (SSI) analysis is performed with the use of the CCNPP Unit 3 SSE, therefore, the exceedance will be directly accounted for in the design of structures, systems, and components.

2.5 Geology, Seismology, and Geotechnical Engineering Departure/Exemption

Departure/Exemption from Minimum Shear Wave Velocity

- Departure/Exemption: Low Strain Shear Wave Velocity
  - The shear wave velocity (LOW STRAIN), at the foundation elevation of the Emergency Power Generation Buildings (EPGBs), is lower than 1000 fps, which is the minimum requirement defined by the U.S. EPR.
  - This departure/exemption is reconciled in FSAR Section 3.7 with a site-specific soil structure (SSI) interaction analysis.

Departure/Exemption from Safe Shutdown Earthquake

- Departure/Exemption: Safe Shutdown Earthquake (SSE) exceeds the US EPR Certified Design Response Spectra (CSDRS) at low frequencies (< 0.3 Hz)
  - This departure/exemption is reconciled in FSAR Section 3.7 with a site-specific soil structure (SSI) interaction analysis that uses the SSE as the seismic input

2.5 Geology, Seismology, and Geotechnical Engineering Departure/Exemption

Departure/Exemption from Soil Properties

- Departure/Exemption: soil properties that fall beyond the analysis bounds of the U.S. EPR (Minimum dynamic bearing capacity, Maximum angle of internal friction, Soil Density, Minimum Coefficient of Static Friction: 0.47, NAB Coefficients of Friction (μ): 0.47)
  - This departure/exemption is reconciled in FSAR Section 3.7 with soil structure interaction and stability analyses that use the site-specific soil properties

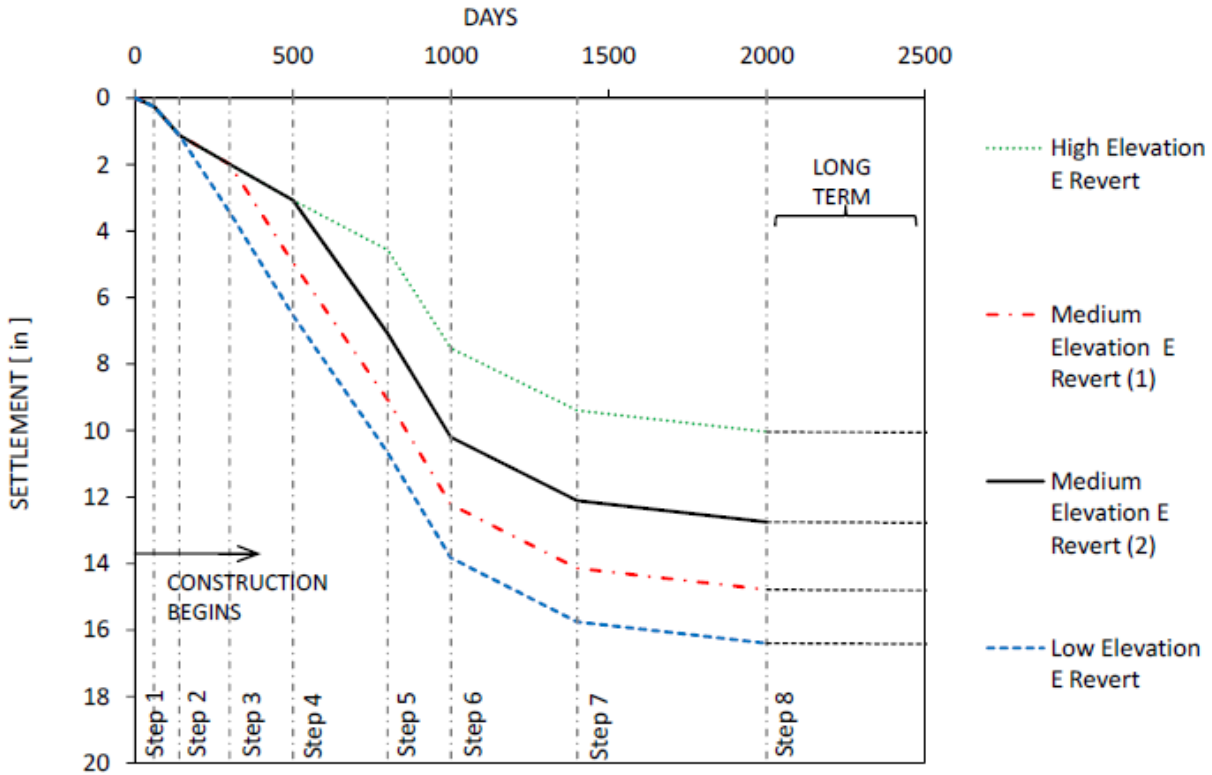
Departure/Exemption from Maximum Differential Settlement of 1/2 inch/50 ft (1/1200) Any Direction Across the Basemat

- Emergency Power Generating Buildings (EPGBs) & Essential Service Water Buildings (ESWBs) estimated site-specific tilt is higher than the allowable value.
  - Evaluation of the effects of the higher tilt, a finite element analysis of the EPGB & ESWB
    - ✓ Results show that increase in design moment based on the additional tilt is less than the U.S. EPR FSAR maximum design moment.
- Therefore, EPGB & ESWB basemats are structurally adequate to resist the increased moments.

2.5 Geology, Seismology, and Geotechnical Engineering Settlement

- The settlement (total settlement and tilt) and excavation related heave of the CCNPP Powerblock Area was carried out under the following premises:
  - Develop a 3D finite element model capable of capturing irregular subsurface conditions, realistic foundation footprint shapes, and asymmetric building loads.
  - Perform a time-dependent simulation, that provides settlement and tilt estimates as a function of time through and after construction.
  - Incorporate a construction sequence and examine the behavior of settlement and tilt as buildings are erected.
  - Account for asymmetric topography, by recognizing that reloading time to original consolidation pressure after excavation, will be variable throughout the foundation footprint.
  - Perform the settlement analysis simultaneously for the NI and adjacent facilities, including the detached safety related structures (EPGB and ESWB).
- The settlement model in the Intake Area is developed in a similar form. The model is much simpler and the influence of neighboring structures is negligible.

2.5 Geology, Seismology, and Geotechnical Engineering Settlement



Notes:

- *Low Elevation: revert to loading modulus at the end of the 2nd load step (140 days)*
- *Medium Elevation (1): revert to loading modulus at the end of the 3rd load step (300 days)*
- *Medium Elevation (2): revert to loading modulus at the end of the 4th load step (500 days)*
- *High Elevation: revert to loading modulus at the end of the 5th load step (800 days)*
- *Long term settlement estimate due to creep and rewatering offset each other and are not significant*

Chapter 2.5
Geology, Seismology, and Geotechnical Engineering
Summary

- Eleven (11) COL Information Items, as specified by U.S. EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 2.5
- No ASLB Contentions
- Four (4) Departures and four (4) Exemptions from the U.S. EPR FSAR for Calvert Cliffs Unit 3, Chapter 2.5
- Eight (8) SER Open Items
- All RAI responses have been submitted

3.8 Design of Category I Structures

Design of Structures, Components, Equipment and Systems
Other Seismic Category I Structures

Description of the Structures

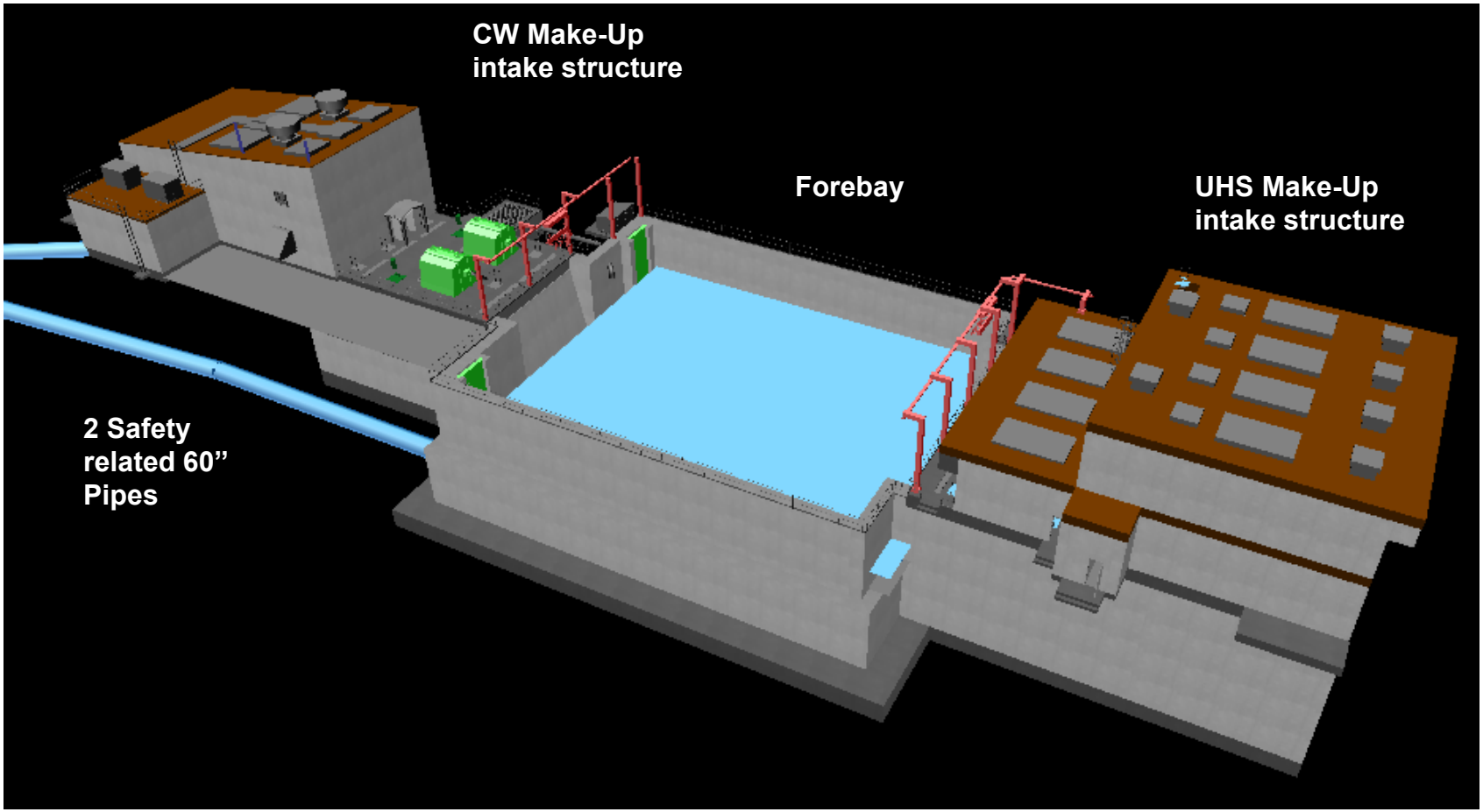
- The standard plant layout and design of other Seismic Category I Structures is as described in the U.S. EPR FSAR without departures.
- The site-specific Seismic Category I structures are:
  - Forebay and UHS Makeup Water Intake Structure (MWIS)
  - Buried Conduit Duct banks
  - Buried Pipe

Design of Structures, Components, Equipment and Systems Foundations

Forebay and UHS Makeup Water Intake Structure

- The Seismic Category I Forebay and UHS MWIS are reinforced concrete structures situated along Chesapeake Bay.
- The UHS MWIS is integrally connected with the Forebay basemat.
- Seismic Category II Circulating Water System (CWS) Makeup Water Intake Structure and Seismic Category I Forebay and UHS Makeup Water Intake Structure share a 5 ft thick common basemat.
- Forebay and UHS Makeup Water Intake Structure
  - Reinforced concrete shear wall and slabs are designed for seismic (including hydrodynamic loads) and non-seismic load combinations.
  - Exterior walls are designed to withstand
    - ✓ Tornado missile impact and
    - ✓ Wave pressures of the Probable Maximum Hurricane (PMH)
    - ✓ Standard Project Hurricane (SPH) severe environmental event
  - Checked for sliding, overturning, and flotation using the stability load combination.

Design of Structures, Components, Equipment and Systems Foundations



Chapter 3
Design of Structures, Components, Equipment and Systems

Summary

- Seventy-six (76) COL Information Items, as specified by U.S. EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 3
- No ASLB Contentions
- No Departures or exemptions from the U.S. EPR FSAR for Calvert Cliffs Unit 3, Chapter 3
- Thirty-six (36) SER Open Items
- All RAI responses have been submitted

Chapter 9
Auxiliary Systems

9.2 WATER SYSTEMS

9.2 WATER SYSTEMS
Ultimate Heat Sink (UHS) Makeup System
Supplemental Information

- Ultimate Heat Sink (UHS) Makeup System
  - Normal nonsafety-related Essential Service Water makeup provides desalinated water to replenish UHS inventory losses.
  - UHS cooling tower normal blowdown discharges water to the retention basin.
  - Emergency safety-related UHS Makeup Water system provides Chesapeake Bay makeup water to each operating UHS cooling tower basin, starting 72 hours post-accident, at a maximum flow rate of 750 gpm and approximately 510 gpm of makeup when the screen wash is operating (300 gpm is required to the basin).
  - Emergency safety-related blowdown is provided, if the normal path is unavailable.
  - The UHS Makeup Water System is designed to permit periodic inspection of components necessary to maintain the integrity and capability of the system to comply with 10 CFR 50 Appendix A, General Design Criterion (GDC) 45.
  - The UHS Makeup Water System is designed to permit operational functional testing of safety-related components to ensure operability and performance of the system to comply with 10 CFR 50 Appendix A, GDC 46.

9.2 WATER SYSTEMS
Post-DBA UHS Makeup Keep-Fill Piping Departure

- Departure: Post-Design Basis Accident (DBA) UHS Makeup Keep-Fill Piping
  - The U.S. EPR Figure 9.2.5-1 does not contain a provision to compensate for the UHS Makeup Water System leakage and maintain the water level in the piping full at all times.
  - The normal UHS makeup keep fill system is designed to provide desalinated water to maintain UHS makeup system full during normal plant operation.
  - The Post-DBA UHS Makeup Keep-Fill line is added to deliver makeup water from the Essential Service Water System (ESWS) to the UHS Makeup Water System to compensate for the leakage loss due to pressure boundary isolation valves, and to keep the UHS Makeup Water System piping full of water at all times.
  - Therefore, the ESWS Emergency Makeup Water line piping and the ESW System return line piping are modified from the configuration in the design certification.
  - The UHS Makeup Water System pressure boundary is maintained through the safety-related Post-DBA UHS Makeup Keep-Fill line check valve.

9.2 WATER SYSTEMS
Ultimate Heat Sink (UHS) Makeup System
Cooling Tower Basin

- Maximum Evaporation and Drift in the Ultimate Heat Sink
  - The U.S. EPR and CCNPP Unit 3 utilize the same 72-hour period of temperature data to determine maximum evaporation of water from the UHS. Therefore, the worst CCNPP Unit 3 meteorological conditions resulting in maximum evaporation and drift loss of water for the UHS over a 72 hour period are bounded by U.S. EPR FSAR Table 9.2.5-3.
  - The Technical Specification required UHS Cooling Tower basin minimum inventory is sufficient to provide 72 hours of cooling following a DBA without makeup.
  - The CCNPP Unit 3 UHS Makeup Water System provides ≥ 300 gpm (required by USEPR FSAR), of makeup water to the each of the four UHS Cooling Tower basin starting 72 hours post DBA.
  - The CCNPP Unit 3 UHS Makeup Water pumps are sized to provide a maximum of approximately 750 gpm to the UHS Cooling Tower basin to maintain adequate Net Positive Suction Head (NPSH) for the ESWS pump for up to 30 days after the DBA and providing for intermittent operation of the screen wash system.

9.2 WATER SYSTEMS
Ultimate Heat Sink (UHS) Makeup System
Cooling Tower Basin

- The maximum non-coincident wet bulb temperature plus the site-specific wet bulb correction factor for Calvert Cliffs 3 exceeds the value provided in U.S. EPR FSAR Table 9.2.5-2, and, therefore, a site specific analysis was done:
  - The U.S. EPR FSAR Table 9.2.5-2 value is 81°F, and the correction factor is 2.5°F.
  - The site-specific maximum (0% exceedance) non-coincident wet bulb temperature is 85.3°F.
  - The site-specific wet bulb correction factor was determined by computational fluid dynamics analysis, considering the meteorology of the site, to be less than 2.5°F.
  - UHS cooling tower performance was verified by showing that the maximum UHS cold water return temperature was less than 95°F, assuming the worst combination of 24-hour temperature conditions from the perspective of minimum cooling from a 30-year hourly regional climatological data set, and assuming a correction factor of 2.5°F.

9.2 WATER SYSTEMS
Ultimate Heat Sink (UHS) Makeup System
Mechanical Draft Cooling Towers

- UHS Cooling Tower Interference on Safety-Related Intakes
  - An evaluation has been performed of the interference effects of the UHS cooling tower plumes on nearby safety-related air intakes.
  - The evaluation concluded that there are no adverse effects on the safety functions of the systems, either due to insensitivity to higher wet bulb temperatures or design features that isolate the fresh air intake of the system.
  - For Main Control Room (MCR) and Safeguard Building (SB) Heating Ventilation & Air Conditioning (HVAC), there is sufficient margin in the system to accommodate the minor effects of a small wet bulb temperature increase – determined to be less than 2.5°F by computational fluid dynamics analysis.

Chapter 9
Auxiliary Systems
Summary

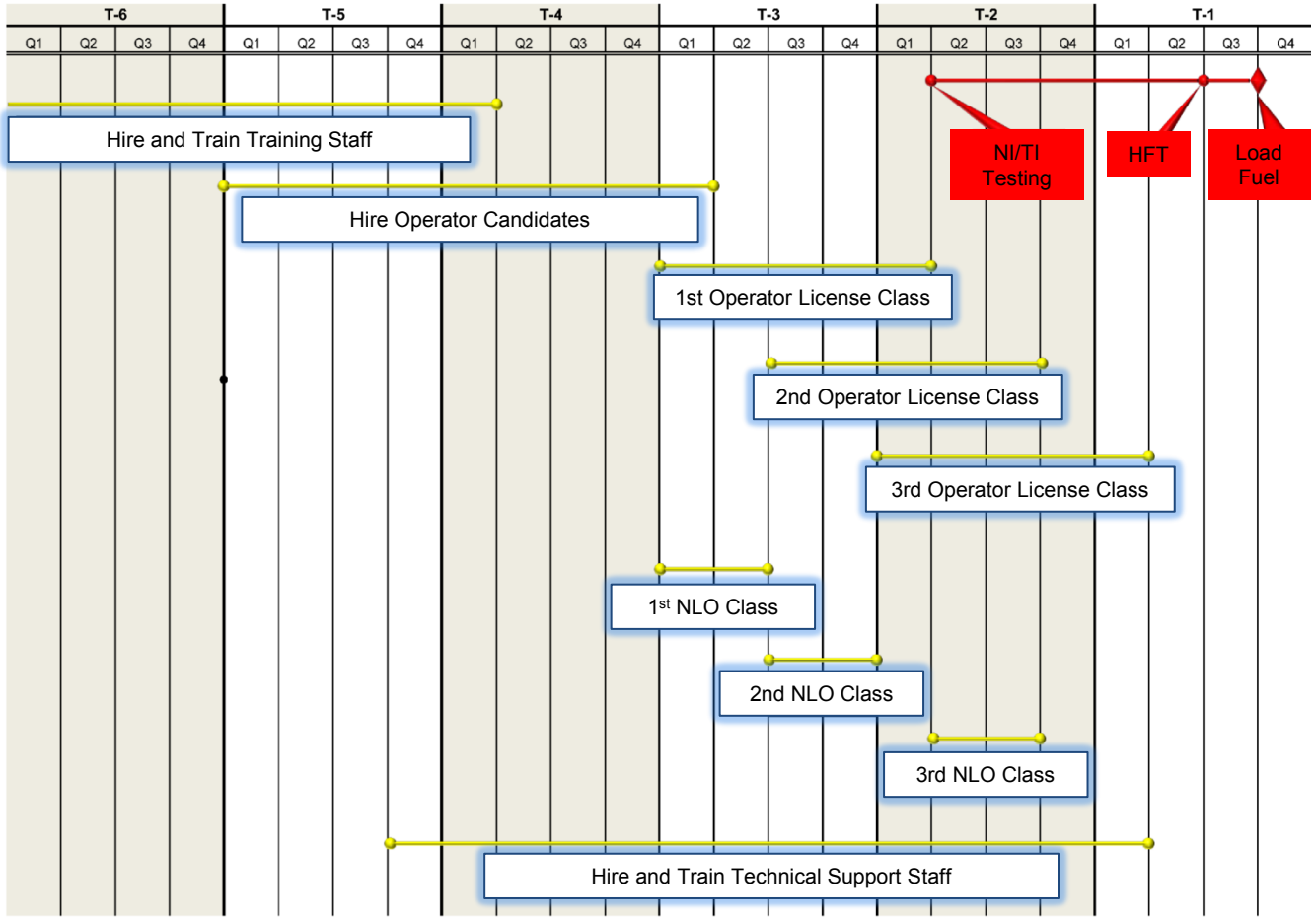
- Thirty Five (35) COL Information Items, as specified by U.S. EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 9
- No ASLB Contentions
- Three (3) Departures and No Exemptions from the U.S. EPR FSAR Chapter 9
- Four (4) SER Open Items
- All RAI responses have been submitted

13.2 TRAINING

13.2 Training
Training Programs

- Training
  - Follows NEI 06-13A “Template for an Industry Training Program Description” including Appendix A (Cold License Training plan) of NEI 06-13A
  - Non-licensed Plant Staff Training Program
    - ✓ 18 months prior to scheduled date of initial fuel load
  - Reactor Operator Training Program
    - ✓ 18 months prior to scheduled date of initial fuel load

13.2 Training
Training Programs
Hiring and Training Schedule of Plant Staff



13.3 EMERGENCY PLANNING

13.3 Emergency Planning
Emergency Planning

- Emergency Planning
  - A comprehensive Emergency Plan is provided in COLA Part 5, Emergency Plan.
  - Emergency Plan, Revision 8, for CC3 was issued April 30, 2013.
  - Emergency Plan incorporates new EP Rule Hostile action requirements.
  - NEI 10-05 for staffing analysis has been addressed.
  - NUREG 0654\FEMA Rep-1 requirements have been incorporated.

Chapter 13
Conduct of Operations
Summary

- Twelve (12) COL Information Items, as specified by U.S. EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 13
- No ASLB Contentions
- No Departures/Exemptions from the U.S. EPR FSAR Chapter 13
- Six (6) SER Open Items
- All RAI responses have been submitted

14.3 INSPECTIONS, TESTS, ANALYSES, AND ACCEPTANCE CRITERIA

(ITAAC)

Verification Programs
Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)

- ITAAC sets (Total: 1521) consist of:
  - Design Certification ITAAC (DC-ITAAC) (1275)
  - COLA ITAAC (246)
    - Site Specific system ITAAC (SS-ITAAC)
    - Emergency Planning ITAAC (EP-ITAAC)
    - Physical Security ITAAC (PS-ITAAC)

Chapter 14
Verification Programs
Summary

- Sixteen (16) COL Information Items, as specified by U.S. EPR FSAR, are addressed in Calvert Cliffs Unit 3 FSAR Chapter 14
- No ASLB Contentions
- No Departures and no Exemptions from the U.S. EPR FSAR
- Thirty-seven (37) SER Open Items
- All RAI responses have been submitted

CONCLUSIONS

Chapters 2.4, 2.5, 3, 9, 13 and 14
Conclusions

- No ASLB Contentions
- There are seven (7) departures and four (4) exemptions.
- Responses have been submitted to 92 of the 93 SER Open Items.
- As of December 05, 2013, eighteen (18) of the nineteen (19) Chapters of the Calvert Cliffs Unit 3 FSAR have completed Phase 3 (all but Chapter 1, which does not require ACRS review).

Acronyms

- ACRS – Advisory Committee on Reactor Safeguards
- ASLB – Atomic Safety & Licensing Board
- CCNPP – Calvert Cliffs Nuclear Power Plant
- CSDRS – Certified Seismic Design Response Spectra
- CEUS – Central and Eastern United States
- COL – Combined License
- COLA – COL Application
- CVSZ – Central Virginia Seismic Zone
- CWS – Circulating Water System
- DBA – Design Basis Accident
- EPGB – Emergency Power Generating Building
- ESWB – Essential Service Water Building
- ESWS – Essential Service Water System
- FSAR – Final Safety Analysis Report
- GDC – General Design Criterion
- GMC – ground motion characterization
- HVAC – Heating Ventilation & Air Conditioning
- IBR – Incorporate by Reference
- ITAAC – Inspections, Tests, Analyses, and Acceptance Criteria
- MCR – Main Control Room
- MVE– Mineral Virginia Earthquake
- MWIS – Makeup Water Intake Structure
- NI – Nuclear Island
- NPSH – Net Positive Suction Head
- NWS – National Weather Service
- PMH – Probable Maximum Hurricane
- PMSS – Probable Maximum Storm Surge
- PMT – Probable Maximum Tsunami
- PSHA – Probabilistic Seismic Hazard Assessment
- RAI – Request for Additional Information
- RCOLA – Reference COL Application
- SB – Safeguards Building
- SER – Safety Evaluation Report
- SLOSH – Sea, Lake, and Overland Surges from Hurricanes
- SPH – Standard Project Hurricane
- SSC – seismic source characterization
- SSCs – Structures, Systems and Components
- SSE – Safe Shutdown Earthquake
- SSI – soil structure interaction
- UHS – Ultimate Heat Sink

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

Presentation to the ACRS Full Committee – 610th Meeting

Briefing on Calvert Cliffs Unit 3 COL Application Safety Evaluation with Open Items for FSAR Chapters/sections 2.4, 2.5, 3 (except 3.7) 9, 13, and 14

Mike Takacs - Presenter
Surinder Arora – Lead Project Manager

December 5, 2013

Major Milestones - Chronology

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

07/13/2007	Part 1 of the COL Application (Partial) submitted
12/14/2007	Part 1, Rev. 1, submitted
03/14/2008	Part 1, Rev. 2, & Part 2 of the Application submitted
08/01/2008	Revision 3 submitted
03/09/2009	Revision 4 submitted
06/30/2009	Revision 5 submitted
09/30/2009	Revision 6 submitted
12/20/2010	Revision 7 submitted
03/27/2012	Revision 8 submitted
03/28/13	Revision 9 submitted
11/6/13	ACRS subcommittee review complete for the remaining Phase 2 Chapters.

Review Schedule

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

Phase - Activity	Target Date
Phase 1 - Preliminary Safety Evaluation Report (SER) and Request for Additional Information (RAI)	April 2010 (Actual)
Phase 2 - SER with Open Items	October 9, 2013
Phase 3 – Advisory Committee on Reactor Safeguards (ACRS) Review of SER with Open Items	December 2013
Phase 4 - Advanced SER with No Open Items	Schedule under Review
Phase 5 - ACRS Review of Advanced SER with No Open Items	Schedule under Review
Phase 6 – Final SER with No Open Items	Schedule under Review

Summary of SE with OI: Section 2.4 Hydrologic Engineering

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
2.4	Hydrologic Engineering	3	2
Totals		3	2

Summary of SE with OI: Section 2.4 Hydrologic Engineering

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

- **RAI 400, Question 2.4-1**: Inconsistent Depiction of CCNPP Unit 3 Site Boundary - FSAR Revision 9 Figure 2.4-1 shows the outline of the CCNPP Unit 3 site boundary that appears to be inconsistent with FSAR Figures 2.4-17 and 2.4-25.

- **RAI 400, Question 2.4-2**: Estimate of Bounding Value for Subsidence Resulting from Plant Groundwater Use - verify that the estimate of drawdown and subsidence remains bounding given the potential operational use of groundwater identified in the COL FSAR.

Summary of SE with OI: Section 2.5 - Geological, Seismology, and Geotechnical Engineering

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
2.5.1	Basic Geologic and Seismic Information	74	**0**
2.5.2	Vibratory Ground Motion	26	2
2.5.3	Surface Faulting	1	0
2.5.4	Stability of Subsurface Materials and Foundations	**33**	**2**
2.5.5	Stability of Slopes	1	0
Totals		**135**	**4**

Summary of SE with OI: Section 2.5.2 - Vibratory Ground Motion

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

- **RAI 381, Question 02.05.02-25**: the staff requested hazard contributions of individual seismic sources to conduct an independent confirmatory study. The staff has not finalized its confirmatory study.

- **RAI 386, Question 02.05.02-26**: the staff requested further information on the sensitivity study conducted to analyze the impact of the Mineral, VA earthquake on the seismicity rate increases.

Summary of SE with OI: Chapter 3 - Design of Structures, Components Equipment and Systems

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
3.2	Classification of Structures, Systems, and Components	13	0
3.3	Wind and Tornado Loadings	4	0
3.4	Water Level (Flood) Design	1	0
3.5	Missile Protection	33	3
3.6	Protection Against Dynamic Effects Associated with Postulated Rupture of Piping	2	0
3.7	Seismic Design	n/a	n/a
3.8	Design of Category I Structures	51	7
3.9	Mechanical Systems and Components	15	2
3.10	Seismic and Dynamic Qualification of Mechanical and Electrical Equipment	1	0
3.11	Environmental Qualification of Mechanical and Electrical Equipment	11	1
3.12	ASME Code Class 1, 2, and 3 Piping Systems, Piping Components, and their Associated Supports	1	1
3.13	Threaded Fasteners (ASME Code Class 1, 2, and 3)	0	0
Totals		132	14

Summary of SE with OI: Section 3.5 – Missile Protection

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

- **RAI 376, Question 03.05.01.03-23**: requests the applicant to provide justification on how the Jaquet electronic turbine overspeed protection system reliability data would be equivalent to that provided by a different supplier, and to evaluate how the associated ITAAC commitment is impacted by a different supplier's reliability data.

- **RAI 376, Question 03.05.01.03-24**: requests that applicant to explain how Alstom Document 75C10001 includes all the relevant information such as valve types, valve control, and overspeed protection systems etc. that is included in the U.S. EPR FSAR standard steam turbine.

- **RAI 376, Question 03.05.01.03-25**: requests that the applicant reference all of the reports associated with the turbine missile probability analysis, probability of fatigue, and probability of destructive overspeed in the COL FSAR.

Summary of SE with OI: Section 3.8 – Design of Category I Structures

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

- **RAI 301, Question 03.08.04-21**: requests a detailed description of the sliding analysis for each SC-I structure. The description should include the values of itemized lateral forces applied and values of itemized shear resistance.
- **RAI 333, Question 03.08.04-32**: requests additional information to justify the assumption that only the East Wall of the UHS MWIS is subject to breaking wave pressure. Requests information on the consideration of the run-up water elevation in the design of the exterior walls of the UHS MWIS.
- **RAI 339, Question 03.08.04-33**: requests the technical basis that the CCNPP method to determine the design member forces due to seismic loads is at least as conservative as the U.S. EPR method or more detailed methods.

Summary of SE with OI: Section 3.8 – Design of Category I Structures

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

- **RAI 339, Question 03.08.04-34**: requests the values of the maximum soil pressures considering all locations of the CBIS basemat design, explanation on how these pressures are obtained, and explanation whether the CCNPP Unit 3 bearing capacities provided in the FSAR are the bearing capacities for localized pressure.

- **RAI 308, Question 03.08.05-9**: requests to explain how the new and updated COL Items regarding settlement of the ESWBs will be addressed and what site-specific conditions will be considered. Also requests to provide additional information on the methodology and procedures used for the settlement evaluation of the CBIS foundation.

Summary of SE with OI: Chapter 9 Auxiliary Systems

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
9.1	Fuel Storage and Handling	2	0
9.2	Water Systems	36	1
9.3	Process Auxiliaries	IBR	0
9.4	Air Conditioning, Heating, Cooling, and Ventilation Systems	8	0
9.5	Other Auxiliary Systems	23	0
Totals		69	1

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

- **RAI 398, Question 09.02.05-32**: Clarification related to the CFD computer model uncertainties, meteorological conditions, and boundary scenarios regarding UHS cooling towers.

Summary of SE with OI: Chapter 13 Conduct of Operations

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
13.1	Organizational Structure of Applicant	1	0
13.2	Training	1	0
13.3	Emergency Planning	66	8
13.4	Operational Program Implementation	1	0
13.5	Plant Procedures	0	0
13.6	Security	109	0
13.7	Fitness for Duty	4	0
13.8	Cyber Security	4	0
Totals		186	8

Summary of SE with OI: Chapter 14 Verification Programs

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
14.1	Specific Information for the Initial Plant Test Program	0	0
14.2	Initial Plant Test Program	60	**0**
14.3	Inspections, Tests, Analyses, and Acceptance Criteria	0	0
14.3.1	Selection Criteria and Methodology	45	**0**
14.3.2	Structural and Systems Engineering	20	1
14.3.3	Piping Systems and Components	5	**1**
14.3.4	Reactor Systems	0	0
14.3.5	Instrumentation and Controls	0	0

Summary of SE with OI: Chapter 14 Verification Programs (cont.)

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

SRP Section/Application Section		Number of RAI Questions	Number of SE Open Items
14.3.6	Electrical Systems	2	0
14.3.7	Plant Systems	1	0
14.3.8	Radiation Protection	0	0
14.3.9	Human Factors Engineering	0	0
14.3.10	Emergency Planning	3	0
14.3.11	Containment Systems	0	0
14.3.12	Physical Security Hardware	8	0
Totals		146	**2**

Summary of SE with OI: Sections 14.3.2, Structural and Systems Engineering and 14.3.3, Piping Systems and Components

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

- **RAI 367, Question 14.03.02-20**: Request to provide design information for seismic Category-II structures to meet ITAAC requirements for ensuring that failure of non-Seismic Category I structures will not impair the safety capability of adjacent safety-related SSCs.

- **RAI 161, Question 14.03.03-02**: For clarity and inspectability, the staff determined that three ITAAC covering 1) design, 2) fabrication and installation, and 3) as-built reconciliation are necessary and sufficient to ensure the piping systems and components are properly designed and constructed in accordance with the ASME Code Section III requirements.

ACRONYMS

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

- ASME - American Society of Mechanical Engineers
- EAL - Emergency Action Level
- EPGB - Emergency Power Generating Buildings
- ESWB - Essential Service Water Buildings
- CBIS - Common Basemat Intake Structure
- UHS MWIS - Ultimate Heat Sink Makeup Water Intake Structure
- CWS MWIS - Circulating Water System Makeup Water Intake Structure
- PMH - Probable Maximum Hurricane
- SPH - Standard Project Hurricane
- CS - Conventional Seismic
- CCNPP - Calvert Cliff Nuclear Power Plant
- CFD - Computational Fluid Dynamics
- NI - Nuclear Island

US-APWR
Design Certification Application

Chapters 6 and 7
Topical Report supporting Chapter 6
LTCC / GSI-191

ACRS Full Committee Presentation

December 5, 2013

Mitsubishi Heavy Industries, Ltd.

Presenters

- **Ryan Sprengel**
  - ✓ DCD Licensing Manager
- **Rebecca Steinman**
  - ✓ DCD Licensing Engineer, Ch 6
- **Erin Wisler**
  - ✓ DCD Licensing Engineer, Ch 7

Introduction

- **Previous ACRS Full Committee meetings**
  - ✓ September 9, 2011 – Chapters covered: 2, 5, 8, 10, 11, 12, 13, 16
  - ✓ September 6, 2012 – Chapter 9 covered
  - ✓ April 11, 2013 – Chapters 4, 15, 17, 19; Topical Reports supporting Chapters 4 and 15, respectively
- **Significant upcoming submittals**
  - ✓ Ch 6 MUAP-07031 Rev. 2 to be submitted, Dec 2013
  - ✓ Ch 7 MUAP-07005 Rev. 9 to be submitted, Dec 2013
  - ✓ Ch 15 LB and SB LOCA topical reports revisions submitted, Dec 2013
- **Adjustment of ongoing US-APWR DC Activities**
  - ✓ Letter (UAP-HF-13256) submitted to NRC 11/5/2013
  - ✓ Coordinated slowdown of DCD Licensing Activities, while maintaining a commitment to US-APWR

Chapter 6 – Engineered Safety Features

- **ACRS Subcommittee meeting held September 17, 2013**
- **Remaining SE Open Items**
  - ✓ Items in which MHI submitted response that is awaiting staff review / confirmation of closure
    - Sparger hydrodynamic loading
    - Design change impact on M&E release analysis under secondary system piping rupture
    - Ch 15 RAIs tied to debris impacts on boron precipitation / LTCC
  - ✓ Other open items have alignment with NRC Staff and closure path is confirmation of changes in DCD Rev. 4
- **Written responses to ACRS SC questions to be submitted, December 2013**
- **No current RAIs**

Chapter 6 – LTCC / GSI-191

- **ACRS Subcommittee meeting held October 1, 2013**
- **Remaining SE Open Item**
  - ✓ Tier 2* designation of debris amounts
- **Written responses to 12 ACRS questions to be submitted, December 2013**
- **No current RAIs**

Chapter 6 – Topical Report

➢ MUAP-07001, The Advanced Accumulator

- ✓ ACRS Subcommittee meeting held September 18, 2013
- ✓ Staff issued public version of advance TRSE on 11/14/13
- ✓ MHI submitted ACC scaling revisions to the LB LOCA (MUAP-07011) 12/4/13 and SB LOCA (MUAP-07013) topical reports on 12/5/13

Chapter 7 – Digital I&C

- **ACRS Subcommittee meeting held April 2013**
  - ✓ 14 questions requiring follow-up
  - ✓ Subsequent discussions held with Staff
- **Written responses to 14 ACRS questions submitted September 2013**
- **RAI responses corresponding to SE Open Items submitted and under Staff review**
  - ✓ Common cause failure, D3 coping analysis, post accident monitoring variables, and others
- **No current RAIs requiring MHI response**

Presentation to the ACRS Full Committee – 610th Meeting

United States – Advanced Pressurized Water Reactor (US-APWR) Design Certification

Safety Evaluation Report with Open Items
for
Chapters 6 & 7

Safety Evaluation Report
for
Advanced Accumulator Topical Report

Perry Buckberg
US-APWR Design Certification Lead Project Manager

December 5, 2013

US-APWR Design Certification Review Schedule

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

	COMPLETION DATE
Phase 1 – Preliminary Safety Evaluation Report (SER)	Completed
Phase 2 – SER with Open Items	May 2014
Phase 3 – ACRS Review of SER with Open Items	August 2014
Phase 4 – Advanced SER with No Open Items	February 2015
Phase 5 – ACRS Review of Advanced SER with No Open Items	April 2015
Phase 6 – Final SER with No Open Items	September 2015
Rulemaking	February 2016

Summary of the US-APWR Safety Evaluation Reports

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

- The staff has issued Safety Evaluation Reports (SERs) with Open Items for Chapters 2, 3 (partial), 4, 5, 6, 7, 8, 9, 10, 11 ,12 13, 15, 16, 17 and 19 (partial).
- Of the issued chapters, all but Chapter 3 (partial) have been presented to the ACRS Full Committee.
- The staff has also issued SERs for five US-APWR Topical Reports.

US-APWR Chapter 6 Engineered Safety Systems

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

- The SE for Chapter 6 addresses the engineered safety systems, engineered safety feature material, containment systems, emergency core cooling systems, habitability systems, fission product removal control systems, inservice inspection (ISI) of Class 2 and Class 3 components
- The following Chapter 6 Open Items were discussed during the September SC Meeting
  - **Open Item RAI 923-6420, Question 06.02.01-21:** Containment Internal Design Changes in the DCD
  - **Open Item RAI 1036-7079, Question 06.02.02-94:** Tube-side and Shell-side Fouling Factors Used for the CS/RHR HX Design
  - **Open Item RAI 597-4590, Question 06.03-85:** SI and RHR/CS Pump Testing
  - **Open Item RAI 881-6203, Question 06.03-104:** ITAAC for SI and RHR/CS Pump Testing

US-APWR Chapter 6 Engineered Safety Systems

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

- Open Items continued:
  - **Open Item RAI 391-2974, Question 06.03-35:** Lack of an Advance Accumulator Small Injection Flow Rate ITAAC
  - **Open Item RAI 982-6036, Question 06.03-111:** Emergency Letdown Sparger Design
  - **Open Item RAI 559-4387, Question 06.04-11:** Flood Barriers
  - **Open Item RAI 927-6460, Question 06.04-16:** Condensate equipment drain lines
  - **Open Item RAI 955-6585, Question 06.04-17:** Refrigerant Leak
- There were no staff action items from the September Subcommittee meeting related to Chapter 6.

US-APWR Advanced Accumulator Topical Report

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

- The following ACC Subjects were discussed during the September SC Meeting
  - Overview of Advanced Accumulator Design
    - Principle of Advanced Accumulator
    - ACC role in ECCS performance during LOCAs
  - ACC Scaled Testing/ Test Results Summary
  - ACC Characteristic Equations
  - Applicability of ACC Characteristic Equations
  - Uncertainty Evaluation and Treatment
  - CFD Scaling Analysis of the Advanced Accumulator
    - Scaling Bias
- There were no staff action items from the September Subcommittee meeting related to the AAC.

US-APWR Long Term Core Cooling

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

- The following LTCC Subjects were discussed during the October SC Meeting
  - GSI-191 Evaluation for Sump Performance
    - Break Selection
    - Debris Generation/Zone of Influence (ZOI)
    - Latent Debris
    - Debris Transport
    - Chemical Effects
    - Debris Source Term Control
  - Strainer Head Loss Evaluation
  - Ex-Vessel Downstream Effects

US-APWR Long Term Core Cooling

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

- In-Vessel Downstream Effects
  - Debris Bypass
  - Core Blockage Acceptance Criteria
  - Fuel Bundle Head Loss Testing
  - Debris Deposition Analysis
- Structural Design of Strainer/Debris Interceptors
- Net Positive Suction Head (NPSH)

- The following Chapter 6 Open Items related to LTCC were discussed during the October SC Meeting
  - **Open Item RAI 840-6096**
  - **Open Item RAI 997-7033**
  - **Open Item RAI 719-5352**
- There were no staff action items from the October Subcommittee meeting related to the LTCC.

US-APWR Chapter 7 Instrumentation and Controls

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

- Chapter 7 addresses the reactor trip system, engineered safety feature systems, analyses of the plant's responses to postulated disturbances and postulated equipment failures or malfunctions.
- The open items discussed during the April Subcommittee meeting are as follows:
  - **Open Item RAI 568-4588 -** Selection criteria for PAM variables should be refined (7.5)
  - **Open Item RAI 753-5742 & Follow-up RAI 988-7021 -** Basis for the inputs and assumptions used in D3 Coping Analysis (7.8)
  - **Open Item RAI 992-6999** - Sufficient evidence to demonstrate that the use of O-VDUs enhance the performance of the safety system ITAAC that adequately verifies testing for normal and abnormal data transmission conditions for all non-safety to safety interfaces (7.9)

US-APWR Chapter 7 Instrumentation and Controls

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

- Open Items continued:
  - **Open Item RAI 995-7024 -** Process to flow down the requirements for MELTAC platform hardware/software components (7.1)
  - **Open Item RAI 993-7027 -** Process to ensure vendor's safety software development process (7.1)
  - **Open Item RAI 996-7040 -** How the plant would be adequately protected from each PCMS failure, including single failures and design defects. (7.7)
- ACRS SC Meeting Actions
  - MHI submitted written responses in September to 14 Subcommittee questions after discussions with the NRC Staff.
  - Two additional items will require NRC staff to update the SE.