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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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ABWR SUBCOMMITTEE

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TUESDAY

JULY 9, 2013

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ROCKVILLE, MARYLAND

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

COMMITTEE MEMBERS:

MICHAEL CORRADINI, Chairman

CHARLES H. BROWN, JR. Member

JOHN W. STETKAR, Member

CONSULTANTS TO THE SUBCOMMITTEE:

WILLIAM HINZE

NRC STAFF PRESENT:

MAITRI BANERJEE, Designated Federal Official

SAMIR CHAKRABARTI

MANAS CHAKRAVORTY

BRAD HARVEY

TOM TAI

ALSO PRESENT:

P.K. AGRAWAL

PETER ARNOLD (via telephone)

SCOTT HEAD

ROBERT HOOKS

BRIAN McDONALD

JAVAD MOSLEMIAN

JOHN PRICE

SURENDRA SINGH

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P R O C E E D I N G S

8:26 a.m.

CHAIR CORRADINI: So the meeting will come to order. This is a meeting of the ABWR Subcommittee for the ACRS. My name is Mike Corradini. I am the Chair of the Committee, of the Subcommittee I should say. ACRS members currently in attendance are Charlie Brown, John Stetkar, and our consultant, Dr. Bill Hinze. We also have Ms. Maitri Banerjee as our Designated Federal Official for the meeting, or we did.

As announced in the Federal Register on June 21st, the subject of today's briefing is seismic design in Sections 3.7 and 3.8 of the COL application submitted by Nuclear Innovation of North America, or NINA, for the South Texas Project Units 3 and 4. This is the first time the Subcommittee is being briefed on these sections. Prior briefings on Chapter 3 have not included these two sections.

The rules for participation in today's meeting were announced in the Federal Register notice on June 21st for an open or closed meeting. However, we expect this meeting will be mostly open to the public.

We'll ask the NRC staff and the applicant to verify only people with required clearance present if we need to go into closed session for a discussion. So we'll kind of rely on you guys.

We have a telephone bridgeline for the public and stakeholders to hear the deliberations. This line will not carry any signal from this end if we need to enter into a closed meeting.

Also, to minimize disturbances, the line will be kept in a listen-in-only mode until the end of the meeting when we will provide a few minutes for public comment. At that time, any member of the public attending this meeting in-person or through the bridgeline can make a statement or provide comments, as desired. We'll check on that as we get close to the end of the meeting to see if there are people on the line that want to make a comment. We also have a separate telephone line for NRC staff consultants to connect with us during our time period.

As the meeting is transcribed, I request that participants in this meeting use the microphones located throughout the room when addressing the Subcommittee. Participants should first identify themselves and speak with sufficient clarity and volume so that they can be readily heard. And please silence all cellphone, pagers, iPhones, iPads, and other stuff like that so that we don't hear buzzing or ringing during the meeting.

We'll proceed with the meeting. I'll start with Mr. Tom Tai of NRO to -- where is Tom? Oh, there he is. Okay. To kind of kick us off. Tom?

MR. TAI: Thank you very much. Thank you, ACRS, to allow us to make a presentation. Thank you. CHAIR CORRADINI: I think you may have to pull that mic closer to you. I don't think the transcriber can hear you guys as easily. So I think we'll turn it over to Scott, as leading off the NINA team. Scott?

MR. HEAD: All right. Thank you very much. Appreciate this opportunity to brief on this topic. I'll just initially say there's nothing proprietary in our presentation, and I'm not aware of any discussions that could happen that could be. So I doubt we'll have that, the need to do that today.

So I'm on the agenda. I'll just stop here for a second. This package is a little different than all the other packages that we presented to ACRS. It doesn't have some of the up-front bookkeeping and discussion of in-depth of departures. We felt like this subject needed a little bit different aspect to it, especially because, if you'll see in the bullets there, that the treatment of the DCD structures and the treatment of this category, the site-specific structures are so different. So we're going to focus on those differences today to let you see how that played out.

Obviously, there's also, for a seismic category 2 over 1 structures, there's a different aspect. So that's how we've broken it out.

And then the other topics, there are a couple of interesting aspects. There's a couple of Part 21s that are associated with this part of the review. There's a Defense Board issue that came up, and then, as I previewed in the last ACRS meeting that we met together on Chapter 2, the flood-level aspect and the -- what was the other -- the tornado wind or hurricane wind and missile upgrade that we made during this review. So that will be covered in other topics.

The attendees today, the people that

will be presenting, this is, will be led by Sargent & Lundy. And there are team members that we have here that have been involved in this review for the entire time.

The next picture is, we've added it as sort of a break with different aspects of the review, but I wanted to add it because, you know, we've been, you've seen this picture many times, but we're finally going to start talking about the buildings in this structure or in this picture. And so it will give you some context as we go through the review.

So if there's not any questions for me, I will go ahead and turn it over to Mr. Hooks.

CHAIR CORRADINI: Mr. Hooks?

MR. HOOKS: Good morning.

CHAIR CORRADINI: Okay. Go ahead.

MR. HOOKS: My name is Bob Hooks. By way of background, after graduating from the Ohio State University --

CHAIR CORRADINI: Uh-oh.

MR. HOOKS: -- I've spent, I've spent 42 years at Sargent & Lundy, all of it in the design of new power plants. By far, most of it in the design of new nuclear plants. My first assignment was

Clinton, Clinton Power Station back in 1972, and my first assignment was to write most of the PSAR for Chapter 3, including Chapters 3.7 and 3.8.

And after that, Byron, Braidwood, six years in Korea, and another six years after Korea at various assignments on the eight units that we worked on over in Korea and, in fact, the STP. So by way of background, that's what I've done for a living is design nuclear power plants.

The next slide, and I want to make sure you don't think we're talking down, but there's a theme that will come out through our process of how we design nuclear power plants. We go through preliminary design, get the systems to all fit in the plant. So we end up with building dimensions and we size the major structural elements, and we do the seismic analysis. And then we do the structural design where, actually, we start with another analysis model and we take all the loads from seismic and the other chapters, 3.3, 3.4, 3.5, Chapter 2, and put all those loads into the model, do the analysis, and come up with a design. It's really 3.7 and 3.8 which is really the design process that we follow when we do a plant.

But there are differences when we get

into the details here. In the DCD, that's already been done. The analysis is done, the plant is designed. So what we had to do there was just look at aspects of it to make sure that that design envelopes our site, whereas, on the site-specific structures we had to follow through all three steps.

And when we do the seismic analysis, primarily in 3.7, this analysis takes into account the soil structure interaction, or SSI, by coupling the structural model with the soil medium and the finite element representation. The SSI analysis is normally performed with 3-D representation, and we get forces, moments, absolute accelerations, relative displacements, and structure response spectra.

Where adjacent structures are separated by soil, for example between, say, the reactor building and the control building, we do a 2-D representation to get the effect of the soil between the two structures or the interaction of those two structures with the soil medium between them.

The program used to perform these analyses is SASSI, a System for Analysis of Soil Structure Interaction. And all of the SSI and SSSI analyses reported in the COLA have been done with

SASSI 2000.

So we go on to the DCD structures, and here we're looking at the, I'll call it purple structures on the slide, which is the control building, the reactor building, the diesel generator fuel oil tunnel that are described in the DCD and discussed in the DCD. And here we will look at the, you know, these are heavy robust structures. They've been designed for a variety of loadings. Standard plant structures have substantial margin, we find, when compared to this site-specific environmental loadings.

Evaluations we did included seismic analysis, stability analysis for the various site conditions with seismic, wind, tornado, hurricane, flooding, and considering the foundation conditions and the backfill materials at the STP site. There are some design provisions for external flooding since the flood level is higher than what was assumed in the DCD. And later in the project, with the new Reg Guide, we did the evaluation for the hurricane loads on the basis of the Reg Guide. We did not find that we needed to make changes as a result of these evaluations, with the exception of adding some flood protection above that level.

There was standard departure related to shear wave velocity in the soil. This ultimately required that we do incriminatory seismic analysis on the reactor building and control building. The difference between the soil properties STP site and the DCD assumptions is that the DCD assumes that the minimum shear wave velocity a thousand feet per second, and we were below that when the testing was done on the materials.

CONSULTANT HINZE: Excuse me. Did you take into account the variation in the shear wave velocity --

MR. HOOKS: Yes.

CONSULTANT HINZE: -- as you have it from the measurements and included this in the SASSI analysis?

MR. HOOKS: Yes.

CONSULTANT HINZE: And so you took into account the actual measurements, not just, you just didn't use a mean value?

MR. HOOKS: I'll let my colleague, P.K. Agrawal -- by way of introduction, P.K., he has been at Sargent & Lundy as long as I have, master's from IIT in Chicago, and been involved in dynamic and seismic analysis for most of his career.

MR. AGRAWAL: All right. Yes, we did take into account the variation in soil properties, as measured, including the geotechnical and geophysical investigations at the site. In addition, when the strong motion earthquake comes, because of the higher strains observed during the strong motion earthquake in comparison to the lower strain values during the geophysical investigations, we did a strain of the program calculators, the strain compatible, so we did take into account the effect of the higher strain in the soil properties, and the soil structure interaction model takes care of all the --

CONSULTANT HINZE: Sure. Very good. Thank you.

MR. HOOKS: And when you take a look at the input spectra versus DCD spectra, the GMRS, or the ground motion response spectra, we were starting from is the green line here. And, of course, this is log scale. And there's substantial margin in the frequencies of interest which are, roughly, 1 - 10 hertz between the input spectra and what the plant was already designed for. And so it is not at all unexpected that we, in the end, have substantial margin when we get finished with the analysis and compare it to the results. That was horizontal. This is the vertical.

So when we did the SSI and SSSI confirmatory analysis, we considered the site-specific soil properties. As P.K. discussed, we modeled the soil profiles with variation of those properties. We refined finite element mesh sizes so that the control building model is capable of passing frequencies up to 33 hertz, both horizontal and vertical. Poisson's ratio values were adjusted to achieve the 5,000-foot per second impression wave velocity below the ground water level.

CONSULTANT HINZE: Bob, before you get into that, can I ask a quick question? What do you mean by refined? Does this mean that you revised the -- what does that mean?

MR. HOOKS: When we put the models together, we have to make sure that we are transmitting frequencies. And the model we used initially would not transmit, so we refined the mesh until we got --

CONSULTANT HINZE: Okay. Thank you.

MR. HOOKS: And when we were finished, the DCD seismic forces, moments, accelerations, response spectra bound the results from our site-specific analysis, as expected.

We have a couple of typical cases here where the green is the results of our analysis and the red is the DCD version. The control building, these are down at the basemat. And the reactor building is at the top of the reactor pressure vessel. And, again, no surprises and plenty of margin.

The determination of soil pressures from the structure soil structure interaction, or SSSI, analysis in SASSI, to evaluate the effect of this on soil pressures, we used 2-D models. And we put together the 2-D model for the reactor building, the 2-D model for the control building. We run those individually so that we can have a baseline, and then we tie them together into a single model with the soil in between, and we run that to find out what effect that has on the soil pressures for which we design the walls.

The models that we're talking about here are very similar to the models that are shown in the DCD, but they have the site-specific properties in the soil. And --

CHAIR CORRADINI: So I have a question since I'm not in this area. So is this a standard practice to take the -- I'll use colors -- to take the red buildings' interaction with the blue buildings by a 2-D coupling? Is that a standard practice in the industry?

MR. HOOKS: I would say that it is. It was done in the DCD.

CHAIR CORRADINI: That's fine. I just wanted to understand because I'm not familiar with what's standard versus what you did --

MR. MOSLEMIAN: It could be that it wasn't 2-D or 3-D models, that DCD had looked into interactional ledges in the structures and the effect on each structure. So because shear wave velocity was below what was considered in the DCD, we repeated that same analysis to ensure that what we get is bounded by the DCD results.

CHAIR CORRADINI: And when you say 2-D, where are you infinite in? The depth? In other words, I'm shaking this building and watching it three-dimensionally and I'm shaking this building or its response to this shaking, and is it the X, Y, and the Z direction is essentially infinite?

MR. MOSLEMIAN: In this --

CHAIR CORRADINI: In building one and building two.

MR. MOSLEMIAN: Right. So you have a section here, 2-D representation here, a 2-D representation here. You're shaking it in all X, Y, and Z --

CHAIR CORRADINI: So infinite in one of the lateral --

MR. MOSLEMIAN: Infinite in that.

CHAIR CORRADINI: Okay, all right. Thank you. All right. Thank you. Go ahead. I'm sorry.

MR. HOOKS: And then the soil pressure profiles from these analysis were bounded by the envelope of the certified design soil pressures when we were finished with this work.

Going on into more 3.8 items, we did update some codes to ACI 349 to the latest edition endorsed by Reg Guide 1.142. In upgrading ACI 349, we also added the current Reg Guide on anchorage of components in concrete, which, in effect, takes exception to what's in 349. And ASME Section III Div 2 Code is updated again to the latest one endorsed by regulatory guides. It was, I think, pretty straightforward. It's easier for both design and construction to work with the most current code that's allowed by the regulations.

The liner plate, there was really a correction from the DCD. There was inconsistency on the material specified in two places in the DCD, and we straightened that out with Departure 3H.1.

We also got into providing additional information on the pre-service and in-service inspection program requirements. These programs implement the requirements of Section XI of the code, specifically subsections IWE and IWL. And the plans are based on the addition in addenda per the requirements of 10 CFR 5055(a).

The structural integrity test, again, will conform to Division 2 of the ASME code, Section CC-6000. Unit 3 will be, will conform to the requirements for prototype containment. And as you stand now, this would be the first ABWR constructed in the United States. That simply means that we would have additional instrumentation, take on additional data with that structural integrity test. Unit 4 SIT would conform to the requirements for a non-prototype. And that completes my discussion there. Are there any additional questions?

CHAIR CORRADINI: No. Keep on going.

MR. HOOKS: Okay. At this point, I will

turn this over to my colleague, Javad Moslemian.

MR. MOSLEMIAN: Good morning. I'm Javad Moslemian. I got my bachelor's from University of Nebraska and my master's degree from Purdue University in 1983. And since then, I've been working as such. I have nearly 30 years of experience, of which 28 years is in the nuclear industry and about 11 years of that is related to design of new nuclear units. I'm also a member of the M690 Code Committee for Structure C.

Bob Hooks covered the design process that we follow for DCD structures. As he noted, that design process is significantly different than what we did for the site-specific seismic category 1 structures.

For DCD structures, they're already designed in the DCD bounding design parameters. What we do is only verify, as he said, the design parameters that are not bounded by the DCD bounding parameters.

For site-specific structures, we essentially design the structure from A to Z. We start with perimeter design. We do seismic analysis. We do number design. And so we carry out the entire design for site-specific structures.

The site-specific seismic category 1 structures, you will see in this picture, are identified using the yellow color. We have the UHS/RSW pump house. We have piping tunnel and diesel generator fuel oil storage vaults.

What we have done in the following slides is, essentially, to give you an overview of the design for site-specific seismic category 1 structures with more emphasis on UHS/RSW pump house because it has some unique design features that other structures don't have.

The site-specific category 1 structures are designed for dead loads, live loads, thermal effects, wind loads, tornado loads, hurricane loads, uplift due to ground water table, loads caused by static and seismic earth pressures, safe shutdown earthquake, as well as internal and external flooding. And it also includes the seismic analysis, several of the evaluations for wind, tornado, hurricane, and flood; design provisions for internal and external flooding; and also design for wind loads, tornado loads, as well as hurricane loads, based on the design input we have obtained from Reg Guide 1.221.

CONSULTANT HINZE: May I ask a question?

MR. MOSLEMIAN: Sure.

CONSULTANT HINZE: Perhaps this is the place to ask it. I note that, in looking at the input spectra for the SASSI or the containment building or reactor building, you used the 1952 Kern County earthquake ground motion. But, yet, in the diesel generator tunnel, you used the 1994 Northridge, and I'm wondering why the two different inputs here and what's the significance of any difference between these?

MR. MOSLEMIAN: Well, to begin with, the two different organizations developed those time histories. One was us developing it for the site-specific design response spectra, and then another organization developed a time history for the DCD. And they were completely independent of each other. And the reg guides, Reg Guide 1.208 provides the guidance for obtaining, for developing a time history and that --

CONSULTANT HINZE: That reg guide, that leads it, as I recall that reg guide, you could select your own. It does give you flexibility.

MR. MOSLEMIAN: Yes, exactly. So the Reg Guide 1.208 provides the guidance for developing the time histories, and that reg guide refers, I believe, to NUREG-6278 where they discuss, you know, that they recommend using so-called real earthquake records as your seed time history. But in the central eastern United States, there aren't that many strong-motion earthquake records available, and they end up actually recommending that you use earthquake motions from western United States.

CONSULTANT HINZE: Well, there are some, you know, there are the Oklahoma earthquake and the Arkansas earthquake, both of 2011, as I recall.

MR. MOSLEMIAN: Right. But the point is that, regardless of what seed times you end up using, you have to scale up the motion to essentially envelope your target design response spectra. Although each one of the seed times may yield you different time histories, that gives you a bonding spectra that bounds the design response spectra.

The results that you get for linear analysis will be very close to each other. They will not be identical, but they will be very close. In other words, if I use Taft or Northridge, I come up with two different time histories. But if I analyze a structure and the response spectra using this given set of time histories and other sort of time histories, the results are going to be close. They will not be identical, but they will be close. But they all --

CONSULTANT HINZE: What do we mean by close? What's close?

MR. MOSLEMIAN: Well, they will be between a few percentage of each other.

CONSULTANT HINZE: A few percent?

MR. MOSLEMIAN: Yes.

CONSULTANT HINZE: And what about using an earthquake from similar seismic terrain, like the Oklahoma earthquake, 5.6, something like that? There was strong motion on that.

MR. MOSLEMIAN: I don't know if -- was that available at the time we did that? You know, we completed this --

CONSULTANT HINZE: It was 2011.

MR. MOSLEMIAN: But we completed this, actually, prior to 2011.

CHAIR CORRADINI: So this was concluded before that --

MR. MOSLEMIAN: Yes, yes, yes.

CHAIR CORRADINI: I was guessing that was going to be the answer but I . . .

MR. HEAD: Well, but there will be a

licensing decision in there, also. If there's earthquakes out there that have been used before and are documented as acceptable to the staff, to maybe impose a new earthquake that has enough data that's long enough, you know, that would be, we'd have to embark upon that effort. And so that's another decision that we go on, but another significant part is this work was all done in 2008 and we had acceptable results. And so . . .

MEMBER STETKAR: This could be a good opportunity to ask something that I was not sure when I was going to ask it. What is the plan, and I don't know whether this is for you or whether this is for the staff, to incorporate the post-Fukushima seismic hazard reevaluation and revise ground motion response models for Units 3 and 4? Will that be completed before the COL is issued?

MR. HEAD: Yes, sir. Yes, sir. And I'll just tell you --

MEMBER STETKAR: So that partially answers because we'll get an updated seismic, both the hazard and the ground motion response.

MR. HEAD: We made a submittal to the staff to show that the -- basically, we took advantage of the fact that one of the test cases was

Houston. And we've moved the site to Houston and did an analysis, not a full re-blown but we demonstrated that, by moving the site to Houston with the site dirt and the results of what the Houston test site was getting, that our curve is still bounded by or the curve you get from that is still bounded by our results that we have on 3 and 4.

So we're confident that nothing will change. The staff is still reviewing that, and that work we expect to be done later this year. And you'll see the results of that in an ACRS meeting we think the first quarter of next year.

MEMBER STETKAR: Has the staff, and I lose track of these things, has the staff settled on an improved set of ground motion response equations? They were still hanging up on all of the post-Fukushima reevaluations because of the, you know, the old EPRI response equations and then kind of tossed out the new set. The staff had concerns that they didn't adequately capture uncertainties or something like that. The last I heard earlier this spring there didn't seem to be resolution on that.

CHAIR CORRADINI: Is that a staff question, or is that --

MEMBER STETKAR: Well, that's when I prefaced this --

MR. HEAD: They're still interacting on that, I think.

MEMBER STETKAR: Scott kind of presented this as if it was a done deal that they had re-done the analysis already, which means they --

MR. HEAD: Well, we haven't, we've used the Houston test site to confirm the adequacy of 3 and 4 and mainly because the major earthquake sources are closer to Houston than they are to 3 and 4.

MEMBER STETKAR: Yes, but they would still, your response spectra would still be affected by those EPRI equations, right?

MR. HEAD: Yes, sir. Yes, sir. And so I think what --

MEMBER STETKAR: So you used Houston. Using what set of EPRI ground motion response equations? The 2004 - 2006 or the proposed whatever they were --

MR. HEAD: You mean the information that's being used, that's being developed right now and discussed with us? We have not used that information. We're aware of the results, though.

And I would just say the results improve our results. But the NRC, we have not provided that to the NRC because that's still in a state of, you know, discussion.

I think the driving force, though, will be the operating fleet, and they'll need to get this resolved later this year so that the operating fleets can complete the work that they have. But when we -- the staff is reviewing our submittals right now, and that will be presented to you, hopefully, over the next year, which will demonstrate, we believe, that the curves that you're shown here are still bounding.

MEMBER STETKAR: Okay, thank you.

MS. BANERJEE: If I may add -- this is Maitri Banerjee, the DFO. We have a scheduled ABWR Subcommittee meeting in February where the Fukushima and Section 2.5 of the STP COLA will be presented.

CHAIR CORRADINI: Okay.

MEMBER STETKAR: Good, thank you.

CONSULTANT HINZE: If I could go back for just a moment, I think it would be very helpful to have an explanatory note about the similarity that one can anticipate with using the Northridge. It just seems to me that anyone reviewing this is going to have that as a question, just like I did. And it would be great to have some kind of explanatory note, piece.

MR. HEAD: And this note would be?

CHAIR CORRADINI: I think what Scott is about to ask is so who does the note get addressed to and how is it, and where would it, you know, would it be in the COLA? I mean, I'm not sure . . .

CONSULTANT HINZE: Well, it's stated one place that you'd use the Taft earthquake and another Northridge. And I think anyone looking at that will have the question in mind and just want you, want it to be clear that this is going to be a modification, at most, of a few percent.

CHAIR CORRADINI: I think Bill's point is well taken. So we're eventually going to have to write a letter. So, at least for us, now you're going to ask me how and where. I'll let somebody figure that out offline. But I think, at least for us, when we write the letter, so that when this comes up as a closed issue, assuming it is a closed issue, then at least we have the appropriate explanation. So I have a tendency to be forgetful, so a paragraph would help me.

MR. HEAD: Okay. So the issue, though,

is a discussion of the Northridge, the use of two different -- and so could I just suggest that we take this as an action item, and then we'll report the conclusions to you in the November ACRS meeting on Chapter 3?

CHAIR CORRADINI: Sure.

MR. HEAD: And we'll go figure out, you know, whether it's --

CHAIR CORRADINI: The proper approach.

CONSULTANT HINZE: Just a footnote.

CHAIR CORRADINI: Okay. Good. Thanks. Keep on going.

MR. MOSLEMIAN: Okay.

CHAIR CORRADINI: If you hear silence, don't assume we're waiting. Just keep on going.

MR. MOSLEMIAN: What we're showing you here is, essentially, the green curve that you see there, that's actually the site-specific GMRS, and the red spectra that you see, that's design response spectra that we have selected to bound that site-specific GMRS. And you will notice that it bounds it quite a bit, and it is, essentially, Reg Guide 160, a spectra, however, in the low-frequency zone. We have modified it slightly to cover the bump that you see in the site-specific response spectra.

What we are showing you here, slide number 24, is the horizontal motion. And slide number 25 is for the vertical motion.

In the site-specific SSI and SSSI analysis, we have considered the following. We do consider site-specific soil properties and site-specific SSE ground motion, including the shear wave velocities.

Seismic analysis diesel fuel storage vault, however, was designed using ABWR DCD SSE ground motion. Even though it's a site-specific structure, since it encases a diesel tank that's designed per DCD design response spectra, we went ahead and designed that structure for the DCD motion, rather than the site-specific motion. So it's designed for a higher ground motion.

We do consider the variation of the soil properties. All of our analysis considers mean, lower bound, upper bound soil properties.

For the Poisson's ratio for the portion of the soil that is below the ground water table, in order to achieve the 5,000-feet per second compression wave velocity, we do vary the Poisson ratio. However, we limit it to 0.495.

SSI analyses has accounted, again, for

refined mesh for the soil structure model so that we get a cut-off frequency of 33 hertz for transfer function calculations. We have done, for the UHS, because of it's uniqueness, you know, you have this UHS basin which could be full at one point and then, if you ever end up using it during the 90-day period, the water may go a lot lower, we have a evaluated that for both empty and full basin cases.

MEMBER STETKAR: I'm like Mike. No, I'm not like Mike. I'm even further outside of my realm of comfort.

CHAIR CORRADINI: That's how you always start every question. Go ahead.

MEMBER STETKAR: How much difference in the final design did it make when you did the empty basin case compared to the full basin case? I read all of those words, but they don't mean a lot to me.

MR. MOSLEMIAN: In the response spectra, it made a significant --

MEMBER STETKAR: That's the impression that I -- okay, thanks. That's the only thing I wanted from you guys, and I'll ask the staff. Thank you.

MR. MOSLEMIAN: Also, in all these site-specific seismic analyses, we do determine soil pressures, again, from both SSI and SSSI analysis. And the analysis of the structures, this structural site accounted for the effect of the heavy structures adjacent to smaller structures.

What I mean by that is, for example, we have the reactor building, which is a huge, heavy structure. And next to that, we have the diesel generator fuel storage vault, which is a tiny structure, relatively light. The motion of the reactor building actually affects the motion for the fuel storage vault. So we do, we do a 3-D analysis where we account for the effect of the heavy structure on the smaller structure. And our design bounds the site-specific motion, as well as the so-called, we call it amplified motion due to the effect of the heavier structure.

CONSULTANT HINZE: Is there any possibility of a saiches in the UHS? Is that considered at all?

MR. MOSLEMIAN: I'm sorry. I did not catch the --

MR. HOOKS: No, it was evaluated in Chapter 2 and is not --

CONSULTANT HINZE: In the UHS.

MR. MOSLEMIAN: Yes, we do account for

sloshing. We do account for both impulsive and convective forces.

CONSULTANT HINZE: Okay.

MR. HOOKS: I was jumping back to Chapter 2 with your question.

MR. MOSLEMIAN: Okay. Just to give you an idea of what our model looked like. Actually, this is the seismic model that we see for UHS/RSW pump house. Believe it or not, this model is a lot bigger than the model for the reactor building because the reactor building, at the time it was, you know, it was a combination of, essentially, the exterior walls and base map of the reactor building. And for the internals, we essentially had a stick model, whereas, for the UHS, this is actually a 3-D representation of the entire UHS/RSW pump house.

And, you know, what you see there, essentially, the green part is the structure itself. The yellow part is the foundation and the size of that. And below you will have the soil layers for the SSI analysis.

One major item for our design for the site-specific structures is actually determining the seismic soil pressures. And we have, you know, throughout the industry, there is significant, evidence of significant -- there is some uncertainty about really which analysis gives you the best representation of the seismic soil pressures that you will have. And I believe, indeed, because of that, in the new provisions for SRP 3.7 and 3.8, it has been proposed that the seismic pressures should be based on methodologies of ASCE 4-98, as well as what you get from SSI analysis and any SSSI analysis that you have performed.

We were proactive. You know, we did this in our design for the site-specific structures at STP 3 and 4. All of our soil pressures are based on three methods. We have the methodology ASCE 4-98. We have the soil pressures we obtained from SSI analysis, as well as SSSI analysis. Our design will bound all of these soil pressures.

Again, in this slide, what we are showing you is that this is the model, the SAP2000 model, that we have actually utilized for the design aspect of the UHS/RSW pump house. The design is done with some equivalent static. They're using equivalent static method where we represent the seismic forces from SSI analysis using the maximum observations that we obtained from SSI analysis, and we show that, by cutting various sections, we show that, actually, the applied dose for this model, using the equivalent static method, is conservative to the results we get from SSI analysis.

So it is a conservative design. It just gives you an idea of what our model looked like.

And I'd also like to point out one more thing that may be of interest. Again, if you compare this design to what you would have done probably in the 80s when you were designing plants, essentially the latest plants that were designed in the States, in those days, you would probably consider maybe eight, nine, ten different load combinations. And because of the limitations that you had out of those load combinations, you probably discuss and provide some reasoning that it appears those load combinations were not really critical and you end up analyzing maybe one or two load combinations. And even for that, it's mostly either manual calculations or very simplistic large mesh size programs.

Just to let you, give you a flavor of what we have here, we have over 1,000, I hope I'm not making -- it is over 1,000.

MR. HOOKS: Yes.

MR. MOSLEMIAN: I believe it's about

1,400, 1,400 load combinations that we have considered for the design of this structure. We have considered various permutations, combinations of the loads.

CHAIR CORRADINI: So you did it, so now you have to pay for it. So now you can calculate to the nth degree. From an engineering judgment standpoint, would you have chosen the five or six and analyzed the one or two any differently? In other words, have you ever thought about going back and saying, well, you know, I don't have the computer but I'd use judgment? Did something pop out of the 1,400 that the one or two or the five or six --

MR. MOSLEMIAN: I can give you my very honest answer. The honest answer is, if a staff or NRC will have agreed for me to cut down the number of load combinations, I would definitely have cut it down. However, the tools are available nowadays and the expectations, since the tools are available, you can run them, why not run it? And I can understand that.

CHAIR CORRADINI: But did you get insight that you wouldn't have gotten by doing the calculations, or is this just, is this 1390 of them that you didn't need to do?

MR. MOSLEMIAN: I wouldn't say that. However, you know, just to, you know, for us, as an analyst, we do run these things, but we also make sure things make sense.

CHAIR CORRADINI: Okay.

MR. MOSLEMIAN: So, you know, we look at the results. Do those results, you know, meet our expectations? Am I seeing the maximum moments somewhere where I should see, maximum shear where I should see. So those are based on those, you know, two or three load combinations that we used to do and get a design.

So that is the basis for us accepting what we are getting. If you see some funny results, then we know there's something wrong, that either --

CHAIR CORRADINI: But nothing popped up is surprising?

MR. MOSLEMIAN: No, nothing surprising. I mean, the behavior we got is essentially what we expected out of the model.

MR. HOOKS: And I would say the loads, too. I mean, we had some areas that are controlled by hurricane or tornado loads, but most areas control probably by the seismic loads. Where those differences occurred, they made sense.

CHAIR CORRADINI: Okay. Thank you.

MR. MOSLEMIAN: Also, since we mentioned tornado, I'd like to mention something else. You know, when you design for tornado, obviously you have to consider tornado wind, along with tornado missiles. The guidance is, essentially, you consider one missile hitting the structure, one missile at a time. However, implementing such a thing in a finite element analysis, we were to run so many different locations for your missile to get the worst location.

In this specific piece of work for UHS, we were very conservative. We hit it with numerous missiles simultaneously to cover all the locations that could be critical for the design. So in that aspect, we were also very conservative in this design.

CONSULTANT HINZE: While you have this up, let me ask you a question about the piping for the RSW. You've analyzed that for the Rayleigh waves. Why didn't you analyze that for the Love waves?

MR. MOSLEMIAN: I think you're talking about the -- okay. Piping tunnel. That was the design -- yes, the common practice for design of the buried pipe, as well as the buried tunnels, is what is specified in the ASCE 4-98. And I believe it's Section 3.52 of that.

CONSULTANT HINZE: 3.8.4.4.2 --

MR. MOSLEMIAN: No, I'm referring to ASCE 4-98.

CONSULTANT HINZE: Oh, okay.

MR. MOSLEMIAN: That document, in Section 3.52 of that, they provide you that the guidance that they have for the design of buried pipes, as well as the tunnels.

CONSULTANT HINZE: Well, Love waves are very important. Why aren't they taken into account?

MR. MOSLEMIAN: Well, you have, essentially, during the seismic motion, you're going to have longitudinal strain, as well as bending strains. The longitudinal strains coming from your Rayleigh waves, as well as your shear wave. Due to Love waves, as well as compression wave and the shear waves, you lose some bending strain. However, if you look at the formulations that they have provided in ASCE 4-98 for determining the longitudinal strain, as well as the bending strains, you will see that the bending strain is relatively very small compared to the longitudinal strain. And reason for that is that the wave velocity goes into the denominator of that term, and it's actually scored. So even if you use the minimum wave or consider the wave velocity 3,000, you have in the denominator a factor of nine million. So the bending strain becomes a very small of the total strain. The longitudinal strain is a lot more.

The formulation that they have provided in the ASCE 4-98 for the bending strain only considers the Rayleigh compression wave, as well as the shear wave. And I believe they considered the Love wave --

CONSULTANT HINZE: Love wave as a shear wave.

MR. MOSLEMIAN: They considered that as nothing specific. They don't provide any specific coefficients for Love wave. They have the specific coefficients for compression wave, shear wave, and the Rayleigh waves. And that's the criteria that we have used to design the --

CONSULTANT HINZE: So someone has analyzed this and determined that the Love wave shared motion is not going to affect the bending moments then to any significant degree? Is that where we're coming from?

MR. MOSLEMIAN: ASCE 4-98 criteria is based on the shear wave, compression wave, and the Rayleigh wave, and that the Love wave itself, separately, is considered insignificant compared to the other three waves.

CONSULTANT HINZE: It's not included with the shear wave? Okay.

CHAIR CORRADINI: Since, again, I'm not following completely, I'm trying to make sure if you guys are saying the same thing to each other. So are you saying his concern about a particular input is included in the shear wave or simply felt to be insignificant compared to what the standard asks you to do?

MR. MOSLEMIAN: Our belief is that the standard considers a Love wave effect insignificant compared to the others.

CHAIR CORRADINI: Okay.

CONSULTANT HINZE: And that's included in 98?

MR. MOSLEMIAN: Yes, in ASCE 4-98.

CONSULTANT HINZE: Okay, thank you.

MR. HEAD: But that discussion we just had is not in 98.

CONSULTANT HINZE: Right.

MR. MOSLEMIAN: Yes. If you look at the tables that they have there, the coefficient and compare the equation for the bending strain versus the equation for the longitudinal strain, you will see that the bending strain, it has a term at the bottom, that gets a score which is a coefficient based on the coefficient, based on the wave type that you have, a Rayleigh wave or compression or a shear wave, it's a coefficient greater than one times your velocity, wave velocity, and the whole term is a score. And the conservative minimum wave velocity is 2,000 feet per second, recommended.

So if you put that in there, you have a term that's already more than 3,000 and it gets a score. So you get something divided by nine million. That's why the bending strain turns out to be a small component.

CONSULTANT HINZE: Thank you.

CHAIR CORRADINI: You got to do a time check. We want to have you finish in about a half an hour.

MR. HEAD: Okay. You have about a half an hour.

CHAIR CORRADINI: I'm just simply pointing out our --

MR. HEAD: I understand that, but we will go quickly through the rest of this and 2 over 1 because the other topics, I think, we want to focus on.

CHAIR CORRADINI: That's fine. I just want to give the staff enough time.

MR. MOSLEMIAN: Okay. I'm not going to spend too much time on this slide. This slide 30, essentially, talks about the loads that were considered for the design of the UHS/RSW pump house. And I believe I verbally discussed this earlier.

Another unique thing about UHS/RSW pump house is because it houses, you know, the cooling water and that. We have, in addition to the programs for concrete design, which is based on ACI 349, we have also followed ACI 350 recommendations which is, essentially, for the environmental engineering concrete structures. And the structure seal design is based on N690-1994 edition. As you notice, the design of all the site-specific structures are based on the latest versions of the steel and concrete codes endorsed by the NRC.

Any question on the design of the site-specific structures?

The next topic on the so-called 2 over 1 structures. These structures in this figure in slide 33 is essentially identified, I guess, in the -- is that blue color? Yes. In blue. You have the turbine building, service building, as well as radwaste building, and control building annex.

The reason these buildings are -- in our terminology we call them 2 over 1. These are not seismic category 1 structures. They don't house any seismic category 1 equipment. However, because of the close proximity to seismic category 1 structures, you want to ensure that under seismic, under momentum loading, they don't have any adverse interaction with the category 1 structures.

I'd also like to point out one thing you'll notice, our design for the 2 over 1 issues considers the most severe design plans that we use for the design of the category 1 structure. So if it's a DCD category 1 structure, the design plan is that we considered for the 2 over 1 evaluation is the same design parameters that we'll use for the category 1 structure. In other words, if it's interaction with the reactor building, that was designed for 0.3g. Our site-specific is 0.13g.

For the 2 over 1 issue, just to make sure the safety margin of category 1 structure is not diminished by any means, we have designed that for the non-safety category 1 structure to the .3g value, rather than for 0.13g.

MEMBER STETKAR: Is that actually true for all of those? I know you did it for the turbine building, but you didn't do it for the service building, did you?

MR. MOSLEMIAN: That is what we are doing, yes. We have been very conservative. I know right now staff is clarifying the requirements for 2 over 1 design in the new provisions to ensure that people don't have to do this. But at the time we were carrying out this design, we followed the law to the letter and we actually implemented that.

MEMBER STETKAR: So you also used 0.3g for the service building? I thought you used the --

MR. MOSLEMIAN: For the 2 over 1.

MEMBER STETKAR: Oh, for the 2 over 1. Okay.

MR. MOSLEMIAN: Keep that in mind. What I'm saying is for the 2 over 1.

MEMBER STETKAR: Got it, got it. Thank you, yes.

MR. MOSLEMIAN: The actual design of the -- this kind of gets back to your point. The actual design of the structures --

MEMBER STETKAR: The actual design with the site-specific --

MR. MOSLEMIAN: Is IBC. For example, they're not safety related. They're IBC 2006 design. For the radwaste building, the design is based on Reg Guide 1.143. Okay. I think I covered that topic.

This slide essentially is explaining what I just talked about, the fact that, you know, if I'm next to a DCD structure, I have to use the parameters of the DCD design for the 2 over 1. And for the stability evaluations of these structures are based on the site-specific soil properties and amplified motions. If there's one structure adjacent to a larger structure, we have to consider amplified motion. And the soil pressures from SSSI from our SASSI analysis. And also we have site-specific ITAACs to ensure that the 2 over 1 acceptance criteria that we have committed our measure in the final design.

And the radwaste building is the next item. Radwaste building is classified as RW-IIa, high hazard. It's in accordance with Reg Guide 1.143. And criteria for the design, it's, you know, it either meets or exceeds the requirements of Reg Guide 1.143 for classification of RW-IIa. Loads and load combinations are per the requirements of Reg Guide 1.143 and structure acceptance is per ACI-349-97 for concrete and AISC/N690, 1984 version, for structure C.

I guess that's the end of the discussion for 2 over 1 structures. If you have any questions, I'd be glad to answer.

CHAIR CORRADINI: Keep on going.

MR. HOOKS: Okay. The other topics, Bob and I will kind of bounce back and forth as he covers them. First, the two Part 21 issues. The Defense Board on the subtraction method was SASSI. The evaluation for hurricane loads and the design provisions for external flooding.

First, Part 21 report related to main steam lines. During detailed design to turbine building, Fluor notified the NRC that the floor response spectra were not completely enveloped by the main steam line design inputs specified in DCD.

In the DCD, making a long story short, take the response in the reactor building and, at the other end of the line in the turbine building, which does not have a dynamic analysis when the DCD was done, the judgment was, as shown in the DCD, use that same, I have two big concrete structures, roughly the same elevation, use the same response spectra or the same seismic inputs at both ends of the main steam line.

When Fluor was doing their work, they did a dynamic analysis or seismic analysis, seismic analysis of the turbine building, and they said we think those responses are going to be higher than what's in the DCD. That's the essence of the Part 21 that was filed.

Their work was based on design work in progress. It was never completed, nor was it ever accepted by NINA. To resolve the issue, NINA agreed to an ITAAC, that whenever that design of that turbine building is completed that there will be a dynamic analysis done to determine if it exceeds or does not exceed those values and take appropriate action at that time.

Any questions?

CHAIR CORRADINI: I don't think I appreciate -- so you're putting off the question? That's the way I read this. Or putting off the answer to the question, I should say.

MR. HOOKS: The building is not designed.

CHAIR CORRADINI: But within the design process, you're going to at least have to consider it so that you don't put yourself in a box?

MR. HOOKS: Right, yes.

CHAIR CORRADINI: Okay.

MR. HEAD: We will pass that ITAAC.

CHAIR CORRADINI: Okay. I figured you would. I'm just trying to understand what it said. Okay.

MR. HOOKS: And then during the initial SSI analysis for STP 3 and 4, our analysts observed that the results in one of the models was inconsistent with expected results. The results just didn't look right to experienced --

MEMBER BROWN: Can I go back, just relative to the outside, since I have no idea about this stuff either, being an electrical guy. But if you're going to do it later and you didn't come to an agreement on what the inputs would be in the turbine building, you said that work was incomplete and it was not accepted, so the number you're going to use when you do this is going to be the DCD value or will it be another value with which you then obtain NRC agreement with prior to doing the design, or am I off base?

MR. HEAD: No, sir. I think we'll start with the DCD, and we will do the analysis. If, during that process, we find something doesn't work for that piping structure, then, yes, if we have to go back to the NRC to get an amendment to change that DCD expectation, you know, that will be part of the process but --

MEMBER BROWN: My point being is if there's an evaluation that says the DCD is not high, it's too low, so there's a number out there that says the DCD value was not okay, so somehow, it would seem to me, that has to be either refuted or justified or something, as opposed to just saying we've done it for the DCD. And I don't, is that going to be a part of this, is that part of the ITAAC to make a judgment relative to that prior piece of, that other --

MR. HEAD: I'm going to let P.K., P.K. has his hand raised behind you.

MR. AGRAWAL: Actually, as it is shown in the slide, the last bullet in the slide shows what the ITAAC says. The ITAAC says that it requires a dynamic analysis of the final turbine building design to confirm that the DCD dynamic input requirements for the main steam line are satisfied. So in order to prove that confirmation, which was the reason for the Part 21, based on the dynamic analysis, it would be confirmed that the DCD requirement is . . .

MR. MOSLEMIAN: I may add a little bit to that. The work that Fluor did for the turbine building, it was based on an incomplete design. The design of the turbine building was not completed, by any means. So when we actually finalized that design, you know, you can affect the spectra at any given point of the structure based on the stiffness that we provide. So it is within our means of, you know, adjusting the stiffness of that portion of the turbine building to make sure that the spectra, the resulting spectra comes at lower than what DCD has considered. MEMBER BROWN: Okay. I understand what you're saying. So you'll use that --

MR. MOSLEMIAN: So we will --

MEMBER BROWN: -- as part of the design --

MR. MOSLEMIAN: Right.

MEMBER BROWN: -- to make sure --

MR. MOSLEMIAN: We will do that in our design.

MEMBER BROWN: All right. That's fine then. That answered my question. Thank you.

CHAIR CORRADINI: Okay. Fine.

MR. HOOKS: Okay. The ACS SASSI. We were cruising along doing our work using ACS SASSI on the confirmatory analyses. We were doing the reactor building, the control building. One of the Fluor models that we were looking at, the results just did not make sense. Investigation concluded that, in one of these models, we were dealing with 80 soil layers exhibited instability.

And in addition to us seeing what it was, we did some work on it and we went to an outside party, third party, and asked for help in verifying what we were seeing within the analysis using SASSI 2000, which confirmed that that model was unstable with ACS SASSI but provided reasonable results with SASSI 2000.

As a result, we submitted a Part 21 report to the NRC regarding this finding. We retired ACS SASSI in favor of SASSI 2000. We upgraded and enhanced our own V&V program with respect to SASSI and applied this enhanced V&V

program to SASSI 2000. We confirmed that SASSI 2000 results did not exhibit that same instability. STP 3 and 4, SSI, and SSSI analyses all rely upon SASSI 2000. None of the work on the project relies on ACS SASSI.

The industry, I can't speak with any kind of confidence on this, but the soil conditions at STP are such that using a large number of layers is required, given the soil conditions we have at South Texas and probably not required to go that high in terms of number of layers at some of the other sites. But I can't, I can't speak to -- I notice John is -- but, at any rate, why we found it and why it wasn't found before, we really don't know. We didn't follow up on ACS SASSI. We sort of lost confidence in it and went a different route and made our report and moved on.

CONSULTANT HINZE: Is it a programming error? What kind of an error is this? What kind of a problem is it? Is it an error in the input parameters? Is it a problem --

MR. HOOKS: It was upgraded to go from, I don't remember the exact numbers, from, say, 50 to 100 layers at some point. And it's not just the number of layers. We know it occurs at high numbers of layers, more than 80, but it only occurred in one out of four models. There are other parameters. You have to get the perfect storm, so to speak --

CONSULTANT HINZE: What I'm hearing you say is you know it's there but you don't know the root cause.

MEMBER STETKAR: Do they have to be saturated soils? Do they have to be deeply saturated soils or is it just --

MR. HOOKS: We never went into that kind of investigation. Once we --

MEMBER STETKAR: That's fine. I was just curious.

MR. HEAD: So, Bob, ACS SASSI is owned by another company.

MR. HOOKS: Right. We don't have the source code.

MR. MOSLEMIAN: Yes, it is very important to ensure that everybody understands we are not, none of our work right now depends on ACS SASSI. That is retired. All of our work is based on SASSI 2000. The numerical instability that was observed, it needs the right parameters. It's just a numerical issue. And we believe the final resolution that ACS SASSI had for the issue was the fact that their version was using an old solver, and that old solver was not accurate and that's why there was instability --

CONSULTANT HINZE: So truncation problems. MR. MOSLEMIAN: Right. And their claim is, again, we are not using ACS SASSI, but the latest claim from ACS SASSI is after they updated their solver they don't have those numerical issues anymore.

CONSULTANT HINZE: And how did you benchmark 2000?

MR. MOSLEMIAN: 2000 benchmarking is where, you know, we have a number of the V&V problems that we run. Of course, again --

CONSULTANT HINZE: With multiple layers?

MR. MOSLEMIAN: Well, in our previous validation, we had up to 20 layers, you know, in our previous validation prior to this discovery. After this discovery, we did do more V&V with a higher number of layers. So when we validate --

CONSULTANT HINZE: How many?

MR. MOSLEMIAN: We went up to 100 layers, which is the limit. Am I right, Surendra? Surendra Singh is our seismic expert. He can --

MR. HOOKS: Let me introduce. Dr. Singh

has been with Sargent & Lundy for 43 years after completing his doctorate at IIT in Chicago and has been, I think, pretty much exclusively involved in seismic and dynamic structural analyses throughout his career. Surendra?

MR. SINGH: Yes. SASSI 2000 has a limit of 100 layers, so now our new validation has up to 100 layers. When we had about 20 layers, we subdivided those layers into 100 layers and brought about the same results, so that is validated again with a large number of layers.

CHAIR CORRADINI: Okay.

MR. MOSLEMIAN: Again, this is Javad Moslemian. Now I'm going to talk about the Defense Nuclear Fuel Safety Board issues that were raised regarding to errors noticed for the subtraction method of analysis of SASSI.

As you may know, SASSI analyses can be done using two methods. One is a direct method, and the other one was a subtraction method. And, recently, there have been discoveries that when using subtraction method you could get some spurious results, and this happens, typically, in frequencies, in high frequencies, and it's been attributed to the vibration of the soil volume. If the natural frequency, for frequencies higher than the natural frequence of the soil volume, you may get some instability with the subtraction method results.

One thing to keep in mind is that, because we were, at the time we were doing the measure, there were seismic analyses. We were kind of aware of this issue being discussed within the industry. The DNFSB had not issued their findings yet, but we had heard about it, so we kind of in the up-front, you know, in this issue, and we kept up with all the developments on this issue.

So we were very proactive, and we went ahead and, essentially, either repeated our work that we had done with the subtraction method using direct method or we made the analyses in modified subtraction. And in the next slide, this figure that you see, I will try to explain.

In the direct method, this represents the so-called excavated volume. That's where actually our structure sits in the soil. The excavated volume, if all the nodes for excavated volume are considered as defined as interaction nodes, that's what is called a direct method.

And for the subtraction method, only the exterior nodes of that excavated volume are declared as the interaction nodes. In other words, direct method and subtraction method are two extremes of the same analysis. One is using very much, you know, the most accurate, and the subtraction method could be approximation.

Now, the one remedy that has been suggested for this issue is so-called modified subtraction method. In the modified subtraction method, what you do, some of the internal nodes of the excavated volume, you choose some additional internal nodes and you also declare those as interaction nodes. By doing that, you're essentially increasing the natural frequency of the excavated soil volume, and that pushes the error to the higher frequency. So let's say you're interested up to 20 hertz. If you ensure that the natural frequency of that excavated soil volume with the interaction nodes that we have defined in the model goes beyond the 20 hertz, then you don't care. That modified subtraction method will give you accurate results.

However, the key thing about modified subtraction method is that, whenever you do this, you have to find the additional interaction nodes you need to add to take care of the problem. So you need to benchmark it. And with all the work that we did in STP is based on the benchmarking that we did for the modified subtraction method that we use for the STP 3 and 4.

CHAIR CORRADINI: Can I just summarize this? This is a bit more detailed. So you have used the MSM, but you need to benchmark it as you use it, as you go along using it?

MR. MOSLEMIAN: Right. You know, you benchmark it for your site-specific --

CHAIR CORRADINI: I understand.

MR. MOSLEMIAN: -- conditions. So what we did for our benchmarking on STP 3 and 4, we had the control building model where we were evaluating for the shear wave velocity that we have. That model, we had run in the direct method.

CHAIR CORRADINI: So that was your way of benchmarking?

MR. MOSLEMIAN: Right. That is direct method. That's the solution, right? So we went ahead and took that model. We implemented modified subtraction method, as we have defined it for STP 3 and 4 project, which is, in addition to the nodes that you have on the sides of the excavated volume, which is for subtraction method, you also define all the nodes at the surface of the excavated volume as interaction node.

With that definition, we repeated in the control building analysis and we compared the spectra that we got from the two models, as well as the forces, moments, and all that. Whatever goes into our designs, they were compared. And the spectras matched very well, and the forces, moments, they were within four percent. So that's how we benchmarked our modified subtraction for the STP 3 and 4 project. And that's essentially what we see in slide 43 discussing the benchmarking and so on.

MEMBER BROWN: Before you -- your last bullet, though, says where the direct method is not feasible. I guess I've got a disconnect. I'm not saying I --

CHAIR CORRADINI: I think what they did is they took some place where they could do all three.

MEMBER BROWN: Yes, I got it.

MR. MOSLEMIAN: I missed one thing. I apologize. I should have explained that. You know, the size of the problem is proportional to cube of the number of interactions. So as the interaction nodes goes up, the size of the problem increased.

The capability of SASSI 2000, you know, the maximum you could handle would be about six or seven thousand interaction nodes. So, for example, for UHS/RSW pump house, if you wanted to go direct method where you have to declare all those excavated volume nodes as interaction nodes, your number of interaction nodes, I believe it will go beyond 16 or 17 thousand nodes. And SASSI 2000 could not simply handle that. So that's why we say wherever feasible, wherever the computer capability would allow us to use that method, we did use that method. Wherever it wasn't possible, originally, we had the subtraction method, but because of the issues with the subtraction method, it changed and we went to modified subtraction method.

CHAIR CORRADINI: But they benchmarked it in length scales or volume scales where they could do a direct comparison between DM and MSM.

MEMBER BROWN: But not for this specific, I mean, this specific structure.

CHAIR CORRADINI: For the control building.

MEMBER BROWN: You used another building to do the --

MR. MOSLEMIAN: That's right, that's right. Yes.

MEMBER BROWN: Okay.

CHAIR CORRADINI: Does that help?

MEMBER BROWN: Yes.

CHAIR CORRADINI: It's still a substantial building, but it's not --

MEMBER BROWN: No, it's not, it's not -- you don't have as many interaction nodes.

MR. MOSLEMIAN: You made a very good observation. The most appropriate way of benchmarking, if possible, is to actually benchmark the actual structure. But whenever that's not possible, the recommendations is you could use smaller models, representative models, and so on to convince yourself that your modified subtraction method is giving you the design. In this case, it wasn't possible for us to, you know, run direct method for the UHS/RSW.

MEMBER BROWN: Got it.

CHAIR CORRADINI: So unless -- I'm going to make a suggestion. Unless there's something that you want to emphasize on resolving this computational benchmarking, I would propose you go on to --

MR. HEAD: Okay.

MR. MOSLEMIAN: No, unless you guys have a question, I don't --

CHAIR CORRADINI: I don't think the Committee does.

MR. MOSLEMIAN: Okay. Then I guess I will stop talking about --

MR. HOOKS: Hurricane loads either one of us can handle. But to conclude the session, what we call late in the game, Regulatory Guide 1.221 was applied to the STP 3 and 4 design, both DCD and site specific. The STP site-specific design basis hurricane wind speed and resulting hurricane generated missile spectrum were determined in accordance with the reg guide, carried out evaluations and designs for the project. Seismic cat 1 structures are designed for the maximum tornado and hurricane loads. Site-specific ITAACs assure that the design of these structures for hurricane winds and missiles will meet the acceptance criteria. The items subject to 2 over 1 were evaluated for the hurricane wind and missiles, as well.

There's some difference in those compared to tornado. They're not major, but they are different. Some of the missiles were a little heavier, some a little lighter, speeds. It's hard to give you a straight comparison between tornado and hurricane because of slight differences here and there, but, effectively, we have designed for both or evaluated for both independently.

MEMBER STETKAR: And hurricane missiles did determine, I think, a couple of places, if I read --

MR. HOOKS: Controlled --

MEMBER STETKAR: Yes.

MR. HOOKS: -- tornado missiles. A few places where they actually controlled the design. I mean, you know, DCD structures with walls that are over a meter thick are set up for --

MEMBER STETKAR: Site-specific.

MR. MOSLEMIAN: Yes, hurricane missiles tend to have a higher velocity.

MEMBER STETKAR: I think the RSW piping and access --

MR. HOOKS: Oh, yes. There, the missiles do control and hurricane would control --

MR. MOSLEMIAN: We did end up adding some shear times.

MR. HOOKS: Yes. And external flooding,

floatation stability based on buoyancy calculations using the design basis flood, the design basis flood being 40 feet above sea level or six feet above finished plant grade. Lateral loads on the structural walls, etcetera. We considered a hydrostatic force, the drag forces, the wind generated, wave forces, and impact on floating debris. Penetrations in doors through the exterior walls located below the flood level are seismic category 1 components, and they're provided with watertight seals. And that was really the change we made there to the DCD structures was to make the openings at the grade for watertight doors or the door openings at watertight doors. And we really didn't change too much in the way of penetrations, if any, or any tight seals to speak of.

But we did have to go back and look at the other seals and so on to make sure that we added the additional hydrostatic head door calculations on these items. It's really a detail more than a --

MEMBER STETKAR: Bob, when I read through the SER, there was quite a bit of discussion about, questions anyway, RAIs, on the analyses of the watertight doors for the reactor building and control building and the diesel generator fuel storage vaults. The fuel oil tunnels and the RSW tunnel also have penetrations, access penetrations, at each end of each tunnel. Are those sealed with watertight doors?

MR. HOOKS: On the tunnel -- separate the tunnels. On the diesel tunnels, the accesses are located above, they're up on top of the water level.

MEMBER STETKAR: And the door access is more than six inches above grade?

MR. HOOKS: Yes.

MEMBER STETKAR: Okay, good. That's a good answer. In other ones, I got the impression they look more like manholes.

MR. HOOKS: Well, they are manholes, but they're located above --

MEMBER STETKAR: Okay. But that's on the diesel --

MR. HOOKS: On the diesel.

MEMBER STETKAR: On the diesels, okay.

MR. HOOKS: On the RSW, there are no active components in the tunnel --

MEMBER STETKAR: Right.

MR. HOOKS: -- to, therefore, allow it to fill up with water.

CHAIR CORRADINI: Say that last part again. I'm sorry.

MR. HOOKS: There is no reason to keep it dry.

MEMBER STETKAR: Do you have cables, for example, power cables instrumentation and control cables, that go out to the RSW pump house and for the cooling tower fans?

MR. HOOKS: Yes, we do. And those are sealed at each end.

MEMBER STETKAR: They are sealed at each end, and are they sealed from the interior of the tunnel?

MR. HOOKS: No.

MEMBER STETKAR: And are there --

MR. HOOKS: They would be under water during the period of the flood.

MEMBER STETKAR: -- junction boxes anywhere in those --

MR. HOOKS: No junction boxes.

MEMBER BROWN: But the cables themselves are just bare cables. They're not in a continuous conduit.

MR. HOOKS: No, they are in trays.

MEMBER BROWN: Open trays.

MR. HOOKS: Right.

MEMBER BROWN: So they would be flooded.

MR. HOOKS: Yes.

MEMBER BROWN: Direct contact with the flood.

MR. HOOKS: Right.

MEMBER BROWN: Okay, fine. I'm sorry to interrupt.

MEMBER STETKAR: And the design specifies there's no junction boxes anywhere in that pool? That's a long pool.

MR. HOOKS: Yes. Yes to both of those questions.

MEMBER STETKAR: Thank you.

CHAIR CORRADINI: Okay.

MR. HEAD: Next page, though, is the punch line on this discussion.

MR. HOOKS: I think this is the slide that you've seen before from previous presentation. And in response to NRC post-Fukushima recommendations, available physical margin for flooding analysis was performed to determine where the Cliff Edge is, as it's called in some of the correspondence. EDGs and the ability to cool the core is maintained until flood water exceeds, levels exceed 51 feet. This is 11 feet above the design basis flood, almost 13 feet above the calculated MCR breach flood and 17 feet above site grade.

When we say that we've done this evaluation, in the evaluation we've looked at buoyance, we've looked at hydrostatic head on walls. We've made the checks. Our design basis remains 40 feet. The evaluations have concluded that we could handle up to 51 feet.

CHAIR CORRADINI: Are there questions from the Committee? I think this was your last slide.

MR. HOOKS: That was our last -- here's our last slide.

CHAIR CORRADINI: Okay. Back to the buildings. Questions from the Committee?

MR. HEAD: Mr. Chairman, I've got to ask, there was, in discussions beforehand there was the potential for a discussion on the radwaste building. Did our slide address any questions with respect to the radwaste building?

CHAIR CORRADINI: I don't think so. I think we're okay.

MR. HEAD: Okay.

MS. BANERJEE: So we're taking one

action item then?

MR. HEAD: Yes. We'll review this. We have an action item that we'll report to you and have addressed somehow by the November meeting. And by somehow, I mean if we update the COLA or, you know, submit a change, then we'll have done that by then. With respect to the two different earthquakes and the logic and our expectations regarding similar results.

MEMBER STETKAR: I was just writing notes here. The RSW piping tunnel is completely sealed on control building and the RSW pump house, so that, even if it does fill with water, no water is going --

MR. HOOKS: That's correct.

MEMBER STETKAR: No piping --

MR. HOOKS: Those are sealed penetrations at the wall. No tunnel penetrates a building. The piping within the tunnel is an individual piping penetration.

MEMBER STETKAR: And that penetration is a sealed --

MR. HOOKS: That's correct.

MEMBER STETKAR: Okay.

MR. HOOKS: Seal rings and . . .

MEMBER STETKAR: Yes, thank you.

CHAIR CORRADINI: Okay. With that, I'll thank the folks from NINA. Let's take a break until 10:15, and we'll start up again with the staff. Thank you.

(Whereupon, the foregoing matter went off the record at 10:01 a.m. and went back on the record at 10:14 a.m.)

CHAIR CORRADINI: Okay. Why don't we get started? The staff is here to inform and educate us. So, Tom, are you going to start us off?

MR. TAI: Yes. Good morning. Thank you again for giving us the opportunity. The STP application restarted in 2008, September/October time frame, and in the STP slides, for the date of the Part 21 for SASSI on the screen, but it was reported, like, from the first or second quarter of 2008. But as soon as that happened, it basically restart everything, not back to Phase 1 but, like, pre-Phase 1 work. So it is over four years before we can come back to talk to you. So I'll let our reviewer to do the discussion.

MR. CHAKRAVORTY: Well, thank you, and good morning. My name is Manas Chakravorty, and I work in the structural division, SCB, Branch 2, of NRC and the NRO. I do have about more than 30 years of nuclear experience encompassing design analysis and operations. And, currently, I'm having some regulatory experience. I have a doctor of science in structural engineering. I am currently a Senior Structural Engineer here.

I've reviewed Section 3.7 of the South Texas Project 3 and 4 COLA, and I was assisted by my colleague, Samir Chakrabarti. And also we had consultant. I don't know whether he'll be able to join by telephone or not. He's in the West Coast. His name is Dr. Mansour Tabatabaie of SC Solutions. Just to mention that Dr. Tabatabaie was one of the regional author of SASSI code way back then.

Okay. Next slide. Let me go over briefly what was our purpose of the review. The purpose of this meeting presentation is primarily to brief the Subcommittee on how we did this review. And the review encompassed Section 3.71, 3.72, 3.73.

Next slide.

MS. BANERJEE: Somebody joined us. Hello? MR. ARNOLD: It's Peter Arnold.

MR. TAI: Hi, Peter. We are starting to

discuss it right now.

MR. CHAKRAVORTY: Okay. The next slide, this is the outline of our presentation or my presentation. I'll go over a little bit about background and review scope, the applicable regulations, topics of interest that we focused quite a bit of our attention, and these are standard design STP site parameters. Again, the departure, environmental departure, particularly the shear wave velocity departure, we reviewed quite diligently site-specific soil structure interaction. We focused on the modeling issues, amplified ground motion input, structural soil and structural interaction, and also significant emphasis was provided on computer program validation. And also we did confirmative analysis to address our still continued some doubts so that, you know, we feel comfortable.

And then also we reviewed Fluor's Part 21 evaluation, conclusions, and then committed questions. Now, we didn't go very far on this ACS SASSI issue.

CHAIR CORRADINI: You didn't go very far on the what issue?

MR. CHAKRAVORTY: The ACS, the first

Part 21, because they outright said they will not use it, so we didn't, you know --

CHAIR CORRADINI: Okay.

MR. CHAKRAVORTY: -- focus too much attention on that.

CHAIR CORRADINI: So maybe I should ask the question I was going to ask the first time. Does that impact other analyses that have used it in the past, or is this unique?

MR. CHAKRAVORTY: No, I don't think it -- first of all, it's a unique thing for varied sites, like a deep soil site. Very few sites are like this.

CHAIR CORRADINI: Sure.

MR. CHAKRAVORTY: And so I wouldn't expect -- furthermore, ACS SASSI, they have already addressed this issue on their program and they have informed all other users, okay. So it has gone through the proper process of Part 21 evaluation.

CHAIR CORRADINI: Thank you.

MR. CHAKRAVORTY: The next slide, background and review scope. Again, STP is a very deep soil site, extending probably several thousands of feet. It incorporated ABWR DCD for this section by reference due to departures and some supplemental information. Our scope included reviewing seismic demand at STP site for the standard plant structures, site-specific structures, and also non-category 1 structures with potential to interact with category 1 structures.

We also reviewed the applicable departures, supplemental information, and combined operating license information items. And also we provide quite a bit of time on validation of seismic analysis, codes used for STP application, in particular also addressing the Defense Nuclear Facilities Safety Board issue on the computer code SASSI.

Next slide. The applicable regulations. Again, these are all not all-inclusive, but these are the primary one that we take a look. Part 50, Appendix A, GDC 2, it reflects consideration of most severe earthquake at the site, potential earthquake. Then Part 50, Appendix S, which provides for seismic design implementation specifics, how we implement the seismic design and perform SSI analysis. And also it provides some minimum design criteria that we need to have at a 0.1g earthquake in the horizon direction with a broad spectrum. So that's the minimum that we have to have. So that provided that in that guideline in Appendix S, not in the regulation.

And then 52.79(d)(1) is the COL applicant. They need to demonstrate that site characteristics falls within the site parameters specified in the DCD. So that was what one of our primary focus because here we did have some departures, so they didn't totally fall under the DCD parameters.

And then 52.80, which is the site-specific ITAAC. In some situations that occurred, we needed some site-specific ITAAC, for example Fluor Part 21. We needed that.

NUREG-1503, that's the ABWR DCD SER. We need to lead it to make sure what was the basis for DCD design. And then NUREG-800, which is our Standard Review Plan guidance which we use continually in any review or evaluation. And then we have Interim Staff Guidance 01 and 017.

ABWR standard design and STP site parameters. Now, for certified design, the design response spectra are referred as CSDRS. That's the certified design. For STP, it is Reg Guide 160, or ABWR is the Reg Guide 160 anchored to 0.3g.

Again, remember, the site-specific

number that we design for is 0.13g, and the standard plant was designed for 0.3g. Okay. So 0.13g, 0.3g. Okay.

Now, GMRS at the STP site is based on the Regulatory Guide 1.208 guidance, primarily. And that's discussed in Section 2.5. Site-specific SSE response spectra defined in the free-field at plant grade. And that says 0.13g and Reg Guide 160 with some modifications at certain frequencies to envelop the GMRS.

And then site-specific SSE response spectra should envelop the GMRS. The corresponding FIRS, FIRS is the Foundation Input Response Spectra, which is what the structure will see at its foundation level. And that has to meet the Appendix S requirement of 0.1g minimum peak horizontal ground acceleration at the foundation level. And also CSDRS need to envelop the site-specific SSE spectra. And then DCD, only one case we saw in our seismic analysis that the shear wave velocity site parameter did not meet, and that's the departure that also the applicant talked about earlier. Now, I didn't put any figures of the enveloping because you already have seen those in the applicant's presentation.

So for shear wave velocity, STP is

really, the STP parameter is lower than the DCD minimum requirement, which is, minimum requirement is 1,000 feet per second. However, in the STP, you know, it was not met, so they have to do a site-specific analysis. They did perform a site-specific SSI analysis to confirm that the standard plant results in the DCD enveloped the results of the site-specific SSI analysis.

The staff used the SRP guidance in reviewing applicant's site-specific SSI analysis of the standard plant structures, including the development of the seismic input, the analytical method, soil structure model refinement, site-specific soil properties, consideration of how they used the ground water in the analysis. And at the conclusion of this evaluation, we feel that the applicant has adequately demonstrated that the DCD seismic analysis results envelop those of the site-specific seismic analysis of the standard plant structures. The applicant, in his previous presentation, probably showed some of those envelop, you know, the margin that they had with the DCD and the site-specific spectra.

The next thing is we did site-specific soil structure interaction analysis and the modeling issues that we looked at.

CONSULTANT HINZE: Excuse me. But does this mean that you're satisfied with the use of both the Northridge the Kern County ground motion for the input for the SASSI?

MR. CHAKRAVORTY: The input to the SASSI, if you want that there, they had used for during the SSI analysis is the site-specific spectra, which is the --

CONSULTANT HINZE: Yes. Are you satisfied that --

MR. CHAKRAVORTY: Yes, I am satisfied because, you know, what I looked at -- first of all, the development of the time history, there are certain requirements in the SRP that the time history that you select should be somehow representative of the magnitude and the distance of the controlling earthquake, and they have done. And there are some criteria in the SRP that one needs to meet, you know, that, even though you were using a seed, eventually, you know, that seed is changed because the design spectra is different than whatever seed they have taken. So to match that, they have to change that design time history. They select that seed, but then they modify it so that the modified time history envelops the design spectra. That's the requirement, so they have done that.

And then also, on top of that, the SRP required only five percent of damping matching. Now, I always go and take a look at also other levels of damping just so that the earthquake has enough magnitude, you know, power in the frequency of interest. So we did that, so, on the whole, I am very comfortable with the time history that they have used for site-specific analysis.

Now, the other one that they have used for the standard plant time history, now, standard plant time history, they also have developed -- and that's, again, a little different than STP site-specific spectra because standard plant is 0.3g Reg Guide 160. However, STP is not 0.3. It is 0.13, you know, with the reg guide spectra, but it is a little bit changed at certain frequencies. So it is not exactly a reg guide spectra. It's a little bit different than some frequencies where they have to beef it up during that spectra.

So there are some differences. But, nevertheless, you know, the method they used, you know, to develop the standard plant time history was another approach that is provided in the SRP. I've forgotten now which approach they used, approach one or approach two, which is a little different approach. What that approach does is that matches the power of the earthquake power spectral density functions. So that's what they did, and that is also quite conservative. So SRP accepts or provides some guidance that both of those are acceptable.

So one was matched using one approach of the SRP, and the site-specific one is another approach of SRP. So there are two approaches, and the one that the standard plant time history that they have used, they have used it, if I'm correct, in tunnel, diesel generator tunnel design, and I think that's basically we want that, we have used it. I don't exactly remember totally, you know, which structure, but I know diesel generator fuel oil tunnel used that standard plant's, you know, time history because this is part of the standard plant design, the diesel generator fuel oil tunnel. That's why they did it.

So you're asking me whether I'm comfortable.

CONSULTANT HINZE: Okay. Very good. Thank you.

MR. CHAKRAVORTY: Okay. Sensitivity

studies. We have done or evaluated a number of sensitivities which address several issues. First of all, we looked at the integrated finite element soil-structure interaction model, structural mesh refinement, foundation soil mesh refinement. We take a look at how they have taken care of the soil parameter variations and uncertainties and the modeling of ground water effect, impact of empty basin for Ultimate Heat Sink model, and then also hydrodynamic effects of water on the UHS basin and columns of structure and components, and also some special considerations of the underground tunnels.

MEMBER STETKAR: Now, let me ask you to go back to that. When I read the story about the Ultimate Heat Sink, I asked the applicant whether the empty basin, as you characterized the sensitivity study, resulted in substantial changes or enhancements to the design, and they indicated that, indeed, it had. Why did the staff ask them to perform an empty basin analysis?

MR. CHAKRAVORTY: We didn't, actually.

MEMBER STETKAR: RAIs seem to indicate that they did, as I read through the --

MR. CHAKRAVORTY: Well, maybe. But --

MEMBER STETKAR: I don't think they did

it voluntarily, for example.

MR. CHAKRAVORTY: My recollection was --

MR. HEAD: Yes, sir.

MEMBER STETKAR: You did it, you did it -- you took the initiative?

MR. HEAD: Yes, sir, we did.

MR. CHAKRAVORTY: That's what I thought.

MEMBER STETKAR: Oh, did you? Okay. Then never mind. Now, I don't know why they would do that, but if they took the initiative, that's on them.

MR. CHAKRAVORTY: In fact, we were surprised, too, seeing --

MEMBER STETKAR: Well, no, as I read through the SER, the SER story goes that, well, if you have a LOCA, you know, a number of days after the LOCA the basin might be empty, so you should evaluate seismic response to the basin and if it's empty. But that started to sound like we were compounding, you know, beyond design basis events or multiple design basis events. But if NINA took the initiative themselves, never mind. Thank you. I wanted to ask them. I thought you would say, no, we did it in response to RAIs. But thank you.

MR. CHAKRAVORTY: Okay. So I remembered

reasonably well. I didn't forget. Okay. The next one that we -- again, the modeling is a very important issue. You know, I mean, we talked about it. When you go to the refinement and see where you get the quantity that you are really interested that your model is correctly representing because actual model is a continuum. We are dividing it into little pieces, okay. So how many piece you need depends on what you are really looking for.

So we looked at that very carefully. And, in fact, we also did a confirmatory analysis to confirm some of those sensitivity studies.

Okay. The next input --

CHAIR CORRADINI: I guess, eventually, you're going to get to what -- and I think Bill was going to ask this in more detail, but I guess I also was curious how your logic of when you do confirmatory and when you don't.

MR. CHAKRAVORTY: Oh, it's very simple. I can tell you now, you know. We use various ways for review. First of all is the guidelines are there. SRP is there, and we use that. Then we go back and read the application itself. If we have questions, we ask RAI. We ask the information.

Then, on a sample basis, we go to the

applicant and take a look at their backups that they have provided, backup calculations, drawings, and other things that is in the --

CONSULTANT HINZE: On a sample basis?

MR. CHAKRAVORTY: Sample basis means we just don't look everything. For example, if we looked at the Ultimate Heat Sinking, a very detailed analysis, okay --

CONSULTANT HINZE: Well, are these picked at random, or are they --

MR. CHAKRAVORTY: No, no, no. We just go and, basically, based on the significance. Okay. Like Ultimate Heat Sink is a big structure, so we need to put more focus on that. On the other hand, say, a vault is not that much of a great structure. It takes very, you know, quick look.

CONSULTANT HINZE: Okay.

MR. CHAKRAVORTY: And we can, you know -- but as far as confirmative analysis, you know, we decided to do a confirmative analysis on the Ultimate Heat Sinks because that's a very complicated structure. So we thought we might like to do that.

Now, we did, for this situation, you know, we did two confirmatory analyses. The first one, the one that we did the first time was because there was this ACS SASSI coming in. There's all these numerical instabilities in these, so we decided that we need to at least, even though they are not using it but it is still SASSI, so we thought we need to independently at least check that there is no instability in the SASSI. And right now, the program that they were using SASSI 2000, you know, corroborates with our analysis.

And we did find, you know, good corroboration. We also found that, in certain instances, their model needs a little tweaking or refinement, which is a good thing, you know. That's what it is for. So we knew that we want to do an Ultimate Heat Sinks confirmatory analysis. And that was it. We are not planning to do a second confirmatory analysis.

The reason we did these when this Defense Board issue came up, okay, the first. And the second was this Poisson's ratio issue, you know. The Poisson's ratio, as you go closer to 0.5, something, denominator starts getting to zero and you try to get large number. So there is a potential there.

But on the other hand, if you use a

lower Poisson's ratio, for example, you may not amplify your vertical wedge properly because, as Poisson's ratio goes close to 0.5, it becomes more stiff and you may transmit high frequencies, you know. So that's what the dilemma was: how far you can go. You don't want to go up to 0.5, but you don't want to leave at a lower number, within like, say, 0.4.

So we wanted to make sure that's -- and they did that, and they were getting, seeing, you know -- so we did that. But then also we wanted to confirm it to an independent analysis that, yes, even though it's close to 0.5 Poisson's ratio or these difference issues that are coming up, you know, if we use a modified subtraction method, doing little changes, or maybe use another layer, you know, they just used the surface layer, maybe use another layer, okay, or I think some more interaction nodes to see whether the results change or not. So that's the reason we did the second confirmative analysis. But it was evolving, okay. We are not planning to do a second confirmatory analysis.

CONSULTANT HINZE: Is one of, is there a criterion for the availability to you of computer programs or access to sufficient amount of computer computational facilities? Is this part of when you perform or how you decide when you're going to perform a confirmatory analysis?

What I'm taking from what you've said is that there are two things that I think you mentioned. One is that very significant things and also where there are identified potential problems. Is the computational aspect of it another aspect of another criteria?

MR. CHAKRAVORTY: Computational aspect, we don't put that much emphasis because when we, for example, we asked our consultant from the very beginning do you have adequate resources, if necessary, to do a confirmatory analysis.

CONSULTANT HINZE: And that is a factor then?

MR. CHAKRAVORTY: Yes, of course. At the NRC, we don't have this capability right now.

CONSULTANT HINZE: Do you ever, well, you do bring in contractors to perform these types of analyses, right?

MR. CHAKRAVORTY: Yes. For this situation, Dr. Mansour Tabatabaie did the analysis, you know. And so for this I'm sure we did that with the consultant, and sometimes we do in-house also. We do have in-house program.

CONSULTANT HINZE: Are these, are these criteria made out in the review plan?

MR. CHAKRAVORTY: I don't think there is any specific criteria for coming up with the independent or confirmatory analysis. Okay. The guidance, they don't state. Now, regulation, not regulation. The SRP has some sections on the audit.

MR. CHAKRABARTI: Yes.

MR. CHAKRAVORTY: They do have some, you know, that, if we need to, we need to do some audits. But they don't specifically say you need to do an independent confirmative analysis.

CONSULTANT HINZE: My original question came from, as I read your document, which is an excellent document, I saw that you were doing confirmatory analyses on various items, and I couldn't really find the single factor that was going through and that was important in the selection of those.

MR. CHAKRAVORTY: Most of the time we do confirmatory analysis, as is know, at least for SASSI big seismic analysis, we try to do that or at least the one that I know we have done it. How about DCD? Have they done anything?

MR. CHAKRABARTI: I don't recall.

MR. CHAKRAVORTY: But this one, from the very beginning, we saw the model, and we said we need to do an independent analysis. Now, there is no regulations that tells us to do that.

CHAIR CORRADINI: So in some sense -- I guess I want to make sure that I get this because this was a question that Bill had. So you said one was clearly significant from a safety standpoint and other where there's identified or uncovered problems where you want to check.

MR. CHAKRAVORTY: Right. If we want to get some additional assurance. That's the whole purpose. Again, the applicant is responsible for doing all their review independent analysis, everything.

Next one is the topics of interest with the structure, site-specific soil structure interactions. Structure-soil-structure interaction. It is again, we call a SSSI effect. And it was emphasized by the applicant that they have done this type of analysis of lateral soil structures.

For this plant, you know, if you see the layout, you know, there are some tunnels going on right beside the reactor building or radwaste building in between. And the soil in between those structures, you know, and those heavy buildings could put some good pressure load on the tunnel, which is kind of sandwiched.

But, anyway, this is important, and applicant has taken into account this. That's one of the issues that we're very concerned from the very beginning, looking at the site.

The next one is the computer program validation. We did quite a bit of this evaluation. We did validation of SASSI2000, SAP2000, and SHAKE2000 computer program that they were using in the STP 3 and 4 applications. Now, we identified some issues regarding sufficiency of the validation documents for STP applications. For example, required mesh refinement for out-of-plane responses, acceptable aspect ratios of the finite elements, accuracy of subtraction method of SASSI program, potential instability when using Poisson's ratio very close to .5.

Now, the subtraction method, I just wanted to mention that, at the beginning, when we were doing this validation, we were having a very difficult time to get a good validation bound certain frequency levels. So we just could not determine what was going on. Eventually, it seems to me now, in hindsight, that that is a Defense Board issue. Even though the Defense Board issue was not there at the time, you know, we were still looking for some validation beyond certain frequency levels. But that's subtraction method.

Anyway, after our review and the application expanded the scope of the validation program using additional test problems, they have performed some additional sensitivity studies to address the staff's concern, including accuracy of subtraction method and the Defense Nuclear Facilities Safety Board concerns, particularly when the subtraction method of SASSI is used.

Then I already mentioned staff's confirmative analysis, ACS SASSI, STP resolved some numerical instability, so we decided that we needed to do that just to get an additional assurance that the current one, the SASSI2000, we're getting the similar results. And also, as I mentioned earlier, for Poisson's ratio issue and also the Defense Board issue would need a second confirmatory analysis.

Defense Board issues. I think it was touched by the applicant. Again, we found that the

Defense Board Nuclear Safety Review Board, they identified a technical issue on subtraction method of the SASSI program. And since STP used subtraction method, so the staff requested the applicant to demonstrate acceptability of the results using the subtraction method.

The applicant then benchmarked the modified subtraction method for STP application against the direct method and used the modified subtraction method to validate the subtraction method results. The applicant performed additional analysis using that modified subtraction method. Seismic demand obtained from the modified subtraction method were compared to those updates from the subtraction method. And appropriate modification practice were determined to modify the subtraction method results.

The staff also performed a confirmatory analysis using the modified subtraction method to evaluate the results. And, basically, we found the modified seismic demand used in the design is acceptable, and they adequately addressed the Defense Board issue.

Fluor Part 21 evaluation I think the applicant has discussed previously. The Fluor notified NRC regarding the ABWR DCD seismic design input requirements for the main steam line, particularly the turbine building. The staff requested the applicant to demonstrate that the dynamic input load for the design of the main steam line in the turbine building would be conservative at the STP site. When we got to Part 21, we requested STP to demonstrate that.

And then the applicant indicated that the design of the turbine building is not yet. It's not complete. The applicant provided a site-specific ITAAC that describes that dynamic analysis of the turbine building will be performed to confirm the DCD main steam line input requirements. And we, basically, accepted the ITAAC.

Let's see. We have reviewed the application and the relevant information in the ABWR DCD, which is incorporated by efforts. And we conclude that sufficient information has been provided in the safety analysis. We've satisfied the NRC regulations and guidance in Section 3.7 of NUREG-800. So that's, basically, I think that concludes my presentation. Now, if you have any questions . . .

CHAIR CORRADINI: Questions from the

Committee?

CONSULTANT HINZE: Yes, if I might. There's been a lot of work that's been done since this analysis by the applicant has been performed. And one of the things that we learned in the non-concurrence for the flood surge, regarding flood surge earlier this year is that the subject matter experts suggested that the hurricane history that was used prior to their involvement was very much out of date.

As a result, I would assume that this new information regarding the historical record on hurricane activity at the STP site will be brought to play in, for example, studying the missile action of the hurricanes. Is that true? And if it is, how is that going to be implemented?

MR. CHAKRAVORTY: You mean missile actions due to hurricane? I think that has been --

CONSULTANT HINZE: I'm sorry. I can't hear you.

MR. CHAKRAVORTY: You asked about missile --

CONSULTANT HINZE: Well, that's an example of the hurricane activity, and the hurricane activity that was used in the analysis that we've seen for 3.7 and 3.8 has been shown to be based upon a hurricane record that is outdated. We learned that in our previous review of the NCP, then in concurrence by Dr. Ahn. And I'm wondering how this new information is going to be implemented into 3.7 and 3.8. Is it? And if it is, how is it going to be done?

MR. TAI: Go ahead.

MR. HARVEY: This is Brad Harvey from the Office of New Reactors. I was the primary reviewer for Chapter 2, the climatology section. The discussion we're talking about I think was the hurricane database that was used to come up with the storm surge. That's a different analysis that is used to come up with the design basis of wind loading and missile loading, okay?

The storms we're looking at are very different that causes a surge versus what causes the maximum winds that you design for, and so we actually have a new, relatively new Reg Guide 1.221 that was issued in October 2011, which used a hurricane database out to, you know, a couple of years before that to come up with a design basis wind load and missile load. So it's a completely different analysis.

CONSULTANT HINZE: I appreciate that. I appreciate that. But the point is that the historical record is, we were told and we had good evidence, was outdated, and that would include things like wind speed which would be involved.

MR. HARVEY: I think the source is based on a 1979 Weather Service 23 report, which used the hurricane data that was available up to that point in time. Our wind load is based on hurricane records that were up in 2000 and 2009 because the report was done by a consultant for us in 2010.

CONSULTANT HINZE: So then what I'm hearing from you is that the parameters that are involved in the, for example, the missiles for the hurricanes have been updated with the best available information?

MR. HARVEY: As of two years ago, yes.

CONSULTANT HINZE: Okay, thank you. I think that takes care of it. Very good.

MEMBER STETKAR: Probably five or six years ago because the report --

MR. HARVEY: Well, actually, I think we might have a public comment in 2010.

MEMBER STETKAR: Yes, the NUREG/CR that it was based on was 2007, I think. Anyway --

CONSULTANT HINZE: In any --

MEMBER STETKAR: Mid to late 2000.

MR. HARVEY: Yes. The two-year report, in terms of going through the NRC bureaucracy of getting new guidance out, it's pretty recent.

MR. CHAKRAVORTY: Any other question on 3.7? Keep on going? Okay. The next one.

MR. CHAKRABARTI: Yes, my name is Samir Chakrabarti. I'm a structural engineer in the Division of Engineering of the NRO. I have about 35 years experience in design and construction of nuclear power plant, including a long time in an operating plant. Before that, I have experience in the design and construction of steel structures in high-rise buildings.

I reviewed Section 3.8 of South Texas Project Units 3 and 4, COLA. The purpose of this presentation is to, same as the last chapter, to brief the Subcommittee on the staff's review of STP 3 and 4, Section 3.8, and answer if there are any questions.

The review team is, I'm the primary reviewer. I was assisted and I consulted Manas, and we had consultants, Dr. Ravindra and Dr. Arnold. And I just heard Dr. Arnold is on the phone available if there's a question that I cannot answer.

The outline, I have tried to have pretty much everything as to the total level of this design, I have looked at in review of this application. So the background and review scope, and then the applicable regulations, highlights of the staff review, which is the major portion of my presentation, and the conclusions.

The background and review scope. Like STP presented, the STP application, essentially, two parts. One is the review of the DCD structures, which are incorporated by reference. If everything was nice and well, we didn't review that one. But there were departures, and also we had to look at some of the condition items that go into DCD to make sure they are addressed correctly. And there was some supplemental information provided by the applicant that I reviewed.

So, to start with, we focused on evaluation of the DCD structures incorporated by reference; evaluation of the design of the site-specific structures, evaluation of 2 over 1 interaction, primarily, not really the design of the structures but to the extent that their potential to interact with category 1 structures; and evaluation of supplemental information.

Here's a list of the regulations and guidance that I used, the primary guidance really used for the SRP 3.8.1 through 3.8.5. And I have used those guidance to make my evaluation.

Evaluation of DCD structures. The reactor building and the control building, these are the Tier 2 DCD structures that are incorporated by reference. And there were several departures which had some impact that I needed to review to make sure the structures can be used at the STP site.

The first one is the STP Tier 1 departure 5.0-1. Two of the items listed in the departures are very important. One is the shear wave velocity, and the other the design basis flood.

So we reviewed the DCD structures for the design basis flood, considering the flood height and velocity, concentrating wave effects and debris impact. And also we reviewed all of the doors and barriers below water level, which is six feet above ground level, they're properly designed and sealed. And the stability of the structures also were reviewed for buoyancy effects and dynamic effect of the flowing flood water.

The shear wave velocity. The impact of shear wave velocity gave you a departure on the design of the structures for, essentially, the effect on the soil pressure profiles that were used for the design, the foundation soil springs that were used for the design, and the differential settlements pertaining to the site-specific soil condition.

We reviewed all the specs and, like soil pressures compared with the DCD soil pressures that were used for the design. The foundation soil springs were computed using the site-specific parameters, and they were compared to the DCD soil springs that were used for the design to make sure the design is okay.

Differential settlements for the site-specific soil were established in Chapter 2.5. And we kind of established some acceptable values of the differential settlements based on the site-specific analysis of the DCD structures.

The other Tier 1 departure for the radwaste building classification. The DCD had radwaste building classified as seismic category 1, and this departure reclassified it. And I reviewed that with this new classification. It is appropriately designed using the criteria provided in Reg Guide 143.

The Tier 2 departure was the departure 1.8-1, which had updated some of the codes, like ACI 349, the ASME Section III, and were reviewed because these DCD structures were designed using the outdated version of the code. And since the version of the code is being changed, I reviewed, but the design, the continued validity of the design to meet the requirements of the new code.

And there are some Tier 2, seven Tier 2 departures which did not require prior NRC approval. But we reviewed those and made sure that they really did not require prior NRC approval.

For the DCD structures, information items. One is the 3.25, which is the structural integrity test. The COLA applicant will provide details of the structural integrity test, and the applicant provided detail, and we've reviewed it to make sure it meets the requirement for ASME Section III, Article CC-6000.

The next information item was foundation waterproofing. This COL item required the applicant to foundation waterproofing to make sure it is capable of transferring the shear, base shear, at the foundation level. We reviewed the waterproofing, and, for the sliding evaluation, we looked at the sliding evaluation of the DCD structures, and we established or the applicant established the minimum coefficient of friction that the waterproofing membrane must have, and they added an ITAAC to make sure the waterproofing membrane mentions that friction instance also. We reviewed what were the environmental qualification to waterproofing membrane. We maintain these performance requirements over time and pressure.

Next is the COL information item 3.24, the site-specific physical properties at the foundation settlement. The site-specific subgrade medium and foundation settlements, I already discussed this one. And this is an item that we looked at, that the foundation can withstand the site-specific settlements and deformations and maximum, the site-specific settlements and deformation, these are really all estimated. So criteria was established to limit the tilting and differential settlements for the foundation mat.

Regarding the supplemental information, the ABWR DCD did not include any discussion of the pre-service and in-service inspection program. The applicant provided this information in Section 3.8.1.7.3., basically ASME Section XI, IWE and IWL criteria, are described in this section.

So this is what we did for evaluation of the DCD structures. Are there any questions so far?

CHAIR CORRADINI: No, go ahead.

MR. CHAKRABARTI: Okay. The evaluation of the site-specific structures. The site-specific structures that ultimately see: pump house, RSW piping tunnel, and the fuel oil storage vault. These are reviewed in totality following the guidance provided in SRP 3.8.4. It has various items that we need to look at, starting from the structure is described properly in the FSAR, and the various other items. I'll go, each of them.

The items that were reviewed for all the site-specific structures. First, the description of the structures, applicable codes, standards, and specifications. We made sure the codes and standards that are being used, they are either endorsed by the NRC, like ACI code. There are many other codes and standards that are used during the design process, at least those that are acceptable in terms of -- for those codes and standards that are not explicitly endorsed by NRC, we go by our evaluation and industry-accepted methods and standards.

The loads and load combinations are very precisely defined in the SRP, and we make sure that the loads and load combinations have been appropriately addressed and described. And that includes all ground water, environmental loads, flood, hurricane, and load combinations so that appropriate factors are used using the guidance.

The design analysis procedure. This is, of course, the major area that we review. We reviewed each of these site-specific structures from the information presented in the FSAR and also during our audits, several audits of the sites.

The seismic analysis. We have reviewed all the seismic analysis from all the information from the 3.7 seismic analyses. This is a chance for it to be static model and if the information resulted in a conservative analysis.

We reviewed the soil spring modeling, modeling of the soil springs, and the finite element for static and dynamic springs, how they're used. And in this analysis, we also looked into if the modeling of the soil springs take into account the potential dishing effect, what they called it. This was done by varying the springs.

The lateral soil pressures. We reviewed how the lateral soil pressures had been used for design of the structures. And as STP already explained, lateral soil pressure is a very, these are not very definitive, as they do this and they have the right pressure. And that's why we used the results from the SSI, SSSI, and also the ASCE 4-98 records. And in addition, we have seen that wherever, for stability evaluation, passive pressure was used, that was also considered in the design of the walls.

The hydrodynamic loads for the UHS basin, we reviewed how the hydrodynamic load was modeled for the design. We have SRP 3.7.3, very clear criteria how it should be handled, both the convective and the impulsive forces. We reviewed how design model and also the lateral pressure that is caused by vertical escalation of the water mass. They added lateral pressure and made sure that it was considered.

The flood levels on these chapters we reviewed, the design basis flood 40 feet msl was used. And we reviewed that all aspects of the flood loading, like hydrostatic, hydrodynamic, wave effects, and debris impact were considered.

The seismic wave propagation effect for the tunnel design, we reviewed how it was done. As STP already described, seismic wave propagation effects are reviewed using the guidance provided in ASCE 4-98. And we reviewed many other published sources regarding determining the minimum apparent wave velocity that should be used. So it is an approximate and conservative method of analysis which does not explicitly calculate the effects due to the various type of waves because the ground motions that are used for determining the strains, they are the result of all kinds of waves, effect of all kinds of waves. And it is considered a standard and conservative way to determine the strains, shear and bending strains, using the ground motions. And we used 3,000 feet per second as the apparent wave velocity.

The stability evaluation was reviewed, and we made sure that the stability evaluation considered all three direction seismic using the 100 percent, 40 percent, 40 percent rule. And all the safety factors, the minimum required by SRP 3.8.5, were maintained.

The bearing pressure. The static and dynamic bearing pressure were reviewed against allowable bearing pressures. The allowable bearing pressures, this part really has been handled in Section 2.5, 2.5S, and we reviewed the portions of that section to make sure the bearing pressures from our analysis were within the allowable bearing pressures.

Tunnels and adjoining structure interface. I think this portion came out before. We did review those interfaces to make sure the seal that is provided on the tunnel is adequate. And also we kind of made an evaluation that, during seismic motion, there will be pressure on the seals and that pressure is accounted for in the design of the walls.

We reviewed the structural acceptance criteria, which are, essentially, the load combinations that are provided. They include the acceptance criteria. And all other acceptance criteria are compared with the applicable guidance and accepted engineering practice.

Materials and quality control. The applicant has provided some information on materials and quality control. The material and quality control was found to be steel and concrete codes endorsed by the NRC. That's what has been stated in the FSAR.

And testing and ISI requirement. Usually, the structures, if there is monitoring of the structures controlled by the Maintenance Rule, and they did mention the structures will be monitored.

Any questions on the design of site-specific category 1 structures?

CHAIR CORRADINI: No.

MR. CHAKRABARTI: Okay. Now I'll go over the seismic category 1 and non-seismic category 1 structures subject to 2 over 1 interaction.

The four structures, these are turbine buildings, service building, control building annex, and the radwaste building. These structures, except for the radwaste building, will be designed using the International Building Code. These structures are not designed yet.

And for the interaction of non-category 1 structures, what we have reviewed, primarily, at this time is the stability evaluation. And the stability evaluation of the structures, except for the radwaste building because the radwaste building has been designed, have been done using a conceptual design at this time. And we made sure the structures remain stable under the site-specific, at least site-specific extreme environmental loads, including seismic, flood, tornado, and hurricane.

The design portion has been covered by ITAAC. These structures will be designed using the IBC for the structure itself. For the 2 over 1 design, the lateral will be designed following the same criteria as category 1 structures. But this detail is all --

MEMBER STETKAR: Samir, let me ask you something on the radwaste building. As I read -- and this is more of a process issue, rather than technical, but it kind of raised a possible concern. As I read through the SER and the RAIs and the responses and things, there seemed to be a lot of pressure from the staff to include a lot of detail in the FSAR regarding the radwaste building in particular.

Similar -- let me finish. Similar levels of detail are not included in the FSAR for any of the other category 2 structures, if I want to call it, even the turbine building. Turbine building, big building. Why? And because I've looked at other DCDs and COL FSARs, and, for these categories of structures, they typically have commitments. For example, for radwaste buildings, to design them according to Reg Guide 1.143, they have commitments. Certainly, they have to do the 2 over 1 analyses. They have to do the soil structures interaction, the SSSI interactions.

Why, in this particular case, did the staff press so hard to have so much detail put in the FSAR, which is now part of the licensing basis, for the radwaste building in particular?

MR. CHAKRABARTI: Okay. The radwaste --

MEMBER STETKAR: Because I'm a little concerned of regulatory creep here.

MR. CHAKRABARTI: The radwaste building, the other buildings which are non-category 1 structures, there are no guidance because they're not covered by SRP 3.8, which is only for category 1 structures.

MEMBER STETKAR: I didn't understand that. Can you say that again?

MR. CHAKRABARTI: The non-category 1 structures, we do not have the guidance to the level of detail or level of information that should be included in the FSAR.

MEMBER STETKAR: That's correct.

MR. CHAKRABARTI: We have that only for seismic category 1 structures.

MEMBER STETKAR: That's right.

MR. CHAKRABARTI: The only exception for radwaste building, the radwaste building is neither a category 1 structure, or, I should say, it has some design requirements --

MEMBER STETKAR: It has design requirements because it's categorized as a high hazard --

MR. CHAKRABARTI: High hazard.

MEMBER STETKAR: -- or hazardous, depending on how they --

MR. CHAKRABARTI: And for that, we have a Regulatory Guide 1.143, which has very, don't ask me why it is to that detail but it has a very detailed description about how it should be designed.

MEMBER STETKAR: Okay.

MR. CHAKRABARTI: At the end of the implementation section of the reg guide, it says that staff will verify it has been designed to meet this criteria. In that sense of any design information, it is not possible to make that determination.

MEMBER STETKAR: And I understand that. What I'm concerned about is for existing certified designs, already certified designs, if I look at the information in the design certification documents and the COL FSARs for what they call the radwaste building, I see rather similar levels of information compared to turbine buildings and other category 2 buildings and that commitment to say we're going to design it according to Reg Guide 1.143. That's all that's in the licensing documents for all of those other already certified --

MR. CHAKRABARTI: For the ABWR design, it used to be a category 1 structure.

MEMBER STETKAR: I know it used to be, but it isn't today.

MR. CHAKRABARTI: It is not.

MEMBER STETKAR: And I don't care what it used to be. It isn't today.

MR. CHAKRABARTI: I know. I have not seen many plants but --

MEMBER STETKAR: Well, I have. And what I'm worried about here is, in particular, for this COL FSAR, are we setting a dangerous precedent simply because you guys got interested in the radwaste building because it used to be a category 1 structure and it's sort of a nice, interesting building to look at? And I certainly would hope that we're not setting that precedent going forward for other design certifications. In other words, suddenly requiring, in the licensing document now, the FSAR, a lot more detailed information about --

MR. CHAKRABARTI: Yes --

MEMBER STETKAR: -- a non-category 1 structure beyond what is normally included --

MR. CHAKRABARTI: Yes, I understand --

MEMBER STETKAR: -- and expected.

MR. CHAKRABARTI: I'll tell you what, in the FSAR STP, FSAR, there were some details about all of the structures --

MEMBER STETKAR: There's some --

MR. CHAKRABARTI: -- which are, which are way above and beyond what you see in other FSARs.

MEMBER STETKAR: That's --

MR. CHAKRABARTI: That includes the category 1 structures, also.

MEMBER STETKAR: Right.

MR. CHAKRABARTI: And the same thing has

happened with the radwaste building also. It's not necessarily that we had asked to give the details to that level. Similar RAIs --

MEMBER STETKAR: But a lot of that detail is for the category 1 structures, the re-analysis of the DCD category 1 structures to confirm that, indeed, the site-specific conditions don't affect the design of those. And, certainly, I'm not arguing with you about the site-specific category 1 structures. Certainly, you need enough information in the FSAR to have confidence that they will be designed appropriately.

MR. CHAKRABARTI: Yes.

MEMBER STETKAR: I'm specifically talking about --

CHAIR CORRADINI: The radwaste building.

MEMBER STETKAR: -- radwaste building.

MR. CHAKRABARTI: Yes. That's what I'm saying. The STP FSAR, in general, has way more information, design information for all structures, including --

MEMBER STETKAR: It doesn't have that same level for the turbine building. Turbine buildings are really big, non-category 1 building. It's got a lot of stuff in it. It's a huge building, and it doesn't have the same level of information --

MR. CHAKRABARTI: It is not --

MEMBER STETKAR: -- and I think I've made my point.

MR. TAI: Could I add to this one?

MR. CHAKRABARTI: Yes.

MR. TAI: The problem with the radwaste building is it has a Tier 1 departure. Right off the bat, it draws attention because the DCD radwaste building was, at least the sub-structure anyway, was cat 1.

MEMBER STETKAR: Sure.

MR. TAI: So a Tier 1 departure, we can't help but draw attention to the design of the new structure.

MEMBER STETKAR: I understand that.

MR. TAI: Okay. So I'm not disagreeing with you that the concern of regulatory creep, and I think STP and Sargent & Lundy will love you for this one, for this question anyway, because, at the same time, the staff cannot write SER based on, okay, trust me, I'll take Reg Guide 1.143 and --

MEMBER STETKAR: But you're doing that for all of the other certified --

MR. TAI: Well --

MEMBER STETKAR: -- designs. That's my point.

MR. TAI: Well, the other structures that you refer to, turbine building is a good example, is an IBR structure.

CHAIR CORRADINI: But if I could just say back to you what you're saying is, because it started as a category 1 and it moved to 2, you've got to look at it more, even though in other DCDs it never was a category.

MEMBER STETKAR: And my point is I recognize that you still have to have confidence, that that now non-category 1 structure will be designed and constructed such that there are no adverse seismic 2 over 1 interactions with any other nearby buildings and that it meets the design criteria for its hazard, its radioactive hazardous material inventory. They're categorizing it as 2a, so fine. But that is exactly the case, the problem that you face in any other certified design that comes in and says our radwaste building is a non-seismic category 1 structure and we're going to design it to 2a or 2b or whatever classification and we have to have assurance that it will not damage any seismic category 1 structures.

So I don't understand why, in this particular case, simply because it went from category 1 to category 2, now the licensing document has to have all of the detailed information about it, whereas others don't.

MR. TAI: I think the 2 over 1 issue has to be addressed, DCD or no DCD, right?

MEMBER STETKAR: Absolutely.

MR. TAI: Okay. Because it now becomes why does the STP radwaste building contain so much more design detail versus a DCD radwaste building in other --

MEMBER STETKAR: Yes.

MR. TAI: And that's what I'm trying to go with. You started with Tier 1 departure, and we started to look at the 2 over 1 evaluations, you can't help but challenge what you design to to give you that 2 over 1 protection anyway.

MEMBER STETKAR: I understand that, and I understand that you need to do that type of evaluation to give yourself assurance that, indeed, the right analyses were done. My point is why do all of the supporting details need to be in the FSAR, in the licensing document? Is that --

MR. TAI: I was --

MEMBER STETKAR: -- to set a precedent?

MR. TAI: Yes. Well, I think STP FSAR, we recognize that the STP FSAR, in general, forget about the radwaste building, in general, probably has a lot more detail than anybody else.

MEMBER STETKAR: It does, but I think it's mostly for, I'll go back to the category 1 structures. Because of the concerns about the particular site, because of some of the concerns about the soil structures interaction for even the DCD cat 1 structures, the reactor building and the control building, for example, and the diesel fuel tunnels. And, certainly, they need to have adequate information in there for the site-specific category 1 structures, which they do. They have a lot of detail in there, and I'll grant you more than, more than the typical, but that's their decision.

I'll go back. I'm exactly focusing on the radwaste building and the bit of concern going forward and worrying, you know, that, because a lot of that detail is now in the FSAR for a non-safety-related, non-category 1 structure, if, during construction at the site, they now find some things that deviate, there are going to be a lot of regulatory issues.

MR. CHAKRABARTI: What I'm telling you, not all of this information that we insisted needs to go in the FSAR. What I had asked for them, because it went from one extreme to another. The first application came in without any information on the radwaste building.

MEMBER STETKAR: Yes. Sure, sure, I got it.

MR. CHAKRABARTI: And at that time, I had asked them I have a reg guide that tells me this is the design criteria that should be used and, at the implementation, it says that the staff will review the design to make sure it meets the criteria. So I asked them give me some information, okay? And the next response was we'll design that to 1.143. To me, that was not adequate. That is repeating the criteria, not really how we are designing it.

So I had asked for a little bit more detail of that one. And instead of just repeating the criteria that it will be designed to remain elastic to the design, that's kind of repeating the criteria.

So I asked them how you'll be achieving

this, how this design, give me the loads that will be considered, load combinations that will be considered, seismic input that will be considered. Give me a description of the structure because, in essence, the guidance, I followed 3.8.4., but then, when the information kept coming in, it was way more than I needed or I expected. In fact, and that's what I was trying to tell you. In the process of evaluation, it probably has gone from one end to the other end.

MEMBER STETKAR: And I understand you, I understand, from a review perspective, you asking for the information so that you can have confidence. It's simply having that level of detail written in the FSAR.

CHAIR CORRADINI: I think you've made your point.

MEMBER STETKAR: I have made my point, and I have to leave --

CHAIR CORRADINI: I sense that we've come to agree to disagree. Let's move on.

MR. CHAKRABARTI: Okay. Next slide is stability evaluation of the turbine building, service building, control building annex, and the radwaste building. The stability evaluation was performed using the conceptual design element of the seismic design demand calculated using the amplified spectra. Extreme environmental loads for stability evaluation were calculated, and they're shown in Table 3H.9.

And then the supplemental information, the hurricane wind design. As the applicant already described, the hurricane wind design was kind of late in the game, so we went back and reviewed all structures, including stability evaluations, with the criteria in Reg Guide 1.221 regarding hurricane wind speed and hurricane missiles and evaluated all these structures. And site ITAACs were revised to include hurricane as one of the environmental forces.

The DNFSB issue has been discussed in detail. Because of that, it had impact of the structural design because a lot of the SSI analysis was used to determine site-specific nodal accelerations and section cut forces. SSI results were used for seismic soil pressure. SSI analyses were used for stability evaluation, and subtraction method was used for some SSI and SSSI analyses.

Now, the applicant, first of all, benchmarked the use of modified subtraction method.

The applicant then performed a detailed evaluation, including additional analysis using the modified subtraction method, as is in the impact.

And during this analysis were some of the design forces, like lateral pressures and axial forces, moments, had increased. But they were only evaluated to be within design limits or available design margins. Available margins in stability evaluation were found to be adequate.

So all the changes that were impacted the --

CHAIR CORRADINI: Go on. We just, we kicked him out. That's not true.

MEMBER BROWN: He really wants to finish within the allocated time.

MR. CHAKRABARTI: So the impact of the Defense Board issue were entirely evaluated, all the designs evaluated for that, and found to be acceptable.

So final conclusions. We believe the STP FSAR COLA has sufficient information regarding stability of the DCD structures and the site-specific structures. And we accept it for design.

CHAIR CORRADINI: Okay. Thank you.

CONSULTANT HINZE: Two questions, if I

might. My electronic copies of your slides have the date 12/3/08.

MR. CHAKRABARTI: Yes, that's --

CONSULTANT HINZE: Is that when those were prepared?

MR. CHAKRABARTI: No. These were, I was using slides from probably our previous presentation. I corrected it, but you didn't get the corrected one. CHAIR CORRADINI: So to say that this has taken a while is a fair statement.

CONSULTANT HINZE: A second question, if I might. I don't find the word confirmatory analysis in any of your slides. When you say confirm in the slides, does that mean you performed an analysis --

MR. CHAKRABARTI: No.

CONSULTANT HINZE: -- or have you just performed a review?

MR. CHAKRABARTI: What we did, we did not perform any confirmative analysis.

CONSULTANT HINZE: I'm sorry. I'm having a hard --

MR. CHAKRABARTI: We did not perform any confirmative analysis for verification or review of the design of the structures.

CONSULTANT HINZE: And why was that the case?

MR. CHAKRABARTI: The way we reviewed, we followed the SRP guidance about how the structure should be, how the information should be given. Then we go and do the audits. We reviewed their calculations to see if the design has been done appropriately. We reviewed their models: loads, load combinations. We didn't see any reason to have any confirmatory analysis.

CONSULTANT HINZE: We heard previously that there are at least two criteria involved in selecting something for confirmatory analysis, and that's significance to safety and a concern about a problem.

MR. CHAKRABARTI: The SRP guidance on how to perform the review does not dictate you to have a confirmatory analysis to come to a safety conclusion. You can do it by review of the application, an audit of their calculations. Confirmatory analysis can be done only if it is considered necessary.

CONSULTANT HINZE: So you didn't consider it necessary?

MR. CHAKRABARTI: No, we didn't consider

it necessary to have any confirmatory analysis.

CONSULTANT HINZE: That would answer it. Thank you.

MR. CHAKRABARTI: Thanks.

CHAIR CORRADINI: Charlie, did you have any questions?

CHAIR CORRADINI: Okay. Before we conclude, I wanted to see, open the phone line to see if we have public comment. Maitri, do I look at the blank --

MS. BANERJEE: I can go and check --

CHAIR CORRADINI: -- the mirror and see if we can open the line, see if anybody is there for public comment.

MS. BANERJEE: Yes, let me go check.

CHAIR CORRADINI: Okay. Then we'll wrap up. One questioner has moved on.

MS. BANERJEE: The line is now open but --

CHAIR CORRADINI: So is there anybody on the line? Are the consultants on the line?

MS. BANERJEE: They're on that line.

MR. ARNOLD: Yes, I am here.

CHAIR CORRADINI: Okay, all right. Different line. Anybody on the public comment line? Going once, going twice, okay. Why don't we continue then with wrap-up comments? So I'll thank the staff for your presentation, and I'll turn to my remaining Committee member and consultant. Mr. Brown?

MEMBER BROWN: I have no additional items. I'm closed, finished, done.

CHAIR CORRADINI: Bill?

CONSULTANT HINZE: Well, I believe that the applicant and the staff have done a very thorough, very comprehensive job. And I think that they should be, that should be acknowledged.

I also think that there needs to be a comment regarding the use of the two different earthquakes for the input. And that's really my only concern at this point.

CHAIR CORRADINI: What about the confirmatory analysis? Do you feel like you understand at least the process they're thinking through?

CONSULTANT HINZE: You know, I see the difference, though, between 3.7 and 3.8. This is, I worry about how much of this is the individual and how much of this is actual policy, if you will.

MS. BANERJEE: If I may add, the two different earthquakes we have taken as an action item. So we expect in another meeting to address --

CHAIR CORRADINI: Yes, Scott never forgets an action item. We'll get an explanation because I do think, to the extent that we want to understand it and reflect it in our letter, when a letter eventually is written, we want to at least get it right. So I think that's fair.

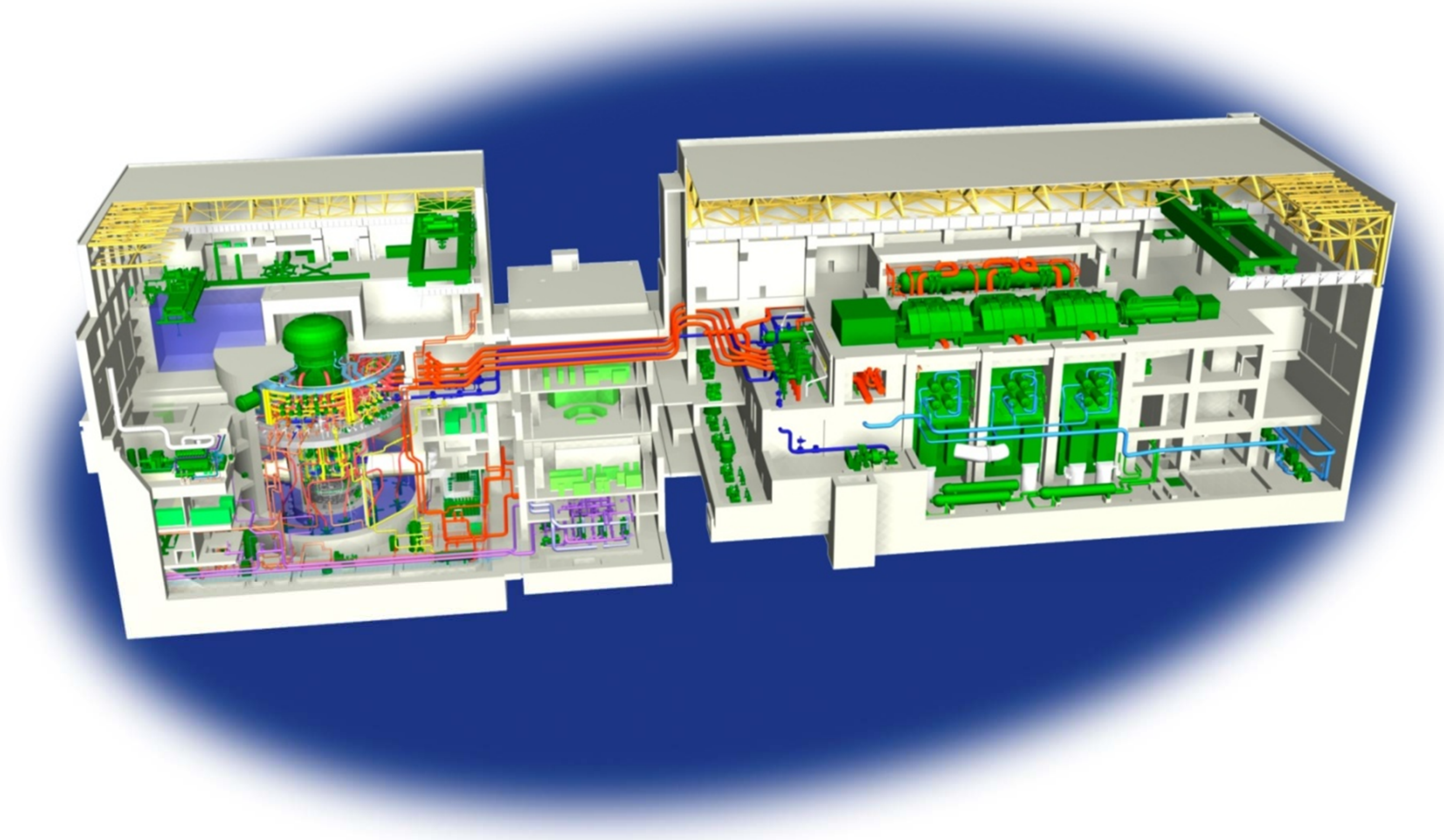
The other thing I guess I would bring up is John's gone, but he's talked to me. I guess this is something that is not STP, but I guess it does concern me, as well, with John about the radwaste building detail. So I understand, I understand where the staff is coming from. But what concerns me is is that you have additional COLs sitting out there, and are you going to require the same level of detail simply because now this sets a precedent? So that's what concerns me, and I think that's what also concerns John. That's why I think he brought it up for a while. So it's not for STP so much as just down the line, if this is going to, this is essentially going to propagate to other COLs.

But other than that, I think I'll thank everybody, and the Subcommittee meeting is adjourned. (Whereupon, the foregoing matter was concluded at 11:36 a.m.)

Nuclear Innovation North America LLC

South Texas Project Units 3 & 4

Presentation to ACRS ABWR Subcommittee: Chapter 3, Sections 3.7 and 3.8



Agenda

- Introduction
- Attendees
- Summary and Contents
  - Standard Plant (DCD) Seismic Category I Structures
  - Site Specific Seismic Category I Structures
  - Non-Seismic Category I Structures Subject to II/I
  - Other Topics
  - Questions and Comments

Attendees

Scott Head	NINA Regulatory Affairs Manager
John Price	NINA Licensing Engineer
Jim Fisicaro	TANE Licensing Engineer
P. K. Agrawal	Sargent & Lundy Building Design Manager
Bob Hooks	Sargent & Lundy Building Design Director
Javad Moslemian	Sargent & Lundy Building Design Manager
Surendra Singh	Sargent & Lundy Seismic Analysis Manager
Brian McDonald	Exponent

Sections 3.7 and 3.8 –
STP 3&4 Plant Structures

Chapter 3, Sections 3.7 and 3.8

The overall design process

- Preliminary design – development of General Arrangements to satisfy system design requirements
  - Building dimensions
  - Size major structural elements
- **Seismic Analysis – Section 3.7**
  - 3D Soil-Structure Interaction (SSI)
  - 2D Structure-Soil-Structure Interaction (SSSI)
- **Structural Design – Section 3.8**
  - Analyze the structure for Normal Loads, Internal Events, and Natural Phenomena
  - Stability evaluations
  - Confirm sizing of structural elements meets Code Requirements
  - Design reinforcing steel to meet Code Requirements

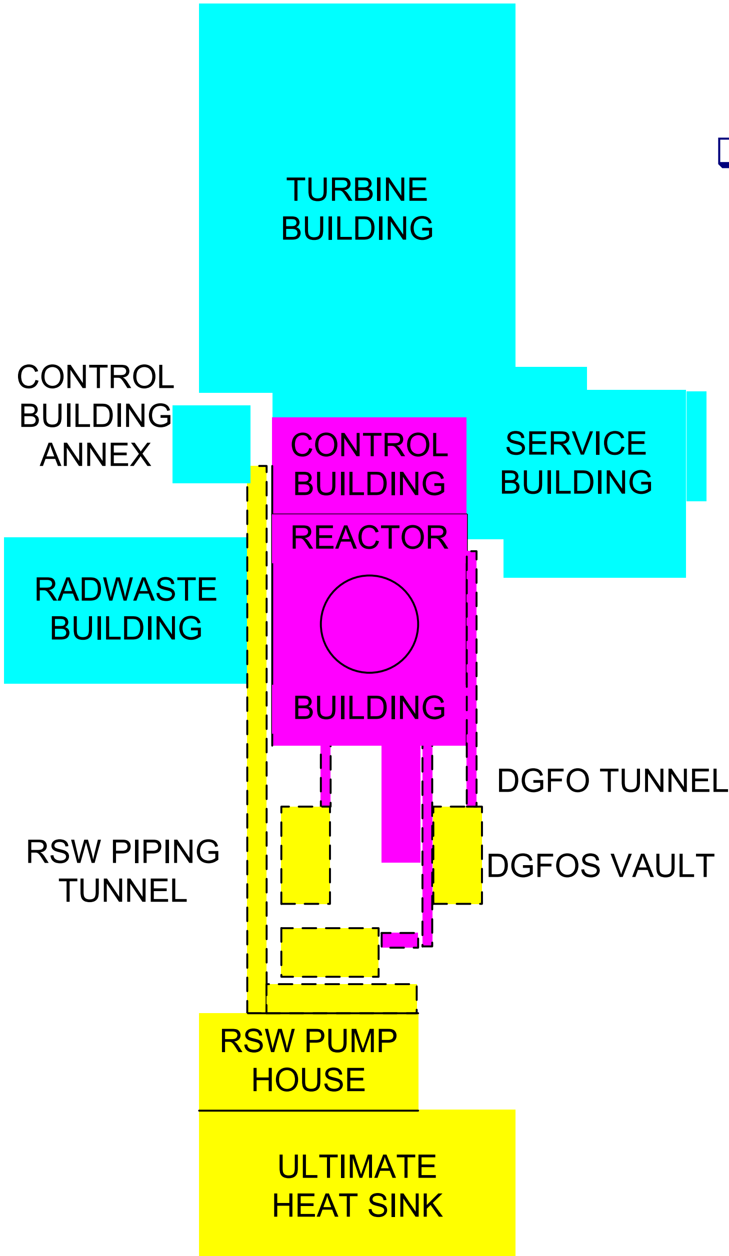
Chapter 3, Sections 3.7 and 3.8

The overall seismic analysis process

- Seismic analysis takes into account soil-structure interaction by coupling the structural model with the soil medium in a finite element representation
- Soil-structure interaction (SSI) analysis is normally performed with 3D representations to obtain forces, moments, absolute accelerations, relative displacements, and In Structure Response Spectra (ISRS)
- Where adjacent structures are separated by soil, Structure-Soil-Structure Interaction (SSSI) analysis is performed using 2D representations to obtain the effect of SSSI on lateral soil pressures
- The program used to perform SSI analysis is SASSI, a System for Analysis of Soil-Structure Interaction
- All of the SSI and SSSI analyses reported in the STP 3&4 COLA have been performed using SASSI2000

Sections 3.7 and 3.8 – Standard Plant (DCD) Seismic Category I Structures

Standard Plant (DCD) Seismic Category I Structures



- The standard plant Seismic Category I structures described in the DCD are:
  - Reactor Building
  - Control Building
  - Diesel Generator Fuel Oil Tunnels (DGFOT)

NON-SEISMIC CATEGORY I (SUBJECT TO II/I)
SEISMIC CATEGORY I STANDARD PLANT
SEISMIC CATEGORY I SITE SPECIFIC

Standard Plant (DCD) Seismic Category I Structures

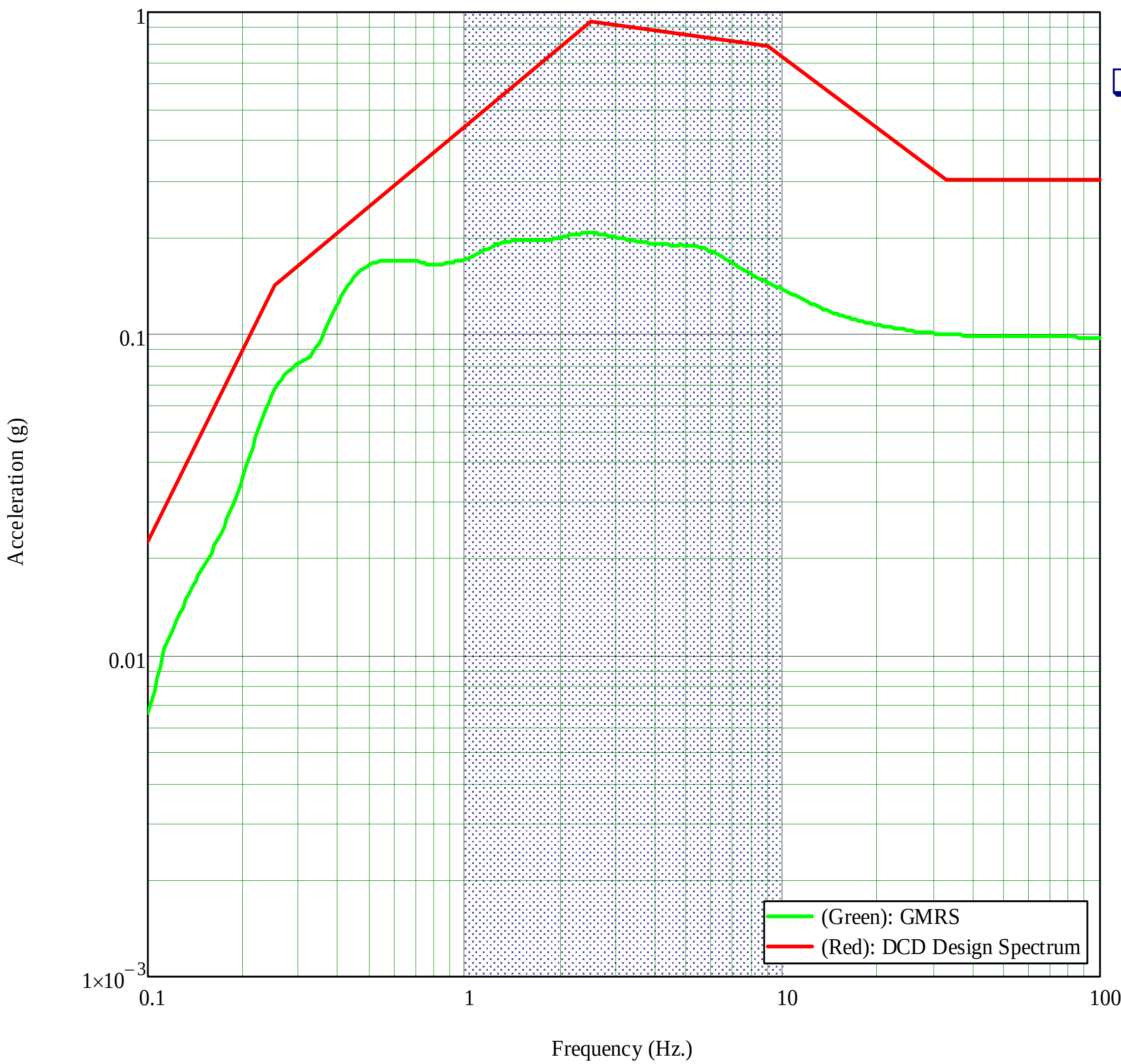
- The standard plant Seismic Category I structures described in the ABWR DCD are heavy and robust structures designed to resist a variety of conservatively selected loadings
- The Standard Plant Structures have substantial margin when compared to the STP 3&4 site specific environmental loadings
- Site-specific evaluations included:
  - Seismic Analyses
  - Evaluation of Building Stability for Seismic, Wind, Tornado, Hurricane, and Flooding Events
  - Design Provisions for External Flooding
  - Evaluation for Hurricane Loads
- These evaluations confirmed that the Reactor Building and Control Building structures described in the ABWR DCD do not require changes due to site specific conditions

Standard Plant (DCD) Seismic Category I Structures

- STP DEP T1 5.0-1 (Table 5.0) documents specific departures from the ABWR DCD generic envelope, including shear wave velocity
- The difference between the soil properties at the STP site and the ABWR DCD assumptions is that the minimum shear wave velocity at the STP 3 & 4 site is less than the minimum shear wave velocity in ABWR DCD Table 5.0
- Site-specific SSI analysis was performed due to the lower shear wave velocity to confirm that the ABWR DCD seismic forces, accelerations, and response spectra bound the results of the site-specific Reactor Building and Control Building SSI analyses

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis –

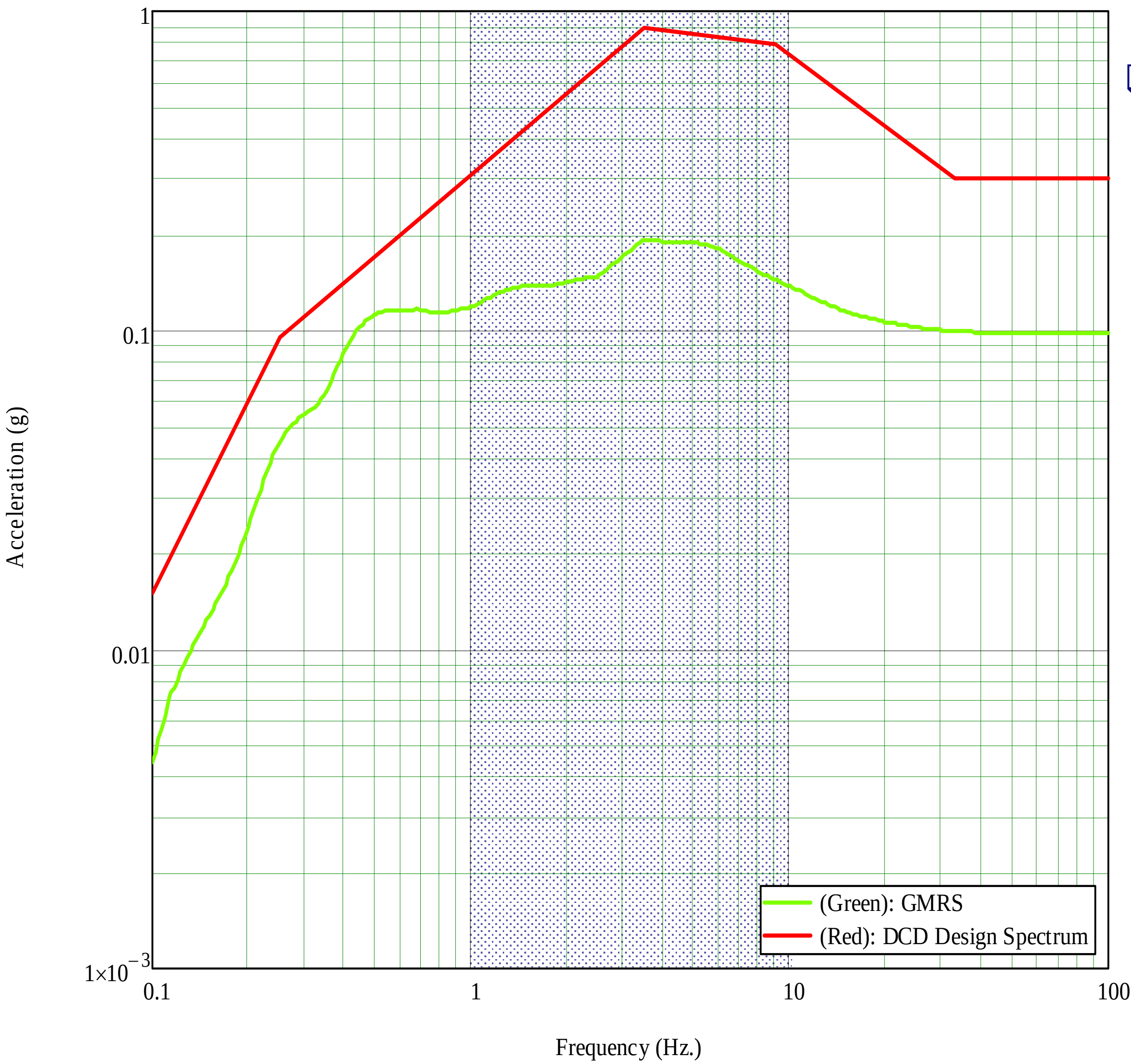


- **The site specific Safe Shutdown Earthquake (GMRS) is enveloped by the DCD Safe Shutdown Earthquake (CSDRS) with substantial margin in the frequencies of interest**

Comparison of GMRS with DCD Design Spectrum (CSDRS) – Horizontal (5% damping)

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis (Continued) –



- **The site specific Safe Shutdown Earthquake (GMRS) is enveloped by the DCD Safe Shutdown Earthquake (CSDRS) with substantial margin in the frequencies of interest**

Comparison of GMRS with DCD Design Spectrum (CSDRS) – Vertical (5% damping)

Standard Plant (DCD) Seismic Category I Structures

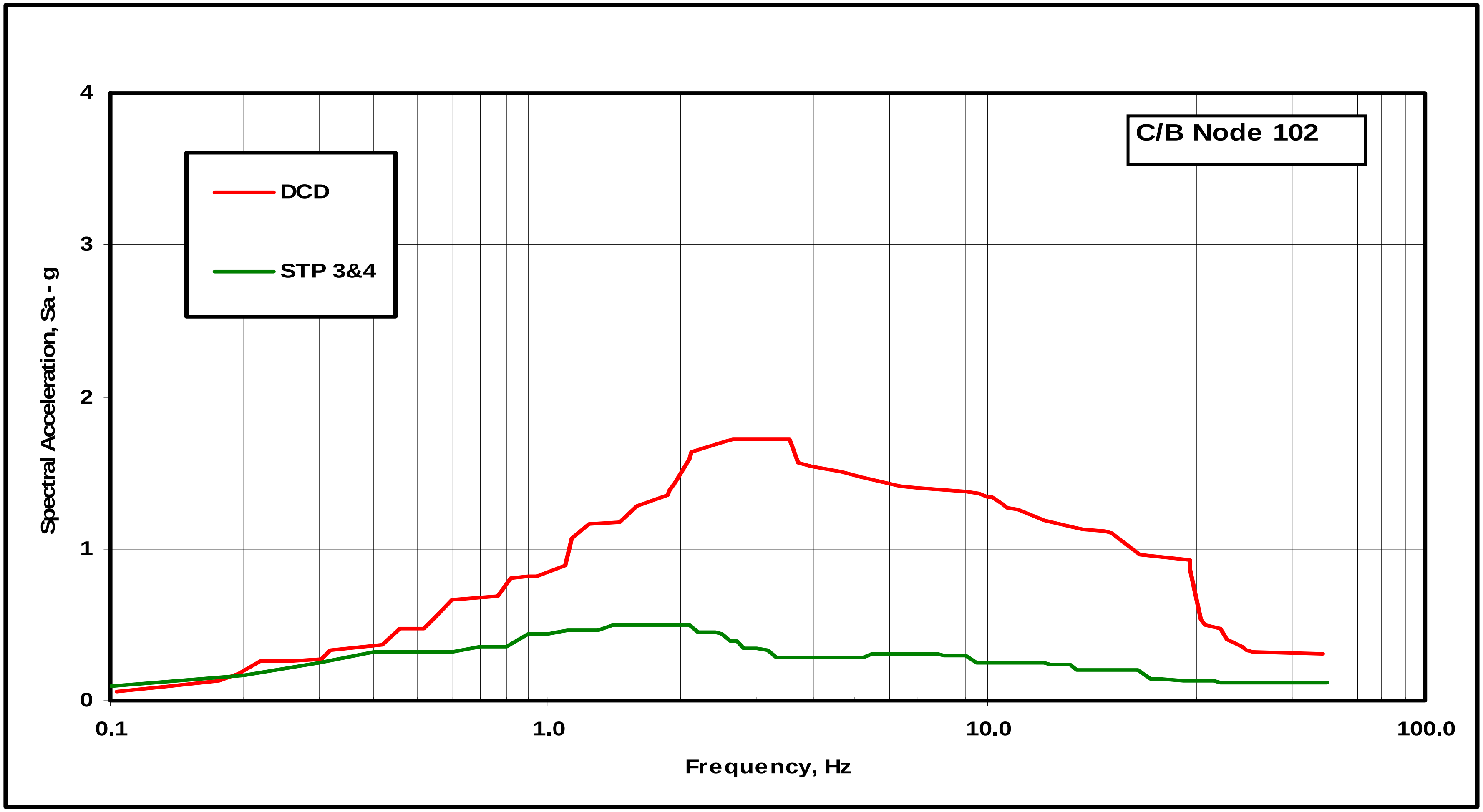
Seismic Analysis (Continued) –

- The site-specific SSI and SSSI confirmatory analyses considered:
  - STP 3 & 4 site-specific soil properties and site-specific SSE ground motion
  - Modeling of soil profiles (with variation of properties) in the SSI analysis
  - Refined finite element mesh size, so that the CB model is capable of passing frequencies up to 33 Hz in both the vertical and horizontal directions
  - Poisson’s Ratio values to achieve 5,000 ft/sec compression wave velocity below groundwater level (Evaluations with maximum values from 0.48 to 0.495)
- The DCD seismic forces, moments, accelerations, and response spectra bound the results of the STP 3 & 4 site-specific SSI analysis

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis (Continued) –

- Typical comparison of Response Spectra curves from the DCD and the site specific seismic analyses

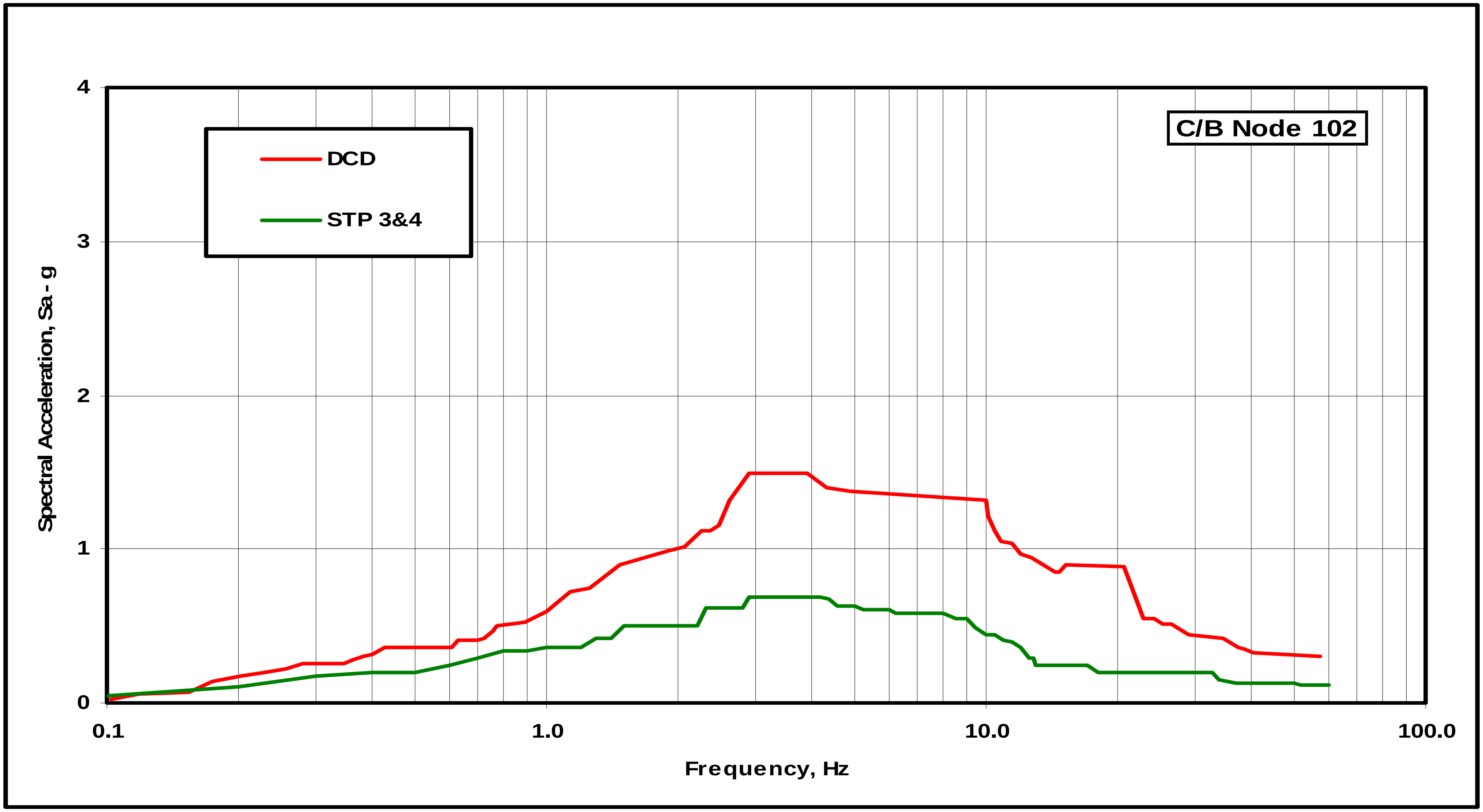


Comparison of Control Building Broadened DCD and STP 3&4 Spectra Node 102 - Horizontal, 2% Damping

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis (Continued) –

- Typical comparison of Response Spectra curves from the DCD and the site specific seismic analyses

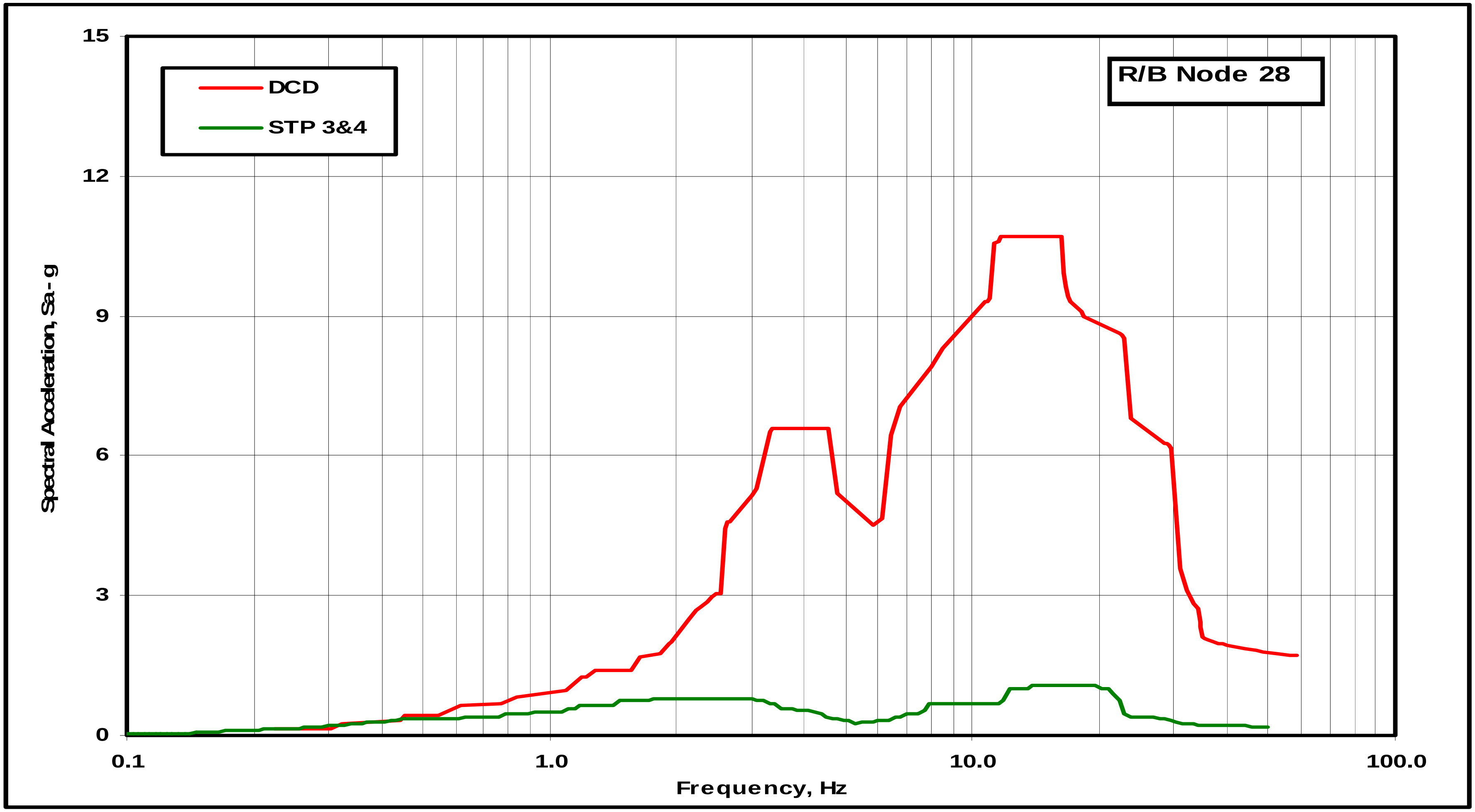


Comparison of Control Building Broadened DCD and STP 3&4 Spectra Node 102 - Vertical, 2% Damping

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis (Continued) –

- Typical comparison of Response Spectra curves from the DCD and the site specific seismic analyses

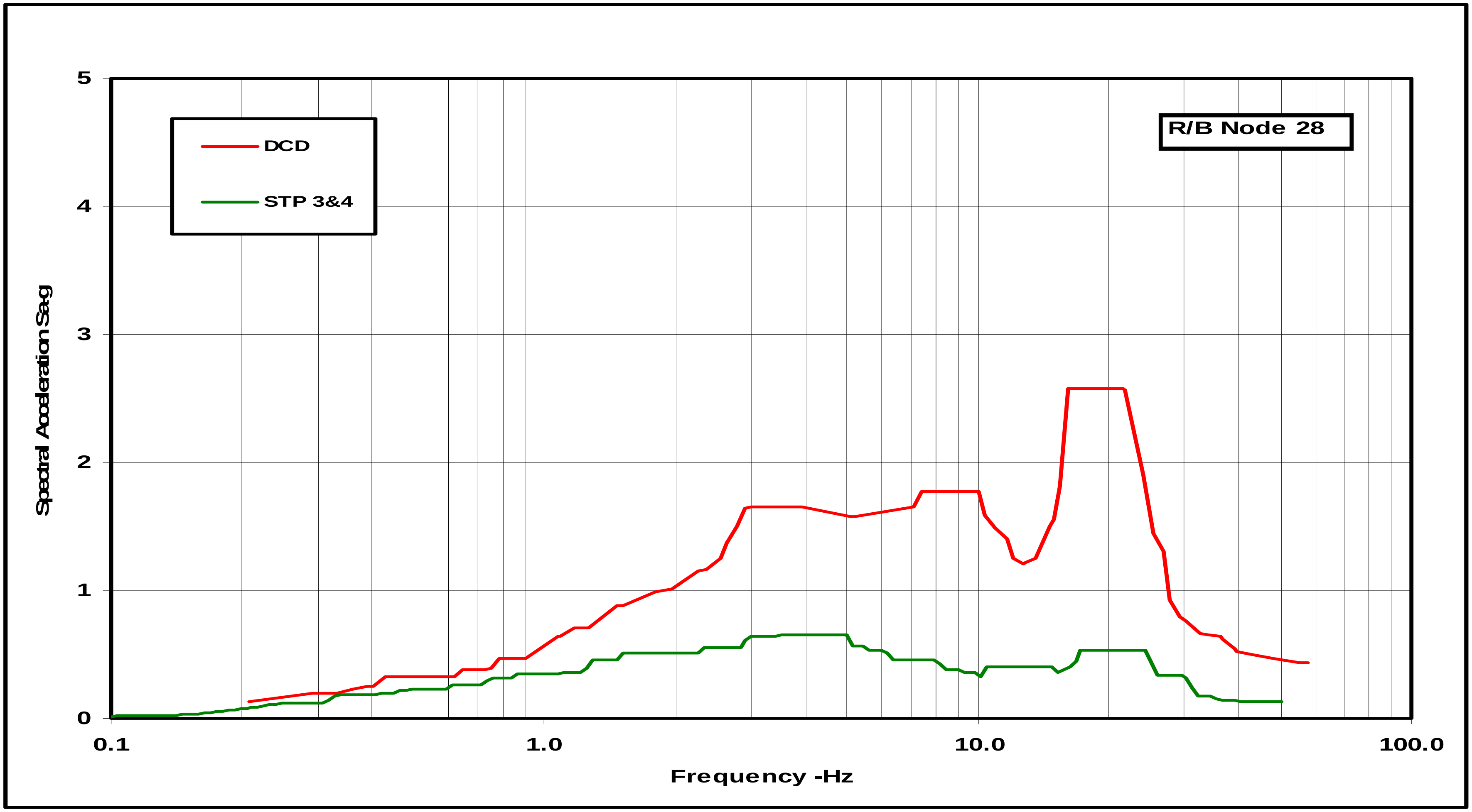


Comparison of Reactor Building Broadened DCD and STP 3&4 Spectra, Node 28 - Horizontal, 2% Damping

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis (Continued) –

- Typical comparison of Response Spectra curves from the DCD and the site specific seismic analyses



Comparison of Reactor Building Broadened DCD and STP 3&4 Spectra Node 28 - Vertical, 2% Damping

Standard Plant (DCD) Seismic Category I Structures

Seismic Analysis (Continued) –

- Determination of soil pressures from Structure-Soil-Structure Interaction (SSSI) analysis in SASSI
  - To evaluate the effect of SSSI on soil pressures, two dimensional (2D) SSI analyses were performed using SASSI2000:
    - Reactor Building and Control Building individually
    - Reactor Building and Control Building together with Turbine Building
  - The 2D models used for these analyses are similar to the models described in the ABWR DCD for considering SSSI effect on the soil pressures on the Reactor Building and Control Building walls
  - The soil pressure profiles from the SSSI analyses are bounded by the envelope of the certified design soil pressures

Standard Plant (DCD) Seismic Category I Structures

Conformance to Updated Codes and Standards –

STD DEP 1.8-1

- The American Concrete Institute Code, ACI 349, is updated to the 1997 edition as endorsed by Regulatory Guide1.142, “Safety-Related Concrete Structures for Nuclear Power Plants” Revision 2, dated 11/01
- Added Regulatory Guide 1.199, “Anchorage Components and Structural Supports in Concrete”, Rev. 0, dated 11/03
- The ASME Section III Division 2 Code is updated to the 2001 edition with 2003 Addenda as endorsed by Regulatory Guide 1.136, “Materials, Construction, and Testing of Concrete Containments,” Revision 3, dated 3/07

STD DEP 3H -1

- Section 3H.1.4.4.3 Liner Plate – Revised to correct the liner anchor material from ASTM A-633 Gr. C to SA-36, consistent with ABWR DCD Subsection 19F.3.2.1 and the ASME Code

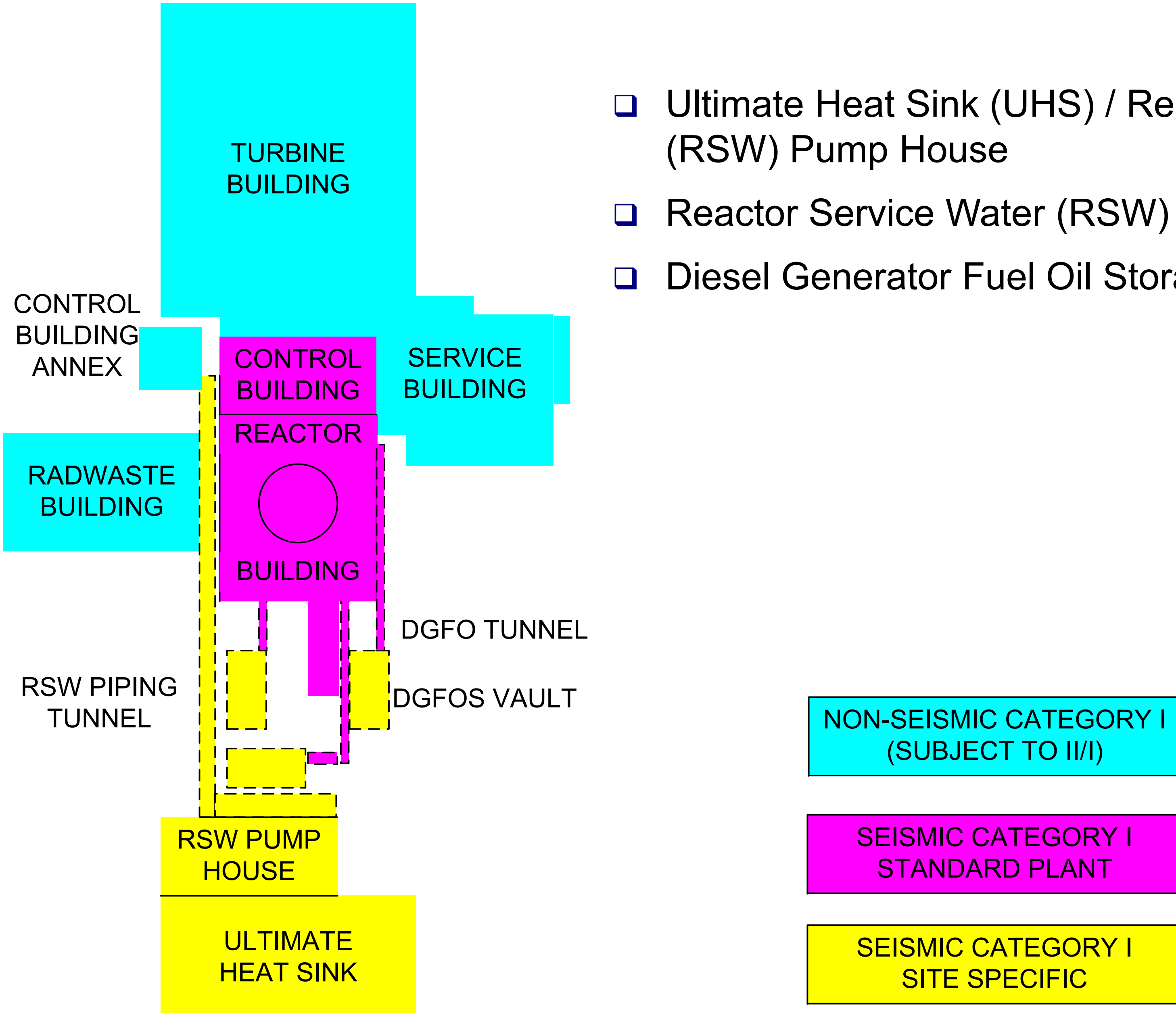
Standard Plant (DCD) Seismic Category I Structures

Conformance to Updated Codes and Standards (Continued) –

- Subsection 3.8.1 includes a description of the Preservice and Inservice Inspection (ISI) Program requirements for ASME B&PV Code, Class CC and MC pressure retaining components of the Containment Structure and their integral attachments
- Subsection 3.8.6 includes a description of the Structural Integrity Test (SIT) for the containment

Sections 3.7 and 3.8 – Site Specific Seismic Category I Structures

Site Specific Seismic Category I Structures



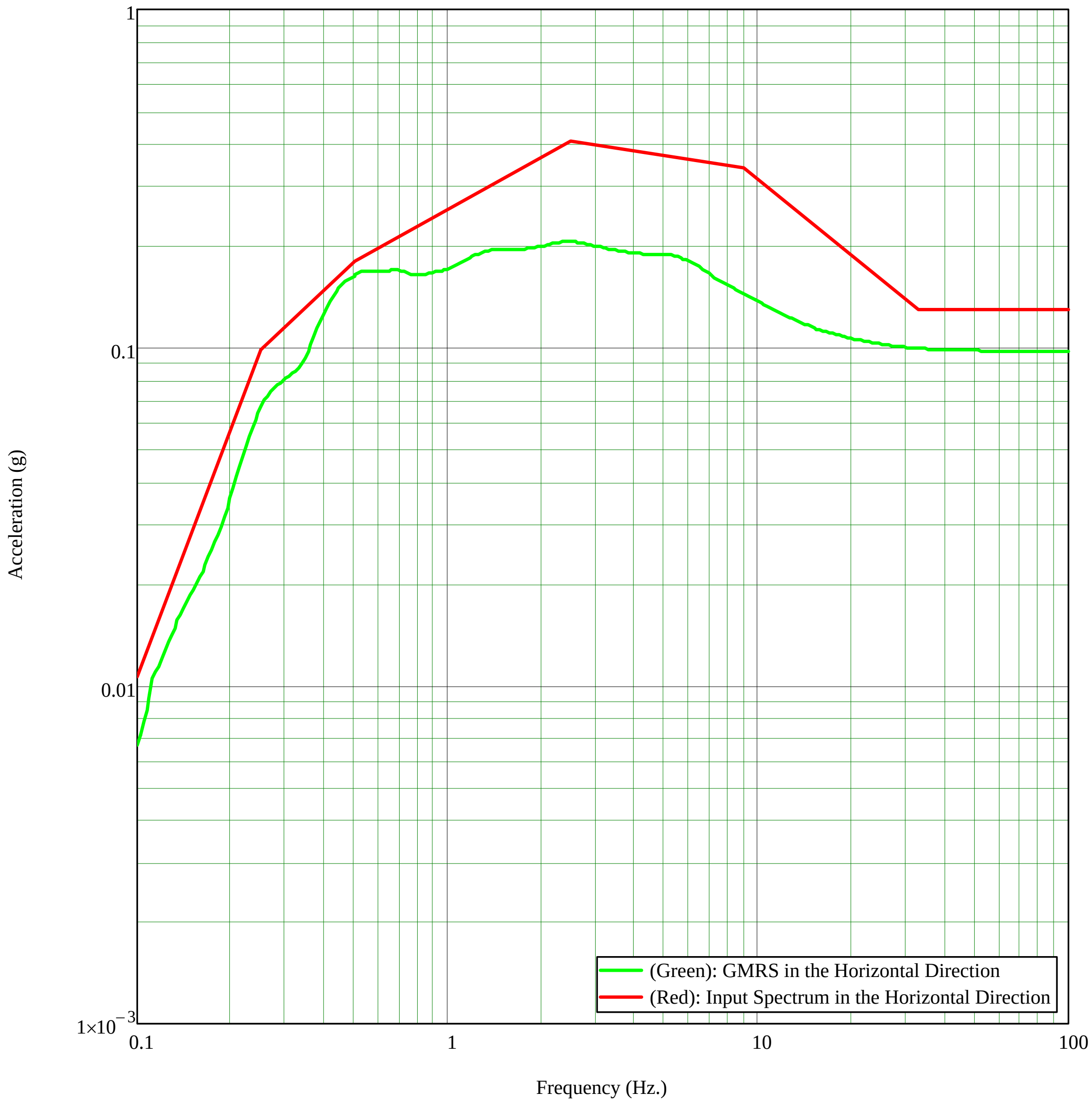
- Ultimate Heat Sink (UHS) / Reactor Service Water (RSW) Pump House
- Reactor Service Water (RSW) Piping Tunnel
- Diesel Generator Fuel Oil Storage Vaults (DGFOSV)

Site Specific Seismic Category I Structures

- The site specific Seismic Category I structures described in the COLA are heavy and robust structures designed to resist a variety of conservatively selected loadings, including:
  - Dead Loads & Live Loads
  - Thermal Effects
  - Wind Loads, Tornado Loads & Hurricane Loads
  - Uplift Due to Groundwater
  - Loads Caused by Static and Seismic Earth Pressures
  - Safe Shutdown Earthquake
  - Internal and External Flooding
- Analyses and evaluations were performed, including:
  - Seismic Analysis
  - Evaluation of Building Stability for Seismic, Wind, Tornado, Hurricane, and Flooding Events
  - Design Provisions for Internal and External Flooding
  - Design for Wind Loads, Tornado Loads and Hurricane Loads

Site Specific Seismic Category I Structures

Seismic Analysis (Continued) –

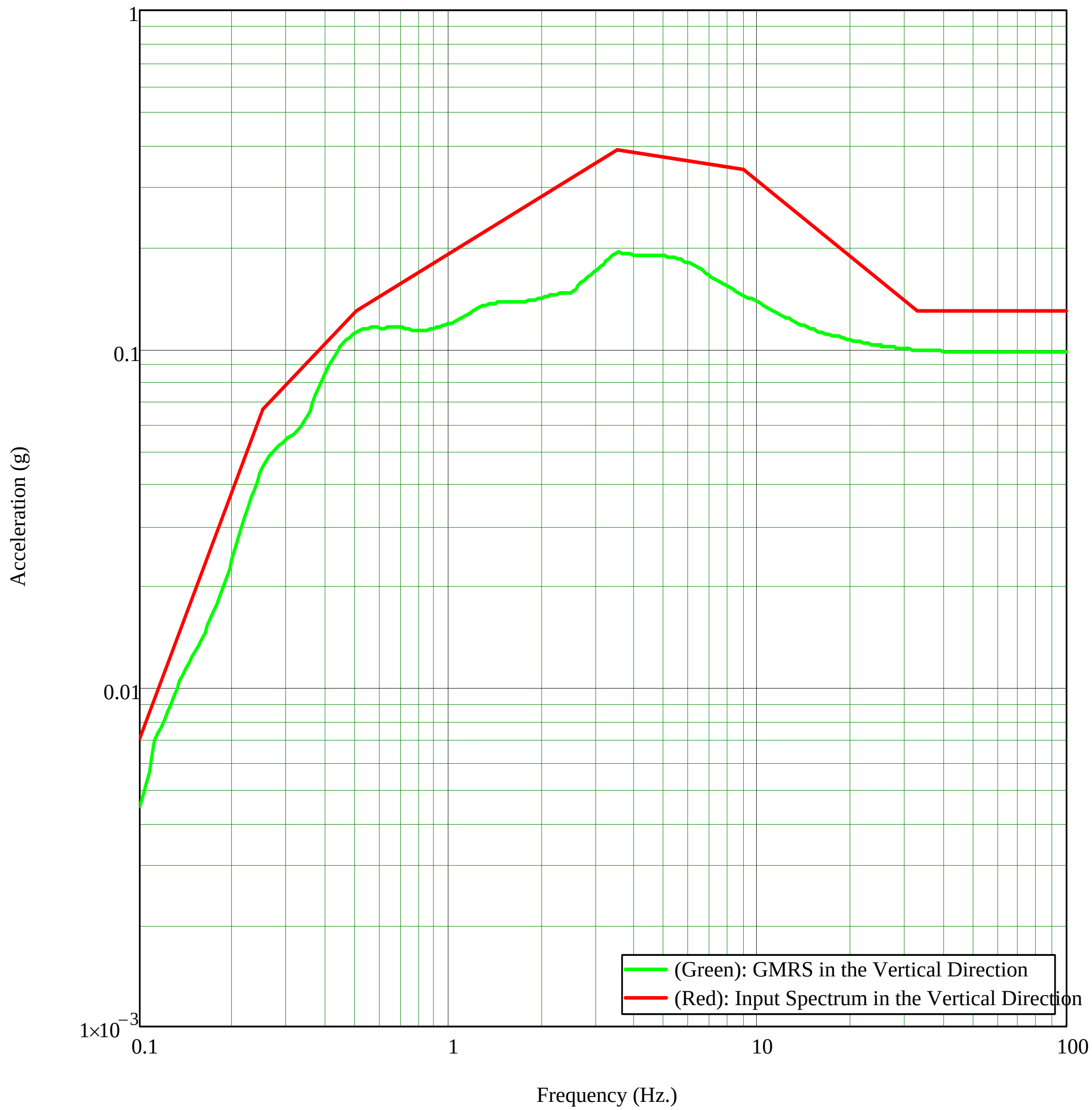


- The site specific Safe Shutdown Earthquake input motion envelops the GMRS with substantial margin in the frequencies of interest

Comparison of GMRS with the Input Spectrum (Horizontal)

Site Specific Seismic Category I Structures

Seismic Analysis (Continued) –



- **The site specific Safe Shutdown Earthquake input motion envelops the GMRS with substantial margin in the frequencies of interest**

Comparison of GMRS with the Input Spectrum (Vertical)

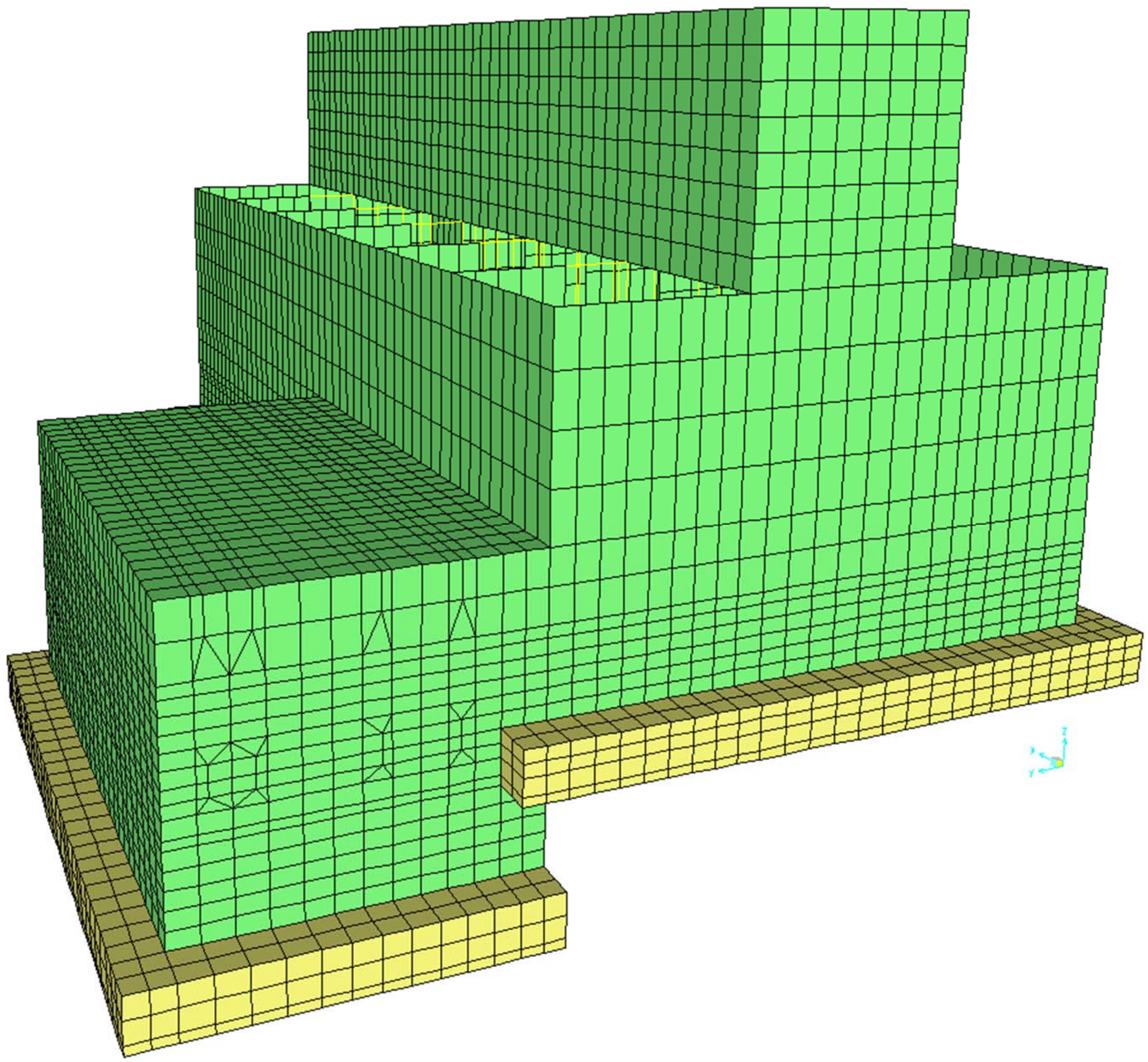
Site Specific Seismic Category I Structures

Seismic Analysis (Continued) –

- The site-specific SSI and SSSI analyses considered:
  - STP 3 & 4 site-specific soil properties and site-specific SSE ground motion, including shear wave velocity
    - Seismic analysis of the Diesel Generator Fuel Oil Vaults use the ABWR DCD SSE ground motion
  - Modeling of soil profiles (with variation of properties) in the SSI analysis
  - Poisson's Ratio values to achieve 5,000 ft/sec compression wave velocity below groundwater level
  - SSI analyses accounted for refined mesh for the soil and structural model with a cut-off frequency of 33 Hz for transfer function calculation
  - Separate analysis cases for both empty and full UHS basin
  - Determination of soil pressures from SSSI analysis
  - The analyses account for the effect of heavy structures adjacent to lighter structures

Site Specific Seismic Category I Structures

Seismic Analysis (Continued) –



SSI Refined Mesh Model of UHS/RSW Pump House

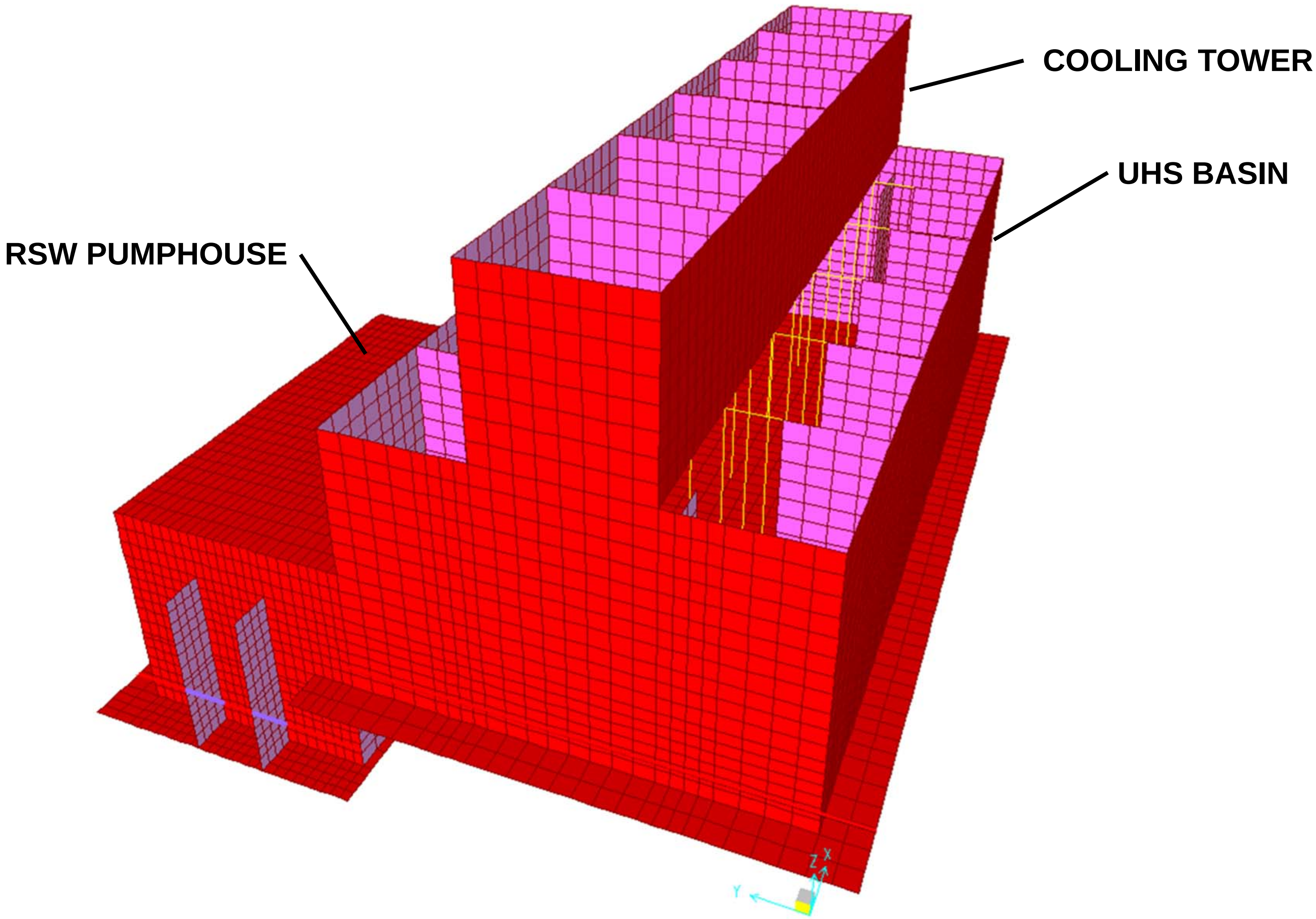
Site Specific Seismic Category I Structures

Seismic Analysis (Continued) –

- Determination of soil pressures
  - To evaluate the effect of SSSI on soil pressures, 2D SSSI analyses, including nearby adjacent structures, were performed
  - Dynamic lateral soil pressures on the walls due to an SSE are calculated from:
    - Methodology defined in ASCE 4-98
    - SSI analysis
    - SSSI analysis
  - The dynamic lateral soil pressures used to design the walls bound the results from SSI and SSSI analyses and ASCE 4-98 methodology

Site Specific Seismic Category I Structures

Structural Analysis and Design Summary –



SAP2000 Finite Element Model for UHS and RSW Pump House Design

Site Specific Seismic Category I Structures

Structural Analysis and Design Summary (Continued) –

- The analysis of the UHS basin and RSW pump house considers the following loads:
  - Dead and live loads on the structures
  - Hydrostatic and hydrodynamic (impulsive and convective) loads corresponding to the water in the basin
  - Soil Pressures applied to the walls
  - SSE forces corresponding to the weight of the structures being acted on by the accelerations established by the SSI analysis
  - Wind loads and tornado and hurricane wind and missile loads
  - Flood loads

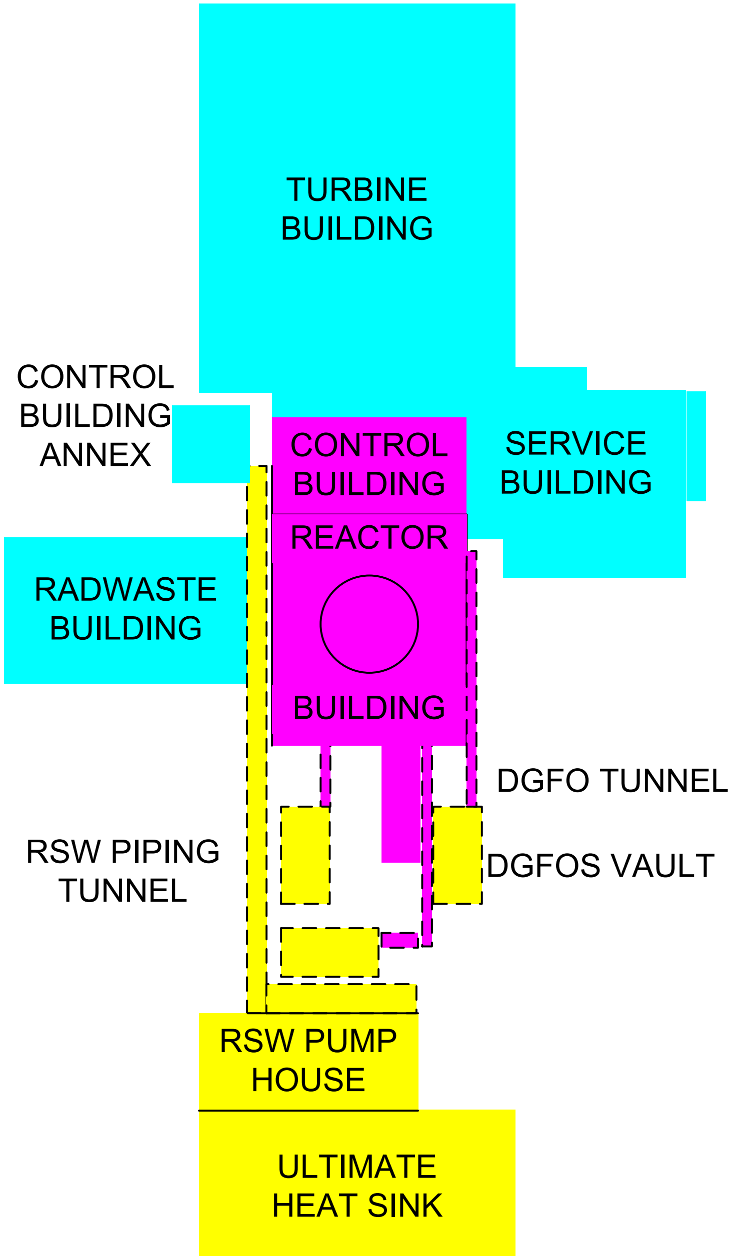
Site Specific Seismic Category I Structures

Structural Analysis and Design Summary (Continued) –

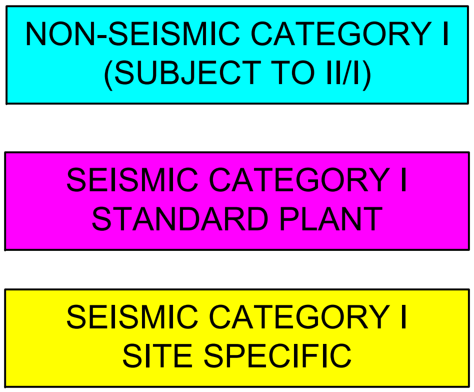
- The load combinations and structural acceptance criteria used to analyze and design the site-specific Category I concrete structures are consistent with the provisions of the following Design Codes and Standards
  - ACI 349, 1997 edition, Code Requirements for Nuclear Safety-Related Concrete Structures
  - ACI 350, 2001 edition, Code Requirements for Environmental Engineering Concrete Structures
  - ANSI/AISC N690-1994, including Supplement 2 (2004), American National Standard Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities

Sections 3.7 and 3.8 – Non-Seismic Category I Structures Subject to II/I

Non-Seismic Category I Structures Subject to II/I



- Non-Seismic Category I Structures located in relatively close proximity to Seismic Category I structures include:
  - Turbine Building
  - Service Building
  - Radwaste Building
  - Control Building Annex



Non-Seismic Category I Structures Subject to II/I

- The Non-Seismic Category I Structures Subject to II/I are designed to accommodate the loading conditions associated with various loads and load combinations which form the structural design basis
- The overall design of the Turbine Building, Service Building and Control Building Annex structures follows the procedures described in the 2006 International Building Code (IBC) (STD DEP 1.8-1)
- The Radwaste Building is designed in accordance with Revision 2 of Regulatory Guide 1.143
- Each Non-Seismic Category I Structure subject to II/I meets the following criteria:
  - The non-Category I structure will be analyzed and designed to prevent its failure under SSE conditions in a manner such that the margin of safety of the structure is equivalent to that of Seismic Category I structures

Non-Seismic Category I Structures Subject to II/I

- The Non-Seismic Category I Structures Subject to II/I are Standard Plant Structures that are designed to meet the II/I criteria based upon the same natural phenomena as the Standard Plant (DCD) Seismic Category I Structures
  - Seismic
  - Tornado
  - Hurricane
  - Flood
- Stability evaluations for the Turbine Building, Service Building, Control Building Annex and Radwaste Building are based upon site-specific analysis which considered:
  - Site-specific soil properties
  - Amplified Spectra
  - Soil pressures from SSSI analysis in SASSI
- Site specific ITAACs assure that the II/I acceptance criteria are met

Non-Seismic Category I Structures Subject to II/I

Radwaste Building Classification and Design Criteria

- The Radwaste Building is classified RW-IIa (High Hazard) in accordance with Revision 2 of Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants" (STD DEP T1 2.15-1)
- Criteria for Design Basis:
  - Analysis and design meets or exceeds the requirements of RG 1.143 for the RW-IIa classification
  - Loads, load combinations, codes & standards, and capacity criteria are in accordance with RG 1.143
  - Structural components are per ACI 349-97 and AISC/N690 (1984)

Sections 3.7 and 3.8 – Other Topics

Other Topics

Other topics applicable to STP 3&4

- 10 CFR Part 21 – Main Steam Line Seismic Analysis
- 10 CFR Part 21 – ACS SASSI
- Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB
- Evaluation for Hurricane Loads
- Design Provisions for External Flooding

10 CFR Part 21 Report Related to Main Steam Lines Dynamic Analysis

- During detailed design of the Turbine Building (TB), Fluor Enterprises notified the NRC that the TB floor response spectra were not completely enveloped by the Main Steam Line (MSL) design inputs specified in the DCD
- This Fluor analysis was based on design work in progress, which was never completed nor accepted by NINA
- Site specific ITAAC 3.0-18 requires a dynamic analysis of the final TB design to confirm that the DCD dynamic input requirements for the MSL are satisfied

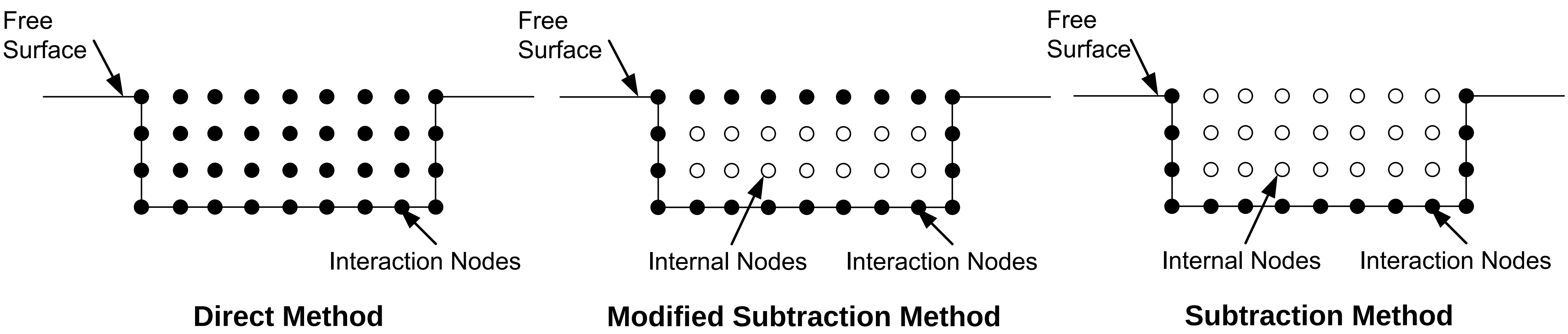
10 CFR Part 21 Report Related to ACS SASSI

- During the initial SSI analyses for STP 3&4, S&L analysts observed that the results in one model were inconsistent with expected results
- Investigation concluded that one of four models using ACS SASSI with more than 80 soil layers exhibited instability – this investigation included independent third party verification using SASSI2000
- As a result, S&L
  - Submitted a Part 21 report to the NRC regarding this finding
  - Retired ACS SASSI in favor of SASSI2000
  - Upgraded and enhanced S&L's V&V program for SASSI
  - Applied the enhanced V&V program to SASSI2000
  - Repeated all of the required analyses using SASSI2000
  - Confirmed that the SASSI2000 results did not exhibit instability
- The STP 3&4 SSI and SSSI analyses rely upon SASSI2000
- There are no STP 3&4 SSI or SSSI analyses that rely upon ACS SASSI

Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB

- SASSI analyses can be performed using the Direct Method (DM) of analysis or the Subtraction Method (SM) of analysis
- For problems with a large number of interaction nodes in the excavated soil volume, it becomes impractical or impossible to perform 3D SSI analysis with SASSI using the DM
- Using the SM, only the interaction nodes on the side and lower boundaries of the excavated volume are considered – greatly reducing the number of interaction nodes and making it reasonable to perform 3D SSI analysis
- Recent studies have shown that use of the SM can produce spurious results – especially when applied to wide, shallow embedded foundations
- The important difference between the DM and SM methods is that the excavated soil volume in the SM solution can vibrate independently from the layered soil halfspace
- This independent vibration, when it occurs, causes the spurious response that has been identified as the subtraction error

Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB



Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB

- The Modified Subtraction Method (MSM) has been proposed to alleviate the effect of the subtraction error
- Using MSM, additional interaction nodes are added to the surface of the excavation, as well as at intermediate points within the excavated volume
- MSM modeling techniques can be benchmarked against DM
- The constraint from the additional interaction nodes increases the natural frequency of the excavated soil volume
- With a higher natural frequency of the excavated soil volume, MSM results diverge from the DM results at a higher frequency than with SM
- Where DM is not feasible, MSM can be used to increase the frequency at which the subtraction error occurs to a higher range of frequencies at which the effects on the structures at the STP 3&4 site are not significant

Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB

- DM was used for several STP 3&4 analyses that required no further evaluation as a result of the issues identified by DNFSB:
  - Reactor Building (Shear Wave Velocity Departure Analysis)
  - Control Building (Shear Wave Velocity Departure Analysis)
  - Diesel Generator Fuel Oil Tunnel
  - RSW Piping Tunnel
- SM was used for several STP 3&4 analyses that required further evaluation as a result of the issue identified by DNFSB:
  - UHS/RSW Pump House
  - Diesel Generator Fuel Oil Storage Vault
  - All 2D SSSI Analyses
  - Reactor Building and Control Building (Analyses to address the impact of heavier structures on lighter nearby structures)

Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB

- The program to address the analyses originally completed using SM:
  - MSM was benchmarked for the STP 3&4 site by analyzing the Control Building model using MSM and comparing the results to those from DM
    - In structure response spectra and transfer functions from MSM compare very well to those from DM
    - Maximum accelerations and forces from MSM compare very well to those from DM (maximum differences less than 4%)
  - UHS/RSW Pump House –
    - Reanalyzed the coarse mesh model of the UHS/RSW Pump House using MSM for the UB In-situ Soil Case (Both full and empty basin cases)
    - The spectra and maximum accelerations from the MSM were compared to those from SM and, where required, a modification factor was determined to modify the results obtained from the SM
  - Diesel Generator Fuel Oil Storage Vault – All analysis cases were repeated using MSM

Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB

- The program to address the analyses originally completed using SM (Continued):
  - 2D SSSI Analyses – The RB + RSW Piping Tunnel + RWB SSSI Model was analyzed for the upper bound back-fill and the lower bound in-situ soil cases using DM and MSM to assess the impact on calculated total soil pressures
    - The method of SSSI analysis (SM, MSM, or DM) has negligible impact on the total force due to seismic soil pressure
    - The method of SSSI analysis (SM, MSM, or DM) has negligible impact on location of the total force due to seismic soil pressure
    - The method of SSSI analysis (SM, MSM, or DM) has negligible impact on the soil pressure distribution for interior walls
    - DM analytical results show some changes in the distribution of seismic soil pressure for exterior walls, all of which are bounded by existing design margin

Seismic Analysis - Resolution of Issues with Subtraction Method of Analysis Identified by DNFSB

- The program to address the analyses originally completed using SM (Continued):
  - Reactor Building and Control Building (Analyses used to calculate amplified motions below adjacent structures) –
    - The Reactor Building SSI model includes the great majority of the light structures adjacent to heavy structures and was used to perform analysis with MSM to examine the impact on the amplified site-specific motions
    - The amplified input motions obtained from MSM analysis of the RB are significantly bounded by the 0.3g RG 1.60 spectra used for:
      - Design of the DGFO Storage Vaults and the DGFO Tunnels
      - II/I design of the Radwaste Building, Service Building and Control Building Annex
    - Design of RSW Piping Tunnel was re-evaluated considering the impact on amplified input motions from MSM analysis and found to be adequate

Evaluation for Hurricane Loads

Design for Site-Specific Hurricane Winds and Missiles

- New Regulatory Guide 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants", October 2011, provides guidance for designing structures for hurricane wind and hurricane generated missiles
- The STP site-specific design-basis hurricane wind speed and resulting hurricane generated missile spectrum were determined in accordance with Regulatory Guide 1.221
- Design for hurricane wind and missiles was carried out using SRP guidelines for tornado wind and missiles
- The Seismic Category I structures are designed for the maximum tornado and hurricane loads
- Site-specific ITAACs assure that design of the DCD Seismic Category I Structures for Hurricane Winds and Missiles meet the acceptance criterion
- Non-Seismic Category I Structures Subject to II/I are evaluated for hurricane wind and missiles

Design Provisions for External Flooding

The design basis flood elevation is at El. 40.0 feet MSL, 6 feet above the finished plant grade (STP DEP T1 5.0-1)

- Flotation stability evaluations are based on buoyancy calculations using the design basis flood level
- The lateral loads on the structural walls and overturning moment on the structure include the effect of the wave-generated hydrodynamic forces and are capable of resisting the following loads:
  - Hydrostatic force
  - Hydrodynamic drag force
  - Wind generated wave forces
  - Impact due to floating debris
- Penetrations and doors through exterior walls located below the design basis flood level are Seismic Category I components provided with watertight seals

Design Provisions for External Flooding

COLA Revision 8 added a new Appendix 1E:

- Response to NRC Post-Fukushima Recommendations, which included:
- Available Physical Margin for Flooding:
  - Analysis performed to determine Available Physical Margin for Flooding, the flood level where ability to cool the core is lost (i.e., Cliff Edge)
  - Emergency Diesel Generators (EDGs) and ability to cool the core is maintained until flood water levels exceed 51 feet MSL:
    - 11 feet above the design basis flood level (40 feet MSL)
    - 12.8 feet above max flood level caused by MCR breach (38.2 feet MSL)
    - 17 feet above nominal site grade (34 feet MSL)

Sections 3.7 and 3.8

Questions and Comments

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

Presentation to the ACRS Subcommittee

South Texas Project (STP) – Units 3 & 4 COLA Review

Chapter 3.7,“Seismic Design”

July 9, 2013

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

Purpose

- Brief the Subcommittee on the staff’s review of the STP 3&4 COL Application Sections
  - 3.7.1 “Seismic Design Parameters”
  - 3.7.2 “Seismic System Analysis”
  - 3.7.3 “Seismic Subsystem Analysis”
- Answer the Committee's questions

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,"Seismic Design" – Review Team

- Project Manager
  - Tom Tai
- Technical Reviewers
  - Manas Chakravorty, Lead (Presenter)
  - Samir Chakrabarti
  - Mansour Tabatabaie (SC Solutions)

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

Outline of Presentation

- Background and Review Scope
- Applicable Regulations
- Topics of Interest
  - ABWR Standard Design and STP Site Parameters
  - STP DEP T1 5.0-1 (Shear Wave Velocity Departure)
  - Site-Specific Soil-Structure Interaction (SSI) Analysis
    Modeling Issues
    Amplified Ground Motion Input
    Structure-Soil-Structure Interaction (SSSI)
  - Computer Program Validation
  - Staff’s Confirmatory Analysis
- DNFSB Issue
- Fluor’s Part 21 Evaluation
- Conclusions
- Committee Questions

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,"Seismic Design"

Background and Review Scope

- STP is a deep soil site extending down several thousand feet
- STP incorporated ABWR DCD for this section by reference with departures and supplements
- Scope included reviewing seismic demand at STP site for the Standard Plant Structures (RB, CB, DGFOT), Site-Specific Structures (UHS/RSW Pump House, RSW Piping Tunnel, DGFOSV), and Non-Category I structures with potential to interact with Category I structures (CBA, TB, RWB, and SB)
- Applicable departures, supplementary information, and COL Information Items
- Validation of seismic analysis codes used for STP application and addressing the Defense Nuclear Facilities Safety Board (DNFSB) Issue on the Computer Code SASSI

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

<u>Applicable Regulations/Guides</u>

- 10CFR Part 50, Appendix A, GDC 2
- 10 CFR Part 50, Appendix S
- 10 CFR 52.79(d)(1)
- 10 CFR 52.80(a)
- NUREG-1503
- NUREG-800 (SRP)
- DC/COL-ISG-01, 017

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

Topics of Interest – ABWR Standard Design and STP Site Parameters

- CSDRS is RG 1.60 anchored to 0.3g applied in the free field at plant grade elevation
- GMRS at the STP site is based on the RG 1.208 guidance and established in Section 2.5S.2
- Site-Specific SSE response spectra are defined at the free field at plant grade as 0.13 g RG 1.60 spectra with some adjustments at low frequencies (2.5 Hz to 3.5 Hz) to envelop GMRS
- Site-Specific SSE response spectra envelop GMRS. The corresponding FIRS meets Appendix S requirement of 0.1g min peak horizontal ground acceleration at the foundation level.
- CSDRS envelop the site-specific SSE response spectra
- DCD Minimum Shear wave velocity site parameter requirement was not met at STP 3 & 4 site

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,"Seismic Design"

Topic of Interests (continued) - STP DEP T1 5.0-1 (Shear Wave Velocity Departure)

- Shear wave velocity at STP is lower than DCD minimum requirement of 305 m/s
- A site-specific SSI analysis has been performed by the applicant to confirm that standard plant results in the DCD envelop the results of the site-specific SSI analysis
- The staff used the SRP guidance in reviewing applicant's site-specific SSI analysis of the standard plant structures including development of seismic input, the analytical method, soil-structure model refinement, site-specific soil properties, consideration of ground water effects, etc
- The applicant has adequately demonstrated that the DCD seismic analysis results envelop those of the site-specific seismic analysis of the standard plant structures

ACRS Subcommittee Presentation
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Chapter 3.7,"Seismic Design"

Topic of Interests (continued) - Site-Specific Soil-Structure Interaction (SSI) Analysis – Modeling Issues

Sensitivity studies performed to address several Issues:

- Integrated Finite Element Soil-Structure Interaction Model
- Structural Mesh Refinement
- Foundation Soil Mesh Refinement
- Soil Parameter Uncertainties
- Modeling Ground Water Effect
- Impact of the Empty Basin for UHS model
- Hydrodynamic Effects of Water in the UHS basin
- Special considerations for underground tunnels

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
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Topic of Interests (continued) - Site-Specific Soil-Structure Interaction (SSI) Analysis - Amplified Ground Motion Input

- Input motion for the SSI analysis for the heavy structures e.g., RB/CB, UHS/RSW pump house – Site-specific SSE applied at ground surface
- Input motion for the SSI analysis for lighter structures e.g., RSW Piping Tunnel, DGFOSVs, DGFOTs – Amplified seismic ground motion input due to the presence of nearby heavy structures e.g., RB and UHS/RSW pump house

ACRS Subcommittee Presentation
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<u>Topic of Interests (continued) - Site-Specific Soil-Structure Interaction (SSI) Analysis – Structure-Soil-Structure Interaction (SSSI)</u>

- SSSI affects the seismic soil pressure induced between the adjacent buildings during a seismic event
- The applicant has considered interaction of adjacent buildings to determine the effect of SSSI on the seismic soil pressure

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

Topics of Interest (Continued) – Computer Program Validation

- Reviewed validation documentation for SASSI2000, SAP2000, and SHAKE2000 computer program features used in the STP 3 & 4 applications
- Staff identified some issues regarding sufficiency of the validation documents for STP applications (e.g., required mesh refinement for out-of-plane responses, acceptable aspect ratio of the finite elements, accuracy of Subtraction Method (SM) of SASSI program, potential instability when using Poisson's ratio close to 0.5, etc)
- Applicant expanded the scope of the validation program using additional test problems and performed sensitivity studies to address the staff’s concerns including accuracy of the SM and DNFSB concerns when SM of the SASSI program is used

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

Topics of Interest (Continued) - Staff’s Confirmatory Analyses

Performed two confirmatory SSI analysis for the UHS/RSW Pump House:

- STP discovered some numerical instability in using ACS SASSI NQA Version 2.2.1 due to large number of soil layers and switched to SASSI 2000 Version 3.0. To gain additional assurance a confirmatory SSI analysis of UHS/RSW Pump House was performed using computer code MTR/SASSI
- A second confirmatory SSI analysis for the UHS/RSW Pump House was performed to assess the impact of using a high Poisson’s ratio for saturated soil. Based on information provided by STP, a comparable model of UHS/RSW Pump House was developed for SSI analysis using MTR/SASSI. This analysis used the modified subtraction method.
- The confirmatory analysis found the SSI analysis of the UHS/RSW Pump House to be acceptable

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,“Seismic Design”

DNFSB Issues

- On April 8, 2011, the Defense Nuclear Facilities Safety Board (DNFSB) identified a technical issue when using the Subtraction Method (SM) of the computer program SASSI for analysis of embedded structures
- Since STP 3&4 used SM, the staff requested the applicant to demonstrate acceptability of the results using SM in STP 3&4 application
- The applicant benchmarked the Modified Subtraction Method (MSM) for STP application against the Direct Method (DM) and used the MSM to validate the SM results
- The applicant performed additional analysis using the MSM method. Seismic demand obtained from the MSM were compared to those obtained from the SM and appropriate modification factors were determined to modify the SM results.
- The staff also performed a confirmatory analysis using the MSM to evaluate the results

Fluor's Part 21 Evaluation

- Fluor notified the NRC regarding exceedance of the ABWR DCD seismic design input requirements for the Main Steam Line (MSL) seismic analysis in the Turbine Building (TB)
- The staff requested the applicant to demonstrate that the dynamic input load for the design of the MSL in the TB would be conservative at the STP site.
- The applicant indicated that a detailed design of the TB is not complete. The applicant provided a site-specific ITAAC that describes that a dynamic analysis of the TB will be performed to confirm the DCD MSL input requirements.

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,"Seismic Design"

Conclusions

The staff has reviewed the application and the relevant information in the ABWR DCD incorporated by reference and concludes that sufficient information has been provided to satisfy the NRC regulations and guidance in Sections 3.7.1 through 3.7.3 of NUREG-0800.

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.7,"Seismic Design"

Discussions/Committee Questions

THANK YOU

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Presentation to the ACRS Subcommittee

South Texas Project (STP) – Units 3 & 4 COLA Review

Chapter 3.8

Seismic Category I Structures

July 9, 2013

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 – Seismic Category I Structures

Purpose

- Brief the Subcommittee on the staff's review of the STP 3&4 COL Application Section 3.8, "Seismic Category I Structures"

- Answer the Subcommittee's questions

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

Review Team:

- Project Manager
  - Tom Tai

- Technical Reviewers:
  - Samir Chakrabarti, Lead (Presenter)
  - Manas Chakravorty
  - M. K. Ravindra (Consultant)
  - Peter Arnold (Consultant)
  - Mansour Tabatabaie (Consultant)

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

Outline of Presentation

- Background and Review Scope
- Applicable Regulations
- Highlights of Staff Review
- Conclusions
- Questions

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

Background and Review Scope

- STP RCOL application includes:
  - Incorporation by reference of ABWR DCD for standard plant structures with site-specific departures and supplements
  - Design information for site-specific seismic category I structures
  - Interaction of non-seismic category I structures with category I structures (II/I interaction)
  - Addressing all COL information items
  - Providing supplemental information to address DNFSB issue and hurricane wind design
- Staff review focused on:
  - Evaluation of DCD structures incorporated by reference
  - Evaluation of design of site-specific category I structures
  - Evaluation of II/I interaction
  - Evaluation of all supplemental information

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

Applicable Regulations/Guides

- 10CFR Part 50, Appendix A, GDC 2
- 10 CFR 52.79
- 10 CFR 52.80
- NUREG-1503 (FSER on ABWR Design Certification)
- NUREG-0800 (SRP)

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 – Seismic Category I Structures

Highlights of Staff Review

Evaluation of DCD structures:

The DCD structures (RB and CB) were evaluated for the applicable departures, COL information items and supplemental information. The major areas of review are described below:

Tier 1 Departures:

- STP DEP T1 5.0-1: Major site parameters introduced by this departure affecting Section 3.8 review are site-specific design basis flood level and shear wave velocity at the STP site.
  - Design Basis Flood: The certified design parameter for site flooding was changed from 1 ft below grade to 6 ft above grade. The RB and CB were evaluated for site-specific flooding including hydrostatic, hydrodynamic, wave effects, and debris loading. Water-tight seals for penetrations, barriers and doors below flood level were reviewed for adequacy.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of DCD Structures (cont.)

- Shear Wave Velocity: Shear wave velocity at STP is lower than DCD minimum requirement of 305 m/s. Site-specific SSI analysis to confirm seismic response of the RB and CB are bounded by the DCD responses is discussed in 3.7. Effect of lower shear wave velocity on lateral soil pressures, foundation spring, and foundation settlements of the RB and CB were reviewed.
  - Effect of soil pressure profiles from SSSI analysis are bounded by the design soil pressures of the certified design.
  - Foundation soil springs based on lower shear wave velocity are higher than the DCD soil spring values except for the lower range soil spring values for the CB. Parametric study was performed to demonstrate that lower soil spring values did not adversely impact basemat design.
  - Differential settlements were estimated for the STP site and acceptable values established for both foundation tilt and mat differential settlement.

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Evaluation of DCD Structures (cont.)

- STD DEP T1 2.15-1: This departure reclassified the Radwaste Building (RWB) structure from seismic category I to RW-IIa (high hazard) in accordance with RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants." The staff reviewed design of RWB using the acceptance criteria provided in SRP 3.8.4 to confirm that the design met the requirements of RG 1.143 for all loads, load combinations, acceptance criteria and codes and standards.

Tier 2* Departure:

- STD DEP 1.8-1: This departure updates the codes and standards used for the DCD structures as below:
  - American Concrete Institute Code ACI 349 is updated to the 1997 edition currently endorsed by the NRC against the 1980 edition used in the DCD.
  - ASME Section III Division 2 Code is updated to the 2001 edition with 2003 Addenda currently endorsed by the NRC against the 1989 edition.
  - RG 1.199, "Anchorage of Components and Structural Supports in Concrete," Rev.0, is added.

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Chapter 3.8 - Seismic Category I Structures

<u>Evaluation of DCD Structures (cont.)</u>

Tier 2* Departure (cont.)

The staff reviewed continued validity of the design of RB and CB structures for the updated code versions using a detailed comparison of the provisions of the code versions. The staff also reviewed FSAR updates for adding RG 1.199.

Tier 2 Departures:

- STD DEP 3H-1: This departure revised the liner anchor material from ASTM A-633 Gr. C to SA-36 to be consistent with Subsection 19F.3.2.1. The staff reviewed the evaluation of the departure performed by the applicant.

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Evaluation of DCD Structures (cont.)

- STD DEP 3B-2: This departure updates the hydrodynamic loads analysis to incorporate a new method of analysis for the pool swell (PS) compared to the method described in the DCD. This resulted in increase in the PS height and pressure loads. Containment and internal structure design was not impacted since the condensate oscillation (CO) loads in LOCA load combination governed the design.
- Other Departures: Applicant's evaluation of several other departures not requiring prior NRC approval were reviewed using the criteria in 10 CFR Part 52, Appendix A, Section VIII.B.5.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of DCD Structures (cont.)

- COL License Information Item 3.25, Structural Integrity Test (SIT): The first ABWR containment is considered a prototype, and the applicant provided the details of the test and instrumentation for STP Unit 3 SIT in FSAR Section 3.8.6.3 to address the COL item. The staff reviewed the details of the test and instrumentation plan provided by the applicant and found them to conform to the requirements of a containment prototype delineated in Article CC-6000 of ASME Section III, Division 2.
- COL License Information Item 3.23, Foundation Waterproofing: The staff reviewed details of the foundation waterproofing described by the applicant to address the COL item.
  - Elastomeric spray-on membrane, 120 mil nominal thickness, is used near the top elevation of the concrete fill. Testing criteria for the membrane under simulated load and environment were reviewed.
  - Sliding stability evaluation of the RB and CB were reviewed. Site-specific ITAAC 3.0-13 was added to verify minimum required coefficient of friction for the membrane to be 0.75 to maintain minimum factor of safety against sliding.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of DCD Structures (cont.)

- COL License Information Item 3.24, Site Specific Physical Properties and Foundation Settlement: The site specific subgrade medium and foundation settlements are reviewed in FSAR Section 2.5S.4. ITAAC 3.0-15 was added to verify maximum allowable foundation tilting of 1:600. RB and CB structures were reviewed to confirm no significant stresses may be induced due to allowable tilting. Foundation settlements reported in this section are based on perfectly flexible mat. Maximum differential settlement within the basemat of the RB and CB were established based on finite element analysis results of these structures.
- Supplemental Information: ABWR DCD did not include any discussion of the containment pre-service and in-service inspection (ISI) program. The applicant described the containment ISI program requirements for ASME Code, Class CC and MC pressure retaining components in FSAR Section 3.8.1.7.3. The staff found that the program description included sufficient details of the containment pre-service and in-service inspection to implement the requirements of ASME Section XI, subsection IWE and IWL. The Edition and Addenda of the Code are based on the requirements of 10 CFR 50, Section 50.55a.

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

<u>Evaluation of Site Specific Seismic Category I Structures</u>

Site-specific seismic category I structures for STP Units 3&4 are:

- Ultimate Heat Sink (UHS)/Pump House (PH)
- Reactor Service Water (RSW) Piping Tunnel
- Diesel Generator Fuel Oil Storage Vault (DGFOSV)

Analysis and design of these structures are included in Appendix 3H.6. In addition, details of Diesel Generator Fuel Oil Tunnel (DGFOT) are included in Appendix 3H.7.

The staff reviewed the design of all seismic category I structures for STP 3&4 site parameters using the acceptance criteria in SRP 3.8.4 and 3.8.5.

ACRS Subcommittee Presentation
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Chapter 3.8 - Seismic Category I Structures

Evaluation of Site Specific Seismic Category I Structures(cont.)

Major Review Areas for Seismic Category I Structures:

- Description of Structures: Descriptive information for the structures were reviewed for sufficient information to define their primary elements.
- Applicable Codes, Standards, and Specifications: Codes, standards, and specifications used by the applicant were reviewed to confirm that they were either endorsed by the NRC including the versions, or were acceptable to the staff based on prior use or as being widely used in the industry.
- Loads and Load Combinations: Loads used for design of the structures were reviewed to ensure that all applicable normal operating loads, loads due to internal events, and the environmental loads were considered. This included dead loads, live loads, thermal loads, rain and snow loads, lateral soil pressure, loads from contained liquids, uplift due to groundwater, severe and extreme environmental loads including wind, tornado, flood, hurricane, etc. Load combinations used were reviewed to confirm they were according to the load combinations recommended by the SRP.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of Site Specific Seismic Category I Structures(cont.)

- Design and Analysis Procedure: Review focus areas for design and analysis procedure are as below:
  - Seismic Analysis: Seismic analysis is performed using equivalent static loads obtained by multiplying the seismic accelerations from SASSI analysis with the structural mass. Computations of the equivalent static loads were reviewed and compared with SASSI results. Finite element models (FEM) used for seismic analysis were reviewed for element type, mesh size and boundary conditions.
  - Soil Spring Modeling: Modeling of soil springs used for FEM for static and dynamic loads were reviewed. Both uniform Winkler springs and non-uniform soil springs were considered to account for coupling of soil springs. Dynamic soil springs were used for short term loading and static soil springs used for all static loads.

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Evaluation of Site Specific Seismic Category I Structures(cont.)

- Lateral Soil Pressure: Lateral soil pressures used for design of structures were reviewed. Static lateral soil pressures included at-rest soil pressure, hydrostatic pressure and surcharge pressure. Dynamic soil pressure included seismic soil pressure from SSI and SSSI analysis (accounts for effects of adjacent structures) as well as dynamic soil pressure computed using ASCE 4-98 methodology. Further, passive pressure was also considered when such pressure was considered for stability evaluation.
- Hydrodynamic Loads for UHS Basin: Modeling of hydrodynamic loads for the UHS Basin was reviewed using the criteria in SRP 3.7.3. Convective and impulsive masses were calculated following Housner's method described in TID 7024, "Nuclear Reactors and Earthquakes." Impulsive masses were applied to the SSI model. Convective masses were treated as equivalent horizontal loads. Horizontal pressure due to vertical acceleration was also considered.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of Site Specific Seismic Category I Structures(cont.)

- Flood Loads: Loadings on structures due to site-specific flooding corresponding to design basis flood level of 40 ft MSL was reviewed. Hydrostatic, hydrodynamic, wave effects and effects due to debris impact were considered.
- Seismic Wave Propagation Effects on Underground Tunnels: Axial and bending strains in tunnels due to seismic wave propagation were reviewed. Seismic wave propagation effects due to site-specific SSE were determined using guidance provided in ASCE 4-98. Additional lateral pressure at tunnel bends due to seismic wave propagation was also reviewed.
- Stability Evaluation: Stability evaluation of structures are performed for site-specific seismic, wind, tornado, hurricane and flooding events. The staff reviewed the methods used for calculating the demands and resisting forces for stability evaluation. Seismic demand considered the three direction earthquake using 100%, 40%, 40% rule. Coefficients of friction used for sliding evaluation were reviewed at all sliding interfaces. Safety factors for sliding, overturning and floatation met the criteria in SRP 3.8.5.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of Site Specific Seismic Category I Structures(cont.)

- Bearing Pressure: Static and dynamic bearing pressures were reviewed against allowable bearing pressures. FSAR Tables 2.5S.4-41B and 2.5S.4-41C report the ultimate static and dynamic bearing pressures with calculated factors of safety. Dynamic bearing pressures were calculated using equivalent static loads applied to the structure. Factors of safety for static and dynamic bearing pressures were reviewed.
- Tunnels and Adjoining Structure Interface: Interface configuration between the tunnels and the adjoining structures was reviewed for potential differential movement at interface and loads imparted by the interface on the adjoining structures. Gaps between the tunnel ends and the adjoining structures were at least 50% larger than the calculated maximum displacements due to seismic and long term settlements to allow for relative movement at the interface. Maximum load of 25 psi is estimated at the interface based on vendor information for the seal material.

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Evaluation of Site Specific Seismic Category I Structures(cont.)

- Structural Acceptance Criteria: Structural acceptance criteria included in the load combinations for steel and concrete elements were reviewed against the design codes. All other structural acceptance criteria are compared with applicable SRP guidance or accepted engineering practice.
- Materials and Quality Control: Material and quality control programs are found to be according to steel and concrete codes endorsed by the NRC.
- Testing and ISI Requirements: There are no explicit testing requirements for site-specific category I structures. Monitoring and maintenance of the structures will be performed under the Maintenance Rule program implemented in accordance with 10 CFR 50.65 and RG 1.160.

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Non-Seismic Category I Structures Subject to II/I Interaction

The following structures are identified as structures subject to II/I interaction based on the criterion that the above-grade-height of these structures are less than their distance from a Category I structure:

- Turbine Building (TB)
- Service Building (SB)
- Control Building Annex (CBA)
- Radwaste Building (RWB)

These structures, except for the RWB, will be designed using the International Building Code (IBC) 2006. RWB is designed per provisions of RG 1.143.

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Chapter 3.8 - Seismic Category I Structures

Non-Seismic Category I Structures Subject to II/I Interaction(cont.)

Design for II/I Interaction:

- Lateral load resisting system for TB, SB, CBA and RWB will be designed to remain elastic under the same natural phenomena as the DCD seismic category I structures including site-specific flood.
- ITAAC Tables 3.0-21 through 23 were added to verify design completion.
- Extreme environmental design parameters are shown in FSAR Table 3H.9-1.

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STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

Non-Seismic Category I Structures Subject to II/I Interaction(cont.)

Stability Evaluation of TB, SB, CBA and RWB:

- Stability evaluation was performed using conceptual design of these structures for site-specific loads.
- Seismic demand calculated using the amplified spectra
- Extreme environmental loads for stability evaluation are shown in FSAR Table 3H.9-1.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of Supplemental Information

Hurricane Wind Design:

- New RG 1.221, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," provides guidance for hurricane wind speeds and missiles.
- Hurricane wind design was no longer enveloped by tornado wind design at STP.
- Applicant evaluated the DCD structures, site-specific category I structures, and non-seismic category I structures with potential to interact with category I structures for the design basis hurricane wind and missiles established for STP.
- Existing design was enhanced where necessary.
- Site-specific ITAACs for hurricane wind design were added for DCD structures.
- Site-specific ITAACs for site-specific category I structures and non-seismic structures subject to II/I interaction were revised to include hurricane wind design.

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Chapter 3.8 - Seismic Category I Structures

Evaluation of Supplemental Information

DNFSB Issue:

Defense Nuclear Facilities Safety Board (DNFSB) identified a technical issue that the results may be non-conservative with the use of subtraction method (SM) in SASSI for analyzing embedded structures.

Impact of DNFSB Issue on Structural Design:

- SSI analysis was used to determine seismic nodal accelerations and section cut forces.
- SSI/SSSI results were used for seismic soil pressure determination.
- SSI/SSSI analysis results were used for stability evaluations.
- SM method was used for some SSI and all SSSI analyses..

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STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

Evaluation of Supplemental Information

Impact of DNFSB Issue on Structural Design(cont.):

- The applicant benchmarked modified subtraction method (MSM) with direct method (DM) for STP application.
- The applicant performed detailed evaluation including additional analysis using MSM for assessing the impact where SM results were used for determining seismic accelerations, lateral soil pressures, and stability evaluation of all structures.
- Existing design margins were found to be adequate for seismic accelerations and lateral soil pressures.
- Available margins in stability evaluation were found to be adequate.

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

<u>Conclusions</u>

The staff reviewed the application and the relevant information in the ABWR DCD incorporated by reference, and concludes that the information provided by the applicant is adequate and acceptable for determination of safety in accordance with the NRC regulations and guidance in SRP Sections 3.8.1 through 3.8.5 of NUREG-0800.

ACRS Subcommittee Presentation
STP – Units 3 & 4 COLA Review
Chapter 3.8 - Seismic Category I Structures

<u>Discussions/Committee Questions</u>

<u>THANK YOU</u>