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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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AP1000 SUBCOMMITTEE

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FRIDAY

JANUARY 18, 2013

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ROCKVILLE, MARYLAND

The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Harold B. Ray, Chairman, presiding.

COMMITTEE MEMBERS:

HAROLD B. RAY, Subcommittee Chairman

J. SAM ARMIJO, Member

DENNIS C. BLEY, Member

DANA A. POWERS, Member

MICHAEL T. RYAN, Member

STEPHEN P. SCHULTZ, Member

WILLIAM J. SHACK, Member

JOHN W. STETKAR, Member

NRC STAFF PRESENT:

PETER WEN, Designated Federal Official

WILLIAM HINZE, Consultant

NILESH CHOKSHI, NRO

STEPHANIE DEVLIN, NRO

VLADIMIR GRAIZER, NRO

DONALD HABIB, NRO

MOHAMED SHAMS, NRO

VAUGHN THOMAS, NRO

BRET TEGELER, NRO

ALSO PRESENT:

ROBERT KITCHEN, PEF

A.K. SINGH, S&L

ROBERT YOUNGS, AMEC

A G E N D A

P R O C E E D I N G S

8:31:11 a.m.

CHAIRMAN RAY: The meeting will now come to order. This is a meeting of the ACRS AP 1000 Subcommittee. I am Harold Ray, Chairman of the Subcommittee.

The ACRS Members in attendance are -- I have a list here but I can see I think we've been joined by others, Steve Schultz, Dana Powers, Sam Armijo, Dennis Bley, John Stetkar, Mike Ryan, Bill Shack, and we have as our consultant to the Subcommittee our friend, Dr. Bill Hinze. Peter Wen is the Designated Federal Official. Excuse me, I lost my place here.

I did because I wanted to elaborate a little bit on the purpose of this meeting since it's a meeting that's a little different than we normally would anticipate in which we're in the process of reviewing an application or an amendment of some kind.

The purpose of this meeting, to now quote from Staff discussion, is to review in this case Progress Energy of Florida's response to the request of the NRC for an evaluation of seismic hazards at the Levy Nuclear Plant site using current NRC requirements and guidance and, if necessary, to update the design basis and the structures, systems, and components important to safety to provide protection from seismic hazards.

The regulations and guidance originate in the Near-Term Task Force Recommendation 2.1 to reevaluate seismic hazards at operating reactor sites to acquire information to facilitate NRC's determination if there's a need to update the design basis, and to collect the information to bring Generic Issue 199 to resolution. The Staff has made the requirements of Near-Term Task Force Recommendation also applicable, therefore, to sites under evaluation for new nuclear power licenses and, thus, we'll begin that process here today.

The Office of New Reactors NRC has requested that Progress Energy provide additional information on the site and reactor plant design concerning implementation of the Near-Term Task Force recommendations. The review report is limited to the seismic portion of those recommendations.

With that then I'll resume the usual recital of our process. We're going to gather information, analyze relevant issues and facts and formulate a proposed position and action as appropriate for deliberation by the Full Committee. I will say there is at this point on the part of the Subcommittee Chairman, at least, no intent or need that I can see for a letter from the Committee on this subject at this time. I've asked the Staff if there's any desire on their part and they'll advise us of that.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register, and we've received no written comments or request for time to make oral statements from members of the public regarding today's meeting.

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

I'm advised we have several people on the phone bridge line listening to the discussion. To preclude interruption of the meeting the phone line is being placed in the listen-in mode, and we will, of course, open the line prior to the conclusion of the meeting.

We'll now proceed with the meeting. And I'd first like to turn to the Project Manager and the Staff, Don Habib, to see if he has any comments at this time. Don?

MR. HABIB: We don't have any comments at this time. Thank you.

CHAIRMAN RAY: All right. Then we will go ahead with Mr. Robert Kitchen of Progress Energy. We'll ask them to take their places before us.

You'll all note that there's a parenthetical Duke Energy, and Duke Energy logos and so on on the presentations. I'm informed it's satisfactory for us to refer to the Applicant still as Progress Energy, and we'll do so. It's your's.

MR. KITCHEN: Good morning, sir.

CHAIRMAN RAY: Good morning.

MR. KITCHEN: I'm Bob Kitchen with Duke Energy, and I'll explain that. We are Progress Energy Florida is the Applicant, but in July of 2012 Progress Energy and Duke Energy merged so now we are still as an Applicant Progress Energy Florida, but we are part of the Duke Energy Corporation, so that's why you see all the logos, et cetera. And you can see on the slide here the territory significantly expanded. In addition to Florida we, of course, have plants in the Carolinas as well as Kentucky, Indiana and Ohio. So, that's the Duke Energy-Progress Energy Florida story.

We're going to talk through, as Mr. Ray indicated, and update the Committee on what we've done to comply with Central and Eastern U.S. seismic update. We'll start -- I'm going to go back and just review where we were, what we talked about the last time.

We talked to the ACRS Committee, actually the last Subcommittee in October 2011 and the Full Committee in December, so we're happy to be back and have an opportunity here to talk to you again.

I have assisting -- actually, the main part of the presentation today will be Dr. Bob Youngs. Bob has been a key member of the EPRI Committee that developed the model for Central and Eastern U.S., and has helped us through the evaluation for Florida. Also have Dr. A.K. Singh who's Vice President of Nuclear Technology with Sargent & Lundy, and A.K. will discuss all the implications or the findings and what they mean in terms of Levy application and design.

The last item on here is really not related to Central-Eastern U.S., but we'll talk a little bit more to clarify, Mr. Ray, some discussion we had on the grout program last time just to make sure it's clear to the Committee what we were trying to communicate, so we'll go through that.

CHAIRMAN RAY: Okay. And did I read that there's been some modification from what we were --

MR. KITCHEN: No, sir.

CHAIRMAN RAY: None.

MR. KITCHEN: And that's the clarification. We're not changing anything.

CHAIRMAN RAY: Okay.

MR. KITCHEN: But we want to make sure that it was clear how we're doing that.

CHAIRMAN RAY: All right.

MR. KITCHEN: As Mr. Ray outlined already, the purpose here is actually our response to the Request for Additional Information. Being an applicant and not a license holder, of course, we didn't get an order or request for information, we got an RAI that we responded to. And that was part of the Fukushima response specifically on the seismic to update the --- evaluate against the current NRC guidance which, of course, is the Central-Eastern U.S. Seismic Update. And then, if necessary, identify what changes we were making in the design application. And I will say that our conclusion is that there are none.

Just to back up a little bit so we're all on the same page, what we told you a year and a half ago, I guess, or a year ago. We -- what we did in our original Final Safety Analysis Report that the Committee reviewed, we used the updated EPRI Seismic Owner's Group model that was updated through December 2006. We used the EPRI 2004-2006 Attenuation Model. We also in that evaluation applied the Updated Charleston Seismic Source which was described in Vogtle Early Site Permit. And there had been some seismic activity in the Gulf of Mexico, we incorporated that in the model. And we also used the CAV or Cumulative Absolute Velocity filter for the evaluation of the Uniform Hazard In-Ground Motion Response Spectra.

That's the inputs and the approach that we took in our original FSAR. However, the conclusions that we discussed with the Committee, the biggest contributor was the Charleston Source which was as events from the updated source as described in Vogtle ESP.

There was a question from the Committee when we talked last time about well, what about the 2008 update from Charleston Source? So, we went back and looked at that, and came back and updated the Committee with that. We determined that, in fact, the evaluation -- what we used in the evaluation was, in fact, closer to the site than 2008 source, so that was conservative and didn't need to be adjusted.

The bottom line is all the spectra that we looked at, ground motion response spectra, the performance-based seismic response spectra, the foundation input response spectra were all enveloped by the certified design.

CHAIRMAN RAY: Let me pause for a second, Bob, and let me say I want to encourage -- we have enough time, I think, here given the restricted subject matter to ask questions as we go so that we're not trying to backtrack later, and we don't have Action Items left over that we can clarify at this time.

And, also, some of the aims that we have here which may or may not get fully satisfied is to have a clear record as to the basis for the conclusion that we reach. Even if we have already read ahead to the end and decided what the end result is, there is a need to make sure that the way we got to this conclusion that Bob just referred to is clear enough. So, sometimes we may ask for things or ask about things to get them on the record where we don't feel there's a good enough record at this point in time, but merely for that reason, as well. And I ask any of my colleagues and our consultant to weigh in in that respect. Go ahead.

MR. KITCHEN: Okay. Thank you, sir.

The last point I want to make, this is just a graphical of the Levy site location and the surrounding seismic activity record. And really the point here is it's a very low seismic region. I think everybody already understands that. But I also want to say that doesn't affect the type of evaluation, the rigor evaluation. There's very significant effort to go back both from our standpoint and for the Staff in terms of review. It's really going back to re-evaluate completely. It took us the better part of 10 months to get to this point, so it's not an insignificant review; even though, as I mentioned, it's a very low seismic area.

CONSULTANT HINZE: Before you change that, if I may ask, what are we looking at here? Is this the CEUS SSC database? I notice that you have added historical. What does that mean?

MR. KITCHEN: Well, go ahead, Bob.

DR. YOUNGS: So, this is actually the figure from the application, so this is the updated EPRI-SOG catalogue that's in the application. It goes through 2006. And the -- what is termed "historical" means it's pre-instrumental earthquakes.

CONSULTANT HINZE: And those were added beyond the EPRI-SOG update?

DR. YOUNGS: Oh, they were-- that's what I'm seeing here. They were added in -- they were added as a part of the EPRI-SOG update, so they were evaluated, so they were information that was not included in the EPRI-SOG catalogue that were coming from other sources. For instance, a number of these are up in the area south of Tennessee where Jeff Munsey had done some research on -- looking for earthquake information in historical records, primarily newspaper reports. So, he had developed a catalogue of additional earthquakes that were included as a part of the EPRI-SOG update in the original application.

CONSULTANT HINZE: How would this differ from the seismic catalogue expression that you prepared for CEUS SSC?

DR. YOUNGS: So, those earthquakes would have been included in the CEUS SSC catalogue.

CONSULTANT HINZE: And how would it -- how would this map different from that?

DR. YOUNGS: That map would differ in that the magnitude scale would be slightly different, as I'll get into in my discussion. The magnitude scale presented on this plot is in terms of body wave magnitude, because that was the catalogue -- the way the catalogue was developed for EPRI-SOG and the update of EPRI-SOG. And in the CEUS SSC model that catalogue was converted to moment magnitude, so the magnitude scale will change a little bit on the size of these figures.

CONSULTANT HINZE: Both up and down.

DR. YOUNGS: Both -- primarily down a little bit because the moment magnitudes are typically a little bit smaller than the body wave magnitudes.

CONSULTANT HINZE: If some --

DR. YOUNGS: But not -- other than that, I would say the catalogue -- the figure would look fairly similar.

CONSULTANT HINZE: Are there any additional earthquake epicenters that are on the CEUS catalogue that aren't on this map?

DR. YOUNGS: I don't know for sure whether there are or aren't. But the -- as we will get into, the rate of activity is based on the updated catalogue is lower than the rate based on the old catalogue.

CONSULTANT HINZE: At some frequencies.

DR. YOUNGS: At the frequencies of interest for our calculations, yes.

CONSULTANT HINZE: How could I compare the CEUS and this map epicenter? Is there some way that I can determine whether there are additional epicenters that are not -- I mean, we're interested in such things as epicenters occurring on faults, and if there are any other epicenters we're interested in looking at those.

DR. YOUNGS: You would have to just make a plot of the two catalogues on top of each other.

CONSULTANT HINZE: You've never done that for this?

DR. YOUNGS: I haven't done that for this.

CONSULTANT HINZE: Okay, thank you.

MR. KITCHEN: All right. We're going to move to --

CHAIRMAN RAY: Just one last thing. You haven't done it for this because?

DR. YOUNGS: Because the -- well, the evaluation of the CEUS model used a catalogue that was -- primarily the basis of that catalogue had all the earthquakes in it that were in the EPRI-SOG catalogue. And there wasn't -- hasn't been any activity in the last two years of any note down in Florida, so we didn't go back through and re-evaluate whether there were minor changes in the location of particular earthquakes between the two catalogues.

CHAIRMAN RAY: Okay. So, in infer that if you added the additional information it would only have a minor effect in your judgment?

DR. YOUNGS: In terms of making a plot of the location of epicenters, yes.

MR. KITCHEN: Do you have any other questions before we move on? Okay. As you can tell, Bob is going to be the presenter of our review here, so we'll go ahead and start into that. And most of the presentation is this, so Bob.

DR. YOUNGS: Good morning, Mr. Chairman and Members. I'm Bob Youngs from AMEC, and I was consultant to Progress on developing the calculations for applying the model to the site. So, what I'm going to be presenting this morning is a summary of the seismic hazard analysis calculations done for the LNP site using the CEUS SCC model, which I'll explain what all the acronyms mean.

So, the outline of my talk is basically a summary -- a brief summary of that model, and then a discussion of the hard rock hazard results for the LNP site using this new model, and then a comparison of the ground motion response spectra, the surface performance-based response spectra, or PBSRS and the foundation input response factor or FIRS, which are based on that model, and comparison of those spectra with spectra that are in the application based on the updated EPRI-SOG model.

So, the CEUS SSC model which stands for Central and Eastern United States Seismic Source Characterization model was developed as a study that was jointly sponsored by EPRI, the U.S. Department of Energy, and US NRC. And, again, the acronym is the Seismic Source Characterization model for the Central U.S., Eastern United States. It was published as a NUREG, NUREG-2115, and the model -- it was intended as a replacement for the EPRI-SOG model that was finished in 1989.

And the study was conducted as a Senior Seismic Hazard Analysis Committee, SSHAC Committee Level 3 study, which basically means that it was led by a technical integration team to put the model together, and it had all through the project a participatory peer review panel that watched over the process and the evaluations from start to finish rather than waiting to the end to review. So, it was reviewed constantly through the process.

And the overall intent of a SSHAC process is to, as indicated here, is to represent the center body and range of technical defensible interpretations of available data, models, and methods for characterizing future seismic activity. So, that was the intent of this model, to basically replace the old model which was conducted prior to the SSHAC guidelines, but was essentially a SSHAC-type process. It was a multi-expert process, EPRI-SOG in 1989 to capture uncertainty, and the guidelines became formalized in the SSHAC process in the `90s. And that was the process applied for this study.

There were some important developments going through the model that came out of the development of the new overall source model. First, and very importantly is we updated the catalogue through the year 2008. The important differences between this catalogue and the EPRI-SOG catalogue is that the earthquake size was redefined in terms of moment magnitude. And the reason for that redefinition is that most ground motion models were predicting the level of shaking in the world, but in particular in the Eastern United States used moment magnitude as the magnitude scale. So, there was always the -- for applications there was always the question of how to convert between the EPRI-SOG model which predicted earthquakes in terms of MB rates, and then you had to convert to do ground motion calculations in terms of moment magnitude. Now, the catalogues were made consistent and the earthquake rates were made consistent with the ground motion models. And that was an extensive effort, and required some development of new conversion relationships to moment magnitudes from other size measures.

Then the second important component was the updated seismic source representations. The EPRI-SOG model had multiple sets of small source zones and large source zones, and this was simplified to a large extent in the new model where we had developed alternative regional source zones to represent distributed seismicity. And then through the recent studies, a number of places have been identified where from the paleoseismic record that there -- repeated large magnitude earthquakes have happened in the past, and those were explicitly modeled as what we call RLME sources, or Repeated Large Magnitude Earthquake sources.

In terms of assessing the evaluations on earthquake recurrence rates, the method used to account for the effect of magnitude uncertainty in assessing earthquake recurrence rates, updated that from a previous procedure that had been developed as part of EPRI-SOG, and improved the characterization of the spatial distribution of recurrence parameters. And, in particular, representing their uncertainty in the model, which was not well captured I think in EPRI-SOG as well as it is captured in the new model.

And fourth was the assessment of maximum magnitude. Maximum magnitude assessment has always been a rather difficult process, and in EPRI-SOG it was primarily based on judgment of the participants of that team. And in the new model we attempted to basically apply more statistical approaches to assessing the maximum magnitude. So, as a part of that process we updated the catalogue of Stable Continental Regions, or SCR, so called SCR earthquakes from a previous catalogue developed by EPRI in 1994.

We used a Bayesian approach that was developed in the 1994 EPRI study by Johnson, et al to estimate maximum magnitude for the source zones, but we updated from that older study with the new information to produce what are prior distributions on maximum magnitude from this worldwide database of Stable Continental Regions or SCR earthquakes.

And then there was another statistical

method that has been proposed for estimating maximum magnitude by Andreas Kijko, which was published in 2000. And that has some applicability in zones where there's enough earthquakes to use it, so we used that where it was possible to use. So, we used more statistical methods for estimating maximum magnitude. So, those are the main points of sort of developments in the development of the CEUS SSC model.

CONSULTANT HINZE: Bob, is there any way to evaluate how good this model is?

DR. YOUNGS: Good? Typically, those evaluations are done by comparisons with some period of recorded history, so I think the -- it was not developed by taking like a training catalogue where you would take say the first half of the century and then try to predict the second half of the century. The problem with that is that the -- we've been going through a whole series of conversions through time and the catalogue rates are based on a time variable completeness.

I would say it's difficult to evaluate -- very difficult to evaluate it now. It will probably be easier to make evaluations as time goes on to see whether we are seeing differences in the rate predictions. I would say, for instance, networks are now more stable in terms of magnitude assessment so that we should be able -- not have to worry about magnitude complete evaluations.

CONSULTANT HINZE: How well did EPRI-SOG do, because we've got a 25-year time history.

DR. YOUNGS: I don't -- well, I know in comparisons with a number of plants that I've worked on in evaluation of the rate of activity -- for instance, when we did the evaluation of the update of the seismicity catalogue, what effect did it have on the EPRI-SOG model? We typically -- what we did was we would take the predicted rates for the period of time based on the original EPRI-SOG catalogue, and then for that catalogue updated through 2006. And, typically, we found that in the few -- in the sites that I looked at that EPRI-SOG produced a higher rate of activity than we saw post 1984. And as we will see here, it also is the case. So, EPRI-SOG was -- in those cases was predicting a little bit higher rate in some places than the updated catalogue would be, but whether that's a really -- I mean, the rate wasn't tremendously higher, but it was higher.

CONSULTANT HINZE: Was this both --

DR. YOUNGS: But I would say -- but EPRI-SOG also had lower Mmax, but those are more evaluation comparisons of a methodology as opposed to a hard definition of is the hazard really different from what was predicted.

CONSULTANT HINZE: Yes, right.

DR. YOUNGS: And, to me, that really requires some time of seeing whether the rates of predicted earthquakes come -- whether the actual rate of earthquakes falls within the predictions of the model.

CONSULTANT HINZE: Thanks very much.

DR. YOUNGS: I mean, there are people who have proposed that's evaluation processes of hazard, but they're usually based on some time period of comparison of what the model predicts versus what happens in the period after that.

CONSULTANT HINZE: Thank you.

MEMBER SHACK: How consistent were your distributions that you got from the Bayesian approach and the statistical approach when they were sort of ––

DR. YOUNGS: From Kijko?

MEMBER SHACK: Yes.

DR. YOUNGS: Typically, the Bayesian approach produced higher -- they were not the same shape. In a few places they were, but typically the Kijko statistical approach predicts somewhat lower maximum magnitude distributions than the Bayesian approach.

MEMBER BLEY: Do you know why? Are you going to show us comparisons of --

DR. YOUNGS: No, I wasn't going to show you.

MEMBER BLEY: Okay.

DR. YOUNGS: It's -- the shape of the Kijko approach is driven by an exponential distribution which is, of course, biased towards low end of its prediction, so it's really -- the mode of that distribution is down on the low side of the range of possible maximum magnitudes; whereas, the Bayesian approach has a sort of -- we use a mean prior for the Bayesian approach. And the mean is typically up fairly high. And then we -- for the Bayesian approach then we use a likelihood function to modify the Bayesian based on what's observed, and that likelihood function has a shape that's fairly similar to the Kijko distribution, so it's peaked at the low end. So, if there's a fair number of earthquakes, the Kijko approach will always be shifted down to the exponential shape; whereas, in the Bayesian approach the -- you start off with a normal let's say of mean around 7-1/4, and then you gradually modify that as the number of earthquakes gets large. So, if the number of earthquakes was very large then I would say they would produce very similar answers. But if the number of earthquakes are very small, then typically the Kijko approach would produce a very small -- an estimate that's much smaller than the Bayesian. But often we wouldn't use it because it wouldn't have enough earthquakes to actually be useable.

MEMBER BLEY: Is there any good justification for either that prior you described or the Kijko distribution?

DR. YOUNGS: The prior is based on what we've seen around the world in stable continental regions as the largest events in the -- that have occurred in similar types of crust. That is it's only justification.

MEMBER BLEY: That's not bad. How about the Kijko one?

DR. YOUNGS: The Kijko is based on the basic concept that earthquakes are exponentially distributed in size.

MEMBER BLEY: Okay.

DR. YOUNGS: And that -- which is also an observable fact. And then it just -- you have to have -- and then it's just working through with that basic information to develop a statistical model. But in order for it to be able to -- I mean, as Kijko himself talks about, in order for it to be useable or provide some meaningful information you need a fair amount of earthquakes in your zone to apply it. So, basically, what we would evaluate was whether in the details of the model we basically -- Kijko gives you a way to assess the uncertainty in his estimate, and with what he called a fiduciary distribution. And, basically, the distribution of maximum magnitude he would predict would come up and level off at some probability level. And, basically, it would become unbounded. There's a certain probability that the maximum magnitude would be very large and his method would not give you any particular answer. And if that probability was large then we felt that the method was not useable.

MEMBER BLEY: Okay.

MEMBER SCHULTZ: And is that what that means in the --

DR. YOUNGS: The last sentence, so in --

MEMBER SCHULTZ: That was the applicability.

DR. YOUNGS: That was the applicability. We evaluated whether we should wait -- basically, we developed with a weighting scheme between the Bayesian approach and the Kijko approach that was based on the fiduciary distribution from Kijko method. And if he predicted 50 percent probability or greater that the earthquake was basically some very large number, we felt his method was not useable. And as that probability got smaller and smaller then we gave more weight to his method.

MEMBER POWERS: So, if you didn't like the answer you didn't use it. That's what you said.

DR. YOUNGS: Yes. I mean, basically, his method would say I don't have -- the statistical method doesn't give me an answer that's useable.

MEMBER POWERS: That you didn't want to use.

DR. YOUNGS: Oh, I -- that the earth -- maximum magnitude is unbounded, yes. And we know from physics that the maximum magnitude is bounded. Cannot have a magnitude 12.

MEMBER POWERS: It's not the 12 that is concerning, it's the 9.2 that's concerning.

DR. YOUNGS: For a -- there was an assessment made in the study that within stable continental regions that earthquakes would be limited to size of 8-1/4, and that was the -- so, that was the additional piece of information we're using to evaluate whether the Kijko method would give us an answer that was useable.

MEMBER POWERS: So, it's really that assessment --

DR. YOUNGS: It's really that assessment that controls.

MEMBER POWERS: -- that's the issue of concern. How did you come to that conclusion?

DR. YOUNGS: That was based on looking at what's been seen in stable continental regions around the world. And the fact -- to get something like the 9, you would need a huge rupture surface such as you only see on subduction zone interfaces.

MEMBER POWERS: Okay.

MEMBER SHACK: But that's built into the CEUS model, that's not peculiar to the Levy --

DR. YOUNGS: No, it's built into the CEUS model that the maximum magnitude anywhere in that model is limited to 8-1/4.

CHAIRMAN RAY: Okay.

DR. YOUNGS: Brief overview of what the model looks like, map view. So, as indicated there are two types of seismic sources included in the model. One is what we call source zones which are zones used to model distributed seismicity throughout the Central and Eastern United States. So, this model basically allows for earthquakes to occur anywhere in the area. There are no holes in the model. So, the source zones, there are two types, or two bases for the definition of what the source zone boundaries are. The first is what we call seismotectonic source zones, and that -- for those zones the zonation is based on differences in geology and tectonic history of portions of the crust in the Eastern United States, Central and Eastern United States.

And then a second type of zone are what we call Mmax zones. And in this case we -- the basic evaluation is that the only real difference between different parts of the Eastern United States is how large the maximum magnitude might get. And, therefore, only two zones as I'll show were defined based on that.

And then as the other type of source were what we call the RLME sources, the sources, the Repeated Large Magnitude Earthquakes where we - based on paleoseismic information we now know that the repeated large events have occurred in a relatively narrow or small geographic region. In some cases they're identified with features, in some cases they're just a very small region where it seemed to be unrepeated. So, we've -- where 10 of those regions were identified and explicit models of repeated large earthquakes were put in those locations.

This shows a map of the seismic source zones, examples of them. There are multiple -- there are alternatives of these in terms of changes to the boundaries, but in general these two differentiate the type of sources.

On the left are the seismotech -- what we call seismotectonic sources, and here, again, the Eastern United States was broken into multiple regions based on differences in history and the tectonic process that formed it.

The site, the LNP site sits down in Northern Florida in the extended continental crust, Gulf Coast Margin Zone. And you can see some other zones to the north. You can see there's the zone -- the Reelfoot Rift Zone which encompasses New Madrid. There's the Eastern Coastal Margin, and then there's -- the Appalachians are under the Paleozoic Extended Zone. And on the right are the Mmax Zones, and that basically breaks the Central and Eastern United States into two regions, one which the crust is shown Mesozoic and younger extension, and one in which the crust has not undergone extension in that time period, so it's older non-Mesozoic extended crust. And that breakdown is the same breakdown that we developed in terms of evaluating the largest earthquakes we've seen around the globe in stable continental regions. They were basically broken into two groups, Mesozoic and younger crust which seem to have somewhat larger maximum events than non-Mesozoic and extended crust.

We also include a model in which the entire Eastern U.S. is just one zone with one Mmax, so that's an alternative of the Mmax zones that's included in the model.

CONSULTANT HINZE: What was the relative weighting of between the --

DR. YOUNGS: Well, Seismotectonic was given 60 percent weight, and Mmax zones were given 40 percent weight. It was felt that tectonic history and geology have some impact on the effect of what seismicity is doing in the Eastern United States, so that was why it was favored, but it wasn't strongly favored. We still don't really understand to a high degree what -- why earthquakes are occurring where they're occurring everywhere, so that's why it was not given a very high weight as you might give it in a region like California, where you would consider that you would have a much better understanding of what's driving the seismic activity.

Here is a map of the RLME sources. There were 10. They were modeled variously as faults or zones of faults, or with preferred orientations, or just zones depending on how much information was known about them. We had uncertainty distributions specified for the average magnitude of those events, again based largely on Paleoseismic data and the estimation of magnitude from that data, so those distributions were fairly broad. And then recurrence parameters were based on the Paleoseismic data itself, basically going back several thousands of years to estimate how frequently large events have occurred within the region.

The zone of interest, primary interest to the site is the Charleston RLME, so there was a Repeated Large Magnitude Earthquake source placed at Charleston. It had multiple geometries for how extensive that was which is shown here. That model was, in fact, very similar to the updated Charleston seismic source model that was developed as a part of the Vogtle application.

So, that's a very brief summary of the model. I mean, there's -- we can talk for hours about it, but I don't know if there are any more questions on the model itself.

So, the next part is to -- what the effect of the use of that model is at the site, so I'll go through the hard -- what we call the hard rock hazard which are basically the hazard computed directly with the EPRI 2004-2006 ground motion models. It represents the ground motions on an outcropping rock of velocity of 2.7 kilometers per second, so basically much harder than we see at the surface at this site, but it's the basic reference ground motion model that is used for hazard computations. So, for this model we've included those portions of the Central -- CEUS SCC model within 1,000 kilometers of LNP site because, I mean, beyond that the contributions from source zones diminish to the point of not being significant.

We included the Charleston RLME source because, again, it's about 250 or so kilometers from the site. We knew from the previous study it was a very important contributor. We also tested the New Madrid source to see whether it had any possible significance to the hazard here, largely because the New Madrid source is the largest source of RLME earthquakes, they're the largest source of specific earthquakes we know in the past, and it has a high rate. Even though it's about 800 and something kilometers from the site it has a fairly high rate, so we also wanted to test to see, to make sure that it was not significant.

We knew from other -- from the tests that were presented in the --

(Coughing.)

DR. YOUNGS: -- for the NUREG-2115 where they had done work -- calculations at Chattanooga and had found that none of the other RLME sources had any significant contribution at Chattanooga, so being much further south from Chattanooga and further away from those sources, we knew that they would not contribute at the LNP site. And, as I said, the model -- the calculations were done using the EPRI 2004-2006 ground motion models, which were the models that were used in the calculations for the LNP application.

CONSULTANT HINZE: Bob, would you tell us about the use of the Gulf Coast version of the models, of the ground motion models?

DR. YOUNGS: Okay, yes. So, the EPRI-SOG 2004, sorry, the EPRI 2004-2006 model developed two sets of equations for calculation of the -- of ground motions. One -- and this was based on earlier work by EPRI in 1993.

The main portion of the Central and

Eastern United States is defined what we call the Mid-Continent Model, which basically means that there aren't any differences or aren't any -- not that there aren't any differences, there aren't any significant differences in predicting ground motion based on differences in crustal properties across that broad region of the Central and Eastern United States. But they were an evaluation -- down in the Gulf Coast region that the rate of attenuation of ground motions was higher than in the Mid-Continent, such that ground motions fell off or attenuated more rapidly with distance. So, EPRI 2004 developed a separate set of ground motion relationships for the Gulf Coast region. So, if we go back one slide, no, go back one more, there, that's good.

So -- and the Gulf Coast Region is not coincident but fairly similar in shape to the Eastern -- the Extended Continental Crust Gulf Coast Source Zone shown on this figure, on Figure 12, the ECC-GC zone, and the GHEC. So, basically, the region down in the Gulf of Mexico and along the Gulf Coast based on observing the data that was available in 1993 primarily displayed a higher rate of attenuation of ground motion with distance than in the Mid-Continent. So, they developed a separate set of equations for that region.

So, in our application, our calculations for the hazard at the site, because it sits down within this Gulf Coast region, we used the Gulf Coast models for all -- for the sources that are in the immediate vicinity of the site, but for the Charleston source because the path is -- that path from Charleston to the LNP is partly Gulf Coast and partly Mid-Continent, and it's about half and half, we used the Mid-Continent model for that region.

So, the EPRI ground motions in 2004 don't provide you a way to do ground motion calculation wherein you have half path in the Mid-Continent and half path in the Gulf. So, the person doing the evaluation has to make usually a choice of which ones to use. So, for the cases where there was a significant portion of the path through the Mid-Continent, we used the Mid-Continent model which would produce higher hazard, so that's what we used for Charleston.

CONSULTANT HINZE: You used that for Houston, and Jackson in your sensitivity --

DR. YOUNGS: In the sensitivity studies they were used for Houston and Jackson for most of the sources around Houston and Jackson, yes.

CONSULTANT HINZE: But not the Savannah. Why didn't you use it for the Savannah?

DR. YOUNGS: The Savannah sits outside of the Gulf Coast region.

CONSULTANT HINZE: Barely, yes.

DR. YOUNGS: Barely outside, but the hazard from Savannah is coming from the Northeast, from Charleston, so it would be coming through Mid-Continent crust. So, our evaluations here use Gulf Coast for the source zones that were in the immediate vicinity of the site. We used Mid-Continent for Charleston because it was coming primarily or at least halfway through the Mid-Continent crust, so we used the Mid-Continent model for that. For New Madrid we used the Gulf Coast model because most of the path is through the Gulf Coast region.

CONSULTANT HINZE: Thank you.

DR. YOUNGS: So, this is a basic comparison of the rock hazard results at the site computed using the two models. This -- on the left we have 10 hertz spectral acceleration, and on the right 1 hertz spectral acceleration. And what are shown on this plot is the mean hazard shown by the red curves, the 16th percentile hazard shown by the blue curves, and the 84th percentile hazard shown by the green curves. And the 16^{th} and 84^{th} represent the uncertainty distribution on the hazard coming from all the alternative components of the model and their weights assigned to them. But a primary focus for the analysis is the mean hazard. That's what's used for ultimately developing the site ground motions.

MEMBER STETKAR: Bob, the mean is typically derived from the uncertainty distribution and these two uncertainty distributions if you're not used to looking at them are very different. On the right-hand side the uncertainty increases as the frequency decreases which is typically what we see because of the lower amount of evidence available, and weights that are assigned to things and so forth. So, for example, if I look at the right end of the right-side distribution I see about a range of roughly 50 between the 16^{th} percentile and the 84^{th} percentile. On the lefthand side the uncertainty basically doesn't change over a very, very broad range of frequencies. I see about a factor of 10 over a very, very broad range of recurrence frequencies. Why is that?

DR. YOUNGS: The 1 hertz motion is more sensitive to maximum magnitude than the 10 hertz motion.

MEMBER STETKAR: So, your decision -- which of those little statistical models you select could have a large effect. Is that true?

DR. YOUNGS: It could have a large -- it has an effect on portions of that model, but at this site the 1 hertz hazard is controlled by Charleston. So, as we'll see on the subsequent slide, so the uncertainty distributions or maximum magnitude do have a larger effect on the hazard from the distributed seismicity sources than they -- but not on -- but they were not used for assessment of the magnitudes associated with the RLMEs. They were directly assessed based on the Paleoseismic records. So, we get to the next slide I can probably get more into that.

MEMBER STETKAR: Okay.

DR. YOUNGS: But if we go back to -- but I will get into that. So, it's primarily the -- on the left the 10 hertz is driven more by rate, and the magnitudes that are affecting that hazard are not at the upper end of the distribution. They are -- and that's true as long as the distribution already has a fairly high center, so it becomes less sensitive to the result than if -- if the maximum magnitudes were say 4, I mean near 5 versus near 7, then you would see a high sensitivity to maximum magnitude in the 10 hertz. But if the distribution -- for instance, the distribution for the local source zone is very broad centered around 7, so once you have a significant weight at a large maximum magnitude then the hazard at 10 hertz becomes less sensitive to what the actual value is because it's driven by the rates of magnitudes 5 and 6.

MEMBER STETKAR: Yes, I hear what you're saying.

DR. YOUNGS: Okay. But at 1 hertz, because the ground motion models, or ground motion amplitude are much at low frequency it's much more sensitive to magnitude than at high frequency, or is more sensitive. Then maximum magnitude comes into play more in the assessment there and, therefore, the distribution starts to see maximum magnitude more and broadens out.

MEMBER STETKAR: All right. Okay, thanks. I'll have to think about that. Thanks.

DR. YOUNGS: So, on this you can see that the -- on the left the 10 hertz -- so, the solid curves are the hazard calculated from the updated EPRI-SOG model that was used in the -- deriving the ground motions for the valuation of the site, so that's basically a model, again as has been described in the past, is a model based on EPRI-SOG study which calculates rates into earthquake rates in terms of MB magnitudes. And then converts them to moment magnitude for ground motion calculations, including some uncertainty in that conversion. And then the dash curves are based on the updated EPRI or the CEUS SSC model which calculates ground rates of earthquakes directly in moment magnitude rate, so the uncertainty in the conversion is done as a part of the rate calculation as opposed to subsequent in the hazard calculation. And then magnitudes are -- everything is defined in moment magnitude.

So, on the left you can see that the mean hazard from the updated model of the CEUS SSC model is a little bit lower than the hazard from the EPRI-SOG model in the important range of 10 to the minus 4 to 10 to the minus 5. And the uncertainties are about the same.

And on the right, again, the mean hazard is about -- is very close to what we got from the EPRI-SOG -- updated EPRI-SOG model, and the distributions are, again, roughly about the same.

You can see that the 5th percentile distribution as you get to very low probability is higher now from the CEUS SSC model than it was from the EPRI-SOG model, and that's primarily I think an effect of maximum magnitude. The maximum magnitudes are higher in this model and, therefore, it's not tailing off as fast as the old EPRI-SOG model at the very low probability, and at the low percentile of the distribution.

MEMBER STETKAR: You said 5^{th} percentile, you mean --

DR. YOUNGS: Yes, well --

MEMBER STETKAR: 16^{th} percentile, or something like that.

DR. YOUNGS: Yes. I often should do this in the 5^{th} percentile, too, it's even more pronounced.

MEMBER STETKAR: Right.

DR. YOUNGS: I can't see that far, anyway. So, this -- that will be good. I lost my glasses and I haven't got them replaced yet. It's only been a year and a half.

So, this breaks down the -- this plot is the -- shows now the mean hazard but now is breaking it down into the contributors from the main components of the model. So, the solid red lines are again the same lines as from the previous plot. The green line now shows the hazard from the distributed seismicity sources, basically things that are not attached to a particular feature or region, so that would be all of the EPRI-SOG -- the solid green lines would be all of the EPRI-SOG source zones, the dashed green lines are all of the CEUS SSC source zones. On the left again is 10 hertz, and on the right again is 1 hertz.

If you look at the -- on the left at the 10 hertz model you can see that the green dashed line is lower than the green solid lines. Basically, we're predicting lower hazard at 10 hertz from the new model from all these distributed seismicity than from the old model, and that is primarily due to a difference in the predicted rate of earthquakes. The new model predicts in terms of rate of moment magnitude earthquakes above 5, a lower rate than the old model. And then the blue curves is the hazard from the Charleston RLME, and as you can see it's basically the same, and that's because the model that is in the CEUS SSC model for the Charleston RLME is very similar to the model that was -- the updated Charleston seismic source that was part of the Vogtle model. So, the hazard from that source is basically the same in the new and old model. And you can -- also shown by the purple curve is what the New Madrid contributes to the site hazard which is extremely low because of its large distance, and the fact that most of the path is through the Gulf Coast region, Gulf Coast Site

Attenuation Region.

We go to the -- sorry, go back. We go to the right-hand plot, we look at the -- this is now the hazard at 1 hertz, and you can see that the green curve, the green dashed curve which is from the new model, the CEUS SSC model, is now higher than the EPRI-SOG model, the old distributed seismicity source. So, we're now getting higher hazard from distributed seismicity than we were getting from -- in the new model than compared to the old model. And that's primarily an effect of maximum magnitude. The new model has higher maximum magnitudes than the old model so it allows for earthquakes to contribute to the hazard that were assumed to not occur or have very low rate occurrence in the old model.

So, the distributed seismicity hazard has gone up at 1 hertz, but the reason the site hazard or the red curve has not changed is because the 1 hertz hazard is controlled by Charleston, and the Charleston models are essentially the same. So, in aggregate the effect on the site of higher distributed seismicity hazard is minimal.

So, this slide just summarizes those conclusions. The hazard for 10 hertz is lower for the new model because the predicted frequency of earthquakes is lower. And the hazard at 1 hertz from distributed seismicity is higher because of higher Mmax, but the hazard, the total hazard at 1 hertz is essentially the same because it's coming from Charleston and the models are essentially the same for Charleston.

CHAIRMAN RAY: There's a lot of discussion I think about Charleston orientation and the weighting given to two different orientations and so on. The record I think is pretty clear on that. They've taken a conservative assumption there, so I don't know if you want to comment on that at all.

DR. YOUNGS: Well, there are issues with how to model the Charleston source, and they're very important if you're very close to it. But the further you get away from it, the less they become because ground motions are calculated with the log of distance. So, differences of 10 kilometers at 200 kilometers, the difference in the logs is pretty minimal. So, that's why a lot of those issues are very important for making the calculation at Savannah but they're not important in making the calculation at Levy.

So, this is a comparison of the rock, a uniform hazard response spectrum at the site calculated. Again, the solid curves are calculated with the updated EPRI-SOG model from 10 to the minus 3 to 10 to the minus 6 from bottom to top, and the dashed curves are calculated using the CEUS SSC model. So, again, the high frequency motions above say 2 or 3 hertz, the hazard from the new model is lower than the old model, and that's primarily due to the fact that we have lower -- a predicted lower rate of activity. And as you get down to the low end of the spectrum the hazard is essentially the same because the Charleston source is controlling that and the rates are basically -- the model is basically the same.

So, then now we need to go take the rock hazard and translate it up to the levels of interest for evaluation of the site. So, there are three sets of spectra that we compute for that, one is the ground motion response spectra or GMRS which is defined at the elevation of the first competent layer, and it's basically the sort of reference ground motion for the site evaluation. Then a more detailed evaluation of the actual -- of facilities, the structures you need two other spectrum, one is the performance-based surface response spectrum or PBSRS, which is calculated at the plant finish grade and related to those are the foundation input response spectra or FIRS, which are calculated at the reactor foundation level. So, those calculations were repeated using the results of the hard rock hazard based on the CEUS model for comparison with the calculations that were done using updated EPRI-SOG model.

For the GMRS, PBSRS and FIRS calculations based on the new CEUS model we applied the EPRI-SOG cumulative absolute velocity model but we applied it using only magnitudes below 5-1/2 based on the new requirements from the Staff in terms of applying the CAV model.

CONSULTANT HINZE: Did that assume that the 75 feet below the map was crowded?

DR. YOUNGS: We did not use the grout. The grout did not affect it. In the evaluations that were done at the site it was determined that the grouting would not have any significant impact on the velocities, the shear wave velocity of the material so it did not -- the grouting did not impact the calculation of the FIRS.

CONSULTANT HINZE: Okay. How was that determined that there was no difference?

DR. YOUNGS: I think they did --

DR. SINGH: We measured -- we had a test

grout area where actually grouted using procedures we intend to use for the actual plant construction, and we measured shear wave velocities after grouting.

CONSULTANT HINZE: But did this change at all with the percentage of grouting, you know, in void space that was in there? You assumed -- what did you do, just do the grout, or did you do an area that you grouted?

DR. SINGH: The area which we grouted.

CONSULTANT HINZE: And --

DR. SINGH: The difference was minimal. All it says is that the amount of cracks or voids in the rock are very small which didn't make any difference relative to the overall velocities, and that is all documented in the FSAR.

CONSULTANT HINZE: Thank you.

DR. YOUNGS: And the velocity -- the travel path would be through the fast path.

CONSULTANT HINZE: Yes, right.

DR. YOUNGS: So, it would -- so with few voids it would -- the shear wave velocity measurer wouldn't see them. If you filled them in you still wouldn't see them.

CONSULTANT HINZE: And it also depends upon how well the grout takes.

DR. YOUNGS: Yes.

DR. SINGH: And the other issue is the grouting is done underneath the nuclear island which is about 200 feet by 300 feet; whereas, the whole site when you talk about the seismic wave propagation you've got to look at a much bigger area. And those are not being --

CONSULTANT HINZE: Right.

DR. YOUNGS: So, as I said, the -- for this new calculation of the GMRS, PBSRS and FIRS we applied the CAV model only to magnitudes below 5-1/2; whereas, in the calculation of the hazard using -- the spectra using the updated EPRI-SOG model, the EPRI CAV model was applied to all magnitudes.

So, we go the next few slides, basically we get to the final result. This is a comparison of -- the left is the PBSRS comparison of the model and on the right is the -- or the FIRS comparison. And the solid curve is the model that's used in the evaluation of the site based on the updated EPRI-SOG model with full CAV applied to all magnitudes. And an important point here it's also been scaled by 20 percent because in our original evaluation at the foundation level we found that the original FIRS based on the updated EPRI-SOG model had a PGA of about .08 g, and in order to meet the minimum requirement of .1 g we scaled everything up by 20 percent, 22 percent to get to a PGA of .1 g at the first level.

CHAIRMAN RAY: Yes, that -- I'm glad you elaborated on that because I was going to ask the question. It was to meet the minimum requirement that caused you to do that.

DR. YOUNGS: Yes.

CHAIRMAN RAY: I've got to ponder what's the minimum requirement established? What does that represent?

DR. YOUNGS: It's in Appendix S.

DR. SINGH: Yes, Appendix S --

DR. YOUNGS: The minimum -- .1 g has to be the minimum requirement at the foundation level for design -- ground motions to be considered in evaluation of the design.

CHAIRMAN RAY: Well, yes. No, I understand that part but I just didn't know why. Okay. All right. This is just a built-in conservatism is all I can think of.

PARTICIPANT: Defense-in-depth.

CHAIRMAN RAY: Well, let's not go there. That's a different issue.

DR. YOUNGS: So, the solid curves which are the curves that were developed based on the updated EPRI-SOG include that 20 percent scale factor to meet the minimum requirement at the foundation level. And the new curves are below that in terms of the PBSRS and the FIRS at the foundation level.

So, the reason that -- there's a combination of reasons why they are -- the old curves are higher but a significant portion of that reason is the 20 percent scale factor that was included in the final evaluation based on the updated EPRI-SOG. So, it compensates -- so, the high frequency would be lower because of lower predicted frequency of earthquakes in the high frequency range. The CAV model would compensate for that, the CAV's adjustment because now the CAV filter would take out or reduce the contribution of earthquakes less than the old in the full application, so that would bring the hazard results up in terms of the GMRS, but the 20 percent scale factor on the old model produces that curve that's higher than the new model. So, there are a bunch of factors running around in here but the 20 percent factor is an important one that goes to the reason why the new results are lower than the old results.

So, this is, again, the PBSRS on the left and the FIRS on the right, and then the next plot shows the GMRS. And here the new result, the dashed line is lower than the old -- the one based on this EPRI-SOG model with the 20 percent scale factor, except that around 1 hertz where it's about 4 percent higher.

So, if we go to the next slide it basically summarizes that result of the PBSRS and FIRS based on the CEUS SSC model and the modified CAVs are enveloped by the spectra based on the updated EPRI-SOG model with full CAV and the 20 percent scale factor. And then the GMRS based on the CEUS SSC model and the modified CAV, they're enveloped by the old GMRS except for it seemed to about up to 4 percent near 1 hertz, so relatively narrow range. And that's a summary of the -- or the bottom line of the comparison. So, are there any more questions -- any questions?

CHAIRMAN RAY: Yes, let's see if there are more questions because we're not going to -- you guys will be around during the second presentation if there's a need. I'm going to -- before we take a break and after we've made sure there aren't any other questions of those here at the table, I think it would be wise to open up the line and see if there's any comment or question that we have on this presentation rather than an hour and a half from now or whenever it is to come back and take more.

DR. YOUNGS: There's more coming, but on our --

CHAIRMAN RAY: Yes.

DR. YOUNGS: -- side --

CHAIRMAN RAY: Okay, yes. I'm sorry. Of course there is.

(Laughter.)

CHAIRMAN RAY: So, I guess when you said that it sort of triggered me to say what I will say when we are done.

DR. YOUNGS: Okay. So, I think now Dr. A.K. Singh will be going through the next phase.

DR. SINGH: As Bob had shown, there were two parts to the NRC RAI to us. One was calculate the new hazards and the new spectras based on the CEUS SSC model. And the other one was that in case the new spectras are not enveloped, are there any design changes relative to the site-specific design.

In addition, the Staff also asked us that we evaluate to a .1 g Reg Guide, Reg Guide Spectra which is anchored to .1 g. In the past when we had done the original analysis we had scaled the site-specific spectra to have a ZPA of .1 g. In this case, the Staff said in addition use a different spectral shape. So, we performed these two analyses as part of a response to the Staff question.

To put the three spectras in perspective, what we had plotted in here, the green line is the Reg Guide 1.60 spectra shape which is anchored to .1 g. The blue line is the scaled FIRS scaled to .1 g which is what Bob had alluded to using the EPRI-SOG model. And the black line is the CEUS, FIRS without the scaling.

And as you could see, that the blue line which was what we had used for all of the site-specific designs, and also compared the flow response spectra generated to the DCD full spectra totally envelopes the black line. However, when you go to the Reg Guide spectra which is anchored to .1 g it is enveloped to the all the high frequency all the way down to maybe about 8 hertz. And then below that the Reg Guide spectra is higher.

So, we performed two separate evaluations; one is, does the CEUS, FIRS results are bounded by what we did before, and the answer was yes. And that is what is summarized in the next slide.

We had performed a soil structure reaction analysis site-specific to show that at the six key locations the flow response spectras generated from Levy-specific analysis were bounded by DCD, and because the CEUS factors are lower than the EPRI-SOG, the same conclusions were drawn. No additional analysis was required.

For the bridging mat and the II/I seismic interaction between adjacent building and the nuclear island, as well as the liquefaction mitigation designs which we implemented, they were based on -- because the adjacent buildings are founded near the surface, we basically based them on the scaled PBSRS which, again, as Bob has shown was also on, so that again was just a comparison saying that because the new spectras are lower we are bounded.

When it came to -- the next slide. We also evaluated impact of the CEUS on the seismic margins which is in Chapter 19, and because the flow response spectras from the CEUS were bounded by the DCD we said that the CEUS does not lower the high confidence low probability of failure capacities which are documented in the DCD.

We also compared the 1.67 times CEUS GMRS, and based on a comparison of this to the 10 to the minus 5 uniform hazard spectra, we basically concluded that the evaluations we had done originally for the site-specific spectra were still bounding the CEUS.

For Reg Guide spectras I had noted earlier in the low frequencies the Reg Guide spectra was higher than the spectras which we had used for the EPRI-SOG. And for that we basically performed an evaluation where we scaled the flow response spectras based on the -- to get the spectras based on 1.60 1g FIRS, and we showed that we're still bounded by the DCD flow response spectra.

And because in the design of the roller compacted bridging mat we had used generic loads from the AP 1000 soft rock case. They were still bounding the new loads from the Reg Guide spectra. And the same thing was true for the seismic II/I where we basically showed that the forces, the ground motions we used were bounded by what the new stuff shows. So, the bottom line was we were able to show that for the Reg Guide 1.6 spectral shape, the designs which we have implemented and documented in the FSAR are conservative.

CHAIRMAN RAY: Well, you're referring to the DCD which I think makes -- at least to me it makes sense. But I'm -- does it cover all of the Seismic I design?

DR. SINGH: The DCD -- well, the only

Seismic I design which is site-specific is the bridging mat. Other than that, the DCD covers everything. But the bridging mat is --

CHAIRMAN RAY: Then that only leaves II/I as the --

DR. SINGH: And the II/I relates to the turbine building and the nuclear island, so that is also site-specific. So, those are the two site-specific structural part, and then the third item, as I mentioned before, was the liquefaction pockets which we found during geotechnical evaluations, and then we have a vertical and horizontal grade system installed to mitigate liquefaction. So, those are the three site-specific designs. Only the bridging mat is the safety-related portion, these other two are more II/I issues.

MEMBER SHACK: Is the comparison with the 1.60 spectra, that was new for this evaluation. Right?

DR. SINGH: Correct.

MEMBER SHACK: That wasn't in the original-

DR. SINGH: That was -- we had to do additional evaluations because of the low frequency exceedance.

CONSULTANT HINZE: Was the liquefaction with the fill material?

DR. SINGH: No, the liquefaction -- during investigations what we found is there are pockets, isolated pockets of soil which is weak, and with the PBSRS we did postulate that it could be liquefaction. So, to mitigate that we basically have a conceptual design in the FSAR which is install vertical and horizontal drains which would relieve the core pressures and not have liquefaction.

CONSULTANT HINZE: There's also some replacement of some of these soils, isn't there?

DR. SINGH: Correct, that is at the top.

CONSULTANT HINZE: Right. Okay.

DR. SINGH: We -- anything above 36, elevation plus 36 to 42 which is the present day grade we're either going to replace or improve, and then from the 42 elevation to the finish grade which is at 51 that would be new fill because -- from flooding consideration, the plant finish grade is at plus 51. That's all I had.

CHAIRMAN RAY: Okay.

MR. KITCHEN: Mr. Ray, that's all we have on the Central-Eastern U.S. seismic update. I do have one other item not related to that for clarification.

CHAIRMAN RAY: Agreed. Understood. Go ahead.

MR. KITCHEN: Okay. The last time we talked at length about the grout program and we've had some questions here today a little bit about that. But in talking to the Staff later, I felt there was one area that we needed to clarify. And to answer your question earlier, Mr. Ray, we're not changing the grout approach. Just want to clarify so that the ACRS -- it's clear to the ACRS what we're doing.

Just to refresh your memory, this is the foundation design concept for Levy. Of course, the AP 1000 nuclear island shown above, and then this line is the basemat for the AP 1000. That's all standard.

At the Levy site because of groundwater considerations, we need to install a diaphragm wall which is shown here, this dark line on either side of the drawing. This basically encircles the nuclear island excavation area, and also to support the excavation and groundwater control we need to do a grouted zone, which is 75 feet below the Avon Park limestone.

So, to do that we would start -- we would inject grout basically to create a barrier, a groundwater barrier at the bottom of the nuclear island excavation, and then the diaphragm wall creates what we call the bathtub. So, it's basically an enclosure for excavation.

The question -- the approach is to do that grouting, obviously, we have to inject and we have to have grout holes for that. We would put the grout holes in the nuclear island at 16-foot spacing. That's what we've discussed. And then the secondary pass grouting would be to split space those 16-foot centers again so you end up with an 8-foot spacing for grout injection. Those holes are all drilled vertically.

The area that might have led to some confusion just as how we discussed in the presentation is that the third -- if we need to, and this is all based on conditions observed during construction activities, but if we need to go to a third round we would make a determination whether to drill those third round grout holes vertically or, if in fact, we needed to -- we felt because of what we were seeing we need to incline or angle grout injection.

And the point we're clarifying is that in talking with the Staff, they felt that in discussion and in the presentation it was indicating that we would -- had made a decision we would always do the inclined grout holes, and that's not the case. We may not need them at all, or if we do need them we may decide to do them vertically as opposed to inclined.

Again, none of this is safety-related. The grouting is there purely for construction support. It has nothing to with the foundation design. We take no credit for the grout. Even though we recognize that it may provide some benefit, it's not credited in the analysis.

MEMBER ARMIJO: What would trigger the need for inclined grouting?

MR. KITCHEN: I think -- and correct me if I'm wrong, but basically we felt the intrusion --

DR. SINGH: Yes, the hydraulic conductivity, we're trying to reduce the amount of water coming in, so if we do not meet our acceptance criteria with the vertical holes we would go to the inclined holes which have a better chance of intersecting any vertical fissures in the rock.

CHAIRMAN RAY: You're wading around in the water --

(Simultaneous speech.)

DR. SINGH: Exactly vertical, the vertical holes are -- but that would depend on actually looking at the hydraulic conductivity and seeing whether that's needed or not needed.

MR. KITCHEN: So, that's the clarification we wanted to make. And that is the last of our presentation unless there are questions.

CHAIRMAN RAY: Okay. Well, the Avon Park limestone is also, of course, an area of questioning because of its susceptibility, perhaps, to void formations and so on over a long period of time. I think we've addressed that. But I don't know, Bill, did you want to pursue it any further?

CONSULTANT HINZE: No, I got it.

CHAIRMAN RAY: Okay.

CONSULTANT HINZE: I do have another question, though, if I might.

CHAIRMAN RAY: Go ahead.

CONSULTANT HINZE: Bob, in the model site calculations in the distributed calculations you used Clusters 1, 2, and 3. You've omitted 4, and you used 4, and there, what was that -- the cause of that, and why did you do that? And what's its impact?

DR. YOUNGS: You mean in terms of the ground motion models?

CONSULTANT HINZE: Yes.

DR. YOUNGS: In terms of the ground motion models we used Clusters 1, 2, and 3 from the EPRI 2004 ground motion model set because they are defined for all magnitudes; whereas, the fourth cluster is defined only for large events. So, the distributed seismicity hazard is coming primarily from smaller magnitude events, so that's why we used Clusters 1, 2, and 3 for that, and Cluster 4 only for large events.

CONSULTANT HINZE: And that was included in the RLMEs.

DR. YOUNGS: And that's -- the RLMEs we used Cluster 4 because they are only large events.

CONSULTANT HINZE: Right. Yes. Okay, thank you.

MEMBER SCHULTZ: In that regard, Bob, what is the definition of large events versus --

DR. YOUNGS: For the EPRI 2004 models it's magnitudes above 6, so Cluster 4 which is based on the Somerville, et al 2001 ground motion simulations, he only simulated earthquakes of 6 and larger, so it was felt in the original model that it should be not applied to events below 6. And because distributed seismicity is mostly -- a lot of the hazards coming from events below 6. It's similar to the way that we did the calculations for using the updated EPRI-SOG model in the same way we applied Clusters 1, 2, and 3 to all the EPRI distributed sources, and then when we calculated hazard from Charleston we used Clusters 1, 2, 3, and 4.

CHAIRMAN RAY: Okay. Any other questions

from those at the table here at this point? We've opened the bridge line to see if there are any comments. We won't necessarily respond to comments, but we want to receive comments if there are any on this portion of today's meeting. Are there any? Or from anyone here in the audience?

(No response.)

CHAIRMAN RAY: Hearing none then we will close the bridge line again. You guys did a terrific job of keeping on schedule. And we're showing a 20-minute break, but in order that we resume on schedule I'll ask that we hold it to 15. I think that's sufficient. And we'll, therefore, resume at 10 minutes after 10:00.

(Whereupon, the proceedings went off the record at 9:55:24 a.m., and went back on the record at 10:11:31 a.m.)

CHAIRMAN RAY: So, we'll resume the meeting please, and ask our colleagues to join us as they can. Don.

MR. HABIB: Good morning. My name is Don Habib. I'm the Project Manager from the Office of New Reactors for the Levy Combined License review. And, specifically, what this presentation covers is the Staff review of the Levy seismic re-evaluation.

The Staff previously presented its Advanced Safety Evaluation of the Levy COL application to the ACRS AP 1000 Subcommittee, and the ACRS Full Committee. This was done in late 2011, and it was followed by an ACRS letter to the Commission that summarized the Committee's conclusions and recommendations.

After that in early 2012, the Staff identified and the Commission determined a new set of requirements to be applied to new and operating reactors as a consequence of the nuclear accident in Fukushima. And these new requirements are described in SECY 12-0025 and its corresponding Staff Requirements Memorandum.

Among these new requirements is one for facilities to update their seismic re-evaluations to current NRC requirements and guidance. And this requirement was established in response to the corresponding Fukushima Near-Term Task Force Recommendation 2.1.

In response to a request for additional information, Progress Energy Florida supplemented its application with additional information about the seismic re-evaluation. The Staff subsequently reviewed that information, prepared its own review, and that appears in a new Chapter 20 of the Advanced Safety Evaluation. So, the presentation that follows summarizes that Staff review as it appears in Section 20.1 of the Advanced SE. There are no open items or confirmatory items in that presentation, or in that Chapter.

The technical staff reviewing the seismic re-evaluation for Levy includes individuals from two technical branches in the Office of New Reactors. This includes Geosciences and Geotechnical Engineering Branch, and the Structural Engineering Branch. From Geosciences and Geotechnical Engineering Branch the reviewers are Dr. Vladimir Graizer, Dr. Stephanie Devlin, and Zuhan Xi. From the Structural Engineering Branch the reviewers are Pravin Patel, Vaughn Thomas, and Bret Tegeler. At this time, I'll turn over the presentation to Dr. Devlin who will continue for the Staff.

DR. DEVLIN: Thank you, Don. Hello, Committee Members.

Regarding the Staff's request for additional information on the seismic re-evaluation, the RAI requested that the applicant evaluate the seismic hazard at the Levy site against current NRC regulations and guidance. To do this, the applicant was requested to test the FSAR seismic evaluation against two new methodologies in use. One is the Central and Eastern United States Seismic Source Characterization model, the CEUS SSC model, and the second is if the applicant chose to use the Cumulative Absolute Velocity Filter, the CAV Filter, then they were to limit that filter to magnitudes of 5.5 and below.

MEMBER SHACK: Where did that come from? I mean, since they did the original one with CAV Filtering in accordance with 1.208, where did the new requirement come from?

DR. DEVLIN: This came from the 50.54(f) letter that was sent out, as well as the SECY recommendations. And it came from Staff research on CAV.

DR. GRAIZER: Technically, if I may add to this, it came from certain concerns that it may miss some earthquake which can produce damage. That's a technical basis. And, basically, it was based on a bunch of studies done by USGS people, and together with NRC people, if you want I can name them, and they -- it's more like to be on the safe and conservative side.

MEMBER SHACK: Well, it's certainly more

conservative.

DR. GRAIZER: Not really -- technically it's probably -- it may be even over-conservative in some cases, but at least we would -- or this group of people decided to be safe.

MEMBER BLEY: Is there a Staff paper or something that --

DR. GRAIZER: It was a presentation at Seismological Society annual meeting. I believe it was not -- it was 2011 presentation by Cliff Munson, Dr. Cliff Munson and Dr. Jornaik. And I'm not sure but I believe there was some kind of communication between them and USGS people. But officially presentation was at SSA 2011.

CHAIRMAN RAY: Okay, Stephanie.

DR. DEVLIN: Regarding the CEUS SCC model, the applicant had previously used an updated EPRI-SOG model, so the Staff was interested in testing the two models against each other. And regarding CAV, as we've heard earlier, the applicant did choose to use the CAV filter, so we were also interested in the implementation of the updated CAV filter along with the CEUS SSC model.

The applicant chose to answer the RAI as a sensitivity study, so they made their approach changes to the FSAR but they did not choose to use the CEUS SSC model, or the updated CAV analysis in their final calculations. Next slide, please.

Similar to the applicant, we'll go through a short preview of the CEUS SSC model before we go into specifically what the Levy applicant did, as well as what the Staff did to confirm their analyses. Pictures here is a time line of the seismic source models which have been used for nuclear power plant applications.

In 1986, the EPRI-SOG Seismic Source Model was developed and has been in use at the NRC since then. Between 1986 and 2012, updates to the EPRI-SOG model have been conducted in an attempt to keep the information up-to-date. Examples are the update to the New Madrid Seismic Zone, as well as the Charleston Seismic Zone. The applicant implemented the necessary updates in its original FSAR submission, so the Staff considers that they used the updated EPRI-SOG model.

In 2012, the CEUS SSC model was published. This model replaces the updated EPRI-SOG model, as well as supersedes any previous models to 2012. Next slide, please.

CEUS SSC model was published as NUREG-2115 in January 2012. The model was a joint effort between the Nuclear Regulatory Commission, the Department of Energy, and the Electric Power Research Institute. The model is a regional model applicable to any nuclear power plant site in the Central and Eastern United States. The model is a regional model -- no, excuse me. The model incorporates the most recent scientific information on seismic sources capable of producing earthquakes in the Central and Eastern United States. It's a composite model with varying alternatives for seismic sources. And then this model is also used for nuclear power plant licensees. They will use this in their analyses as -- in their responses to the Near-Term Task Force Recommendation 2.1 analyses. Next slide, please.

The Central and Eastern United States Seismic Source Model Study Region is shown here in the black lines. The western boundary is set as the approximate location of the Foothills of the Rocky Mountain. To the north, the boundary is set 200 miles beyond the Canadian border, and to the south and east it is set to the coastline -- 200 miles past the coastline of the U.S. Additionally, the study region is limited to the Continental Crust.

The CEUS model documentation, NUREG-2115, shows the model implemented at seven test sites which are shown in green stars on this map. Additionally, the Levy site, LNP, is also shown here. Next slide, please.

CONSULTANT HINZE: How do we update that? When do we update -- you've given us a time line for updating. How about when do we update this again?

DR. DEVLIN: Well, there will be smaller updates when significant and important information appears, so I don't think there's any planned specific update right now for say the Mineral, Virginia earthquake, but we are considering -- we look into it, make sure that the model still holds for that. It's not specific to the Levy site because that's not an important source for Levy. So, the Staff as well as users of the model need to consider any new information since 2008, and then 2012 when it was published for updates.

CONSULTANT HINZE: And are there criteria that you have in mind, that the NRC has in mind to establish when there needs to be a modification or looking at it again?

DR. DEVLIN: We don't have a specific criteria. We often debate on whether 10 percent or 15 percent rises -- change in hazard rises to the level, so it's a decision that Staff makes.

CONSULTANT HINZE: So, Central Virginia did trigger some thinking about this then.

DR. DEVLIN: Correct.

CONSULTANT HINZE: Okay, that's --

DR. DEVLIN: Yes, not for the Levy site.

CONSULTANT HINZE: Sure.

DR. DEVLIN: But, in general, for the use of the model, yes.

MEMBER SCHULTZ: So, then there's a process that's ongoing that causes evaluations to occur at some periodic -- on some periodic basis, or is it only based on what happens?

DR. DEVLIN: I don't know -- I'm not aware of a periodic update. I know that -- I think it happens when new and significant information comes out and then it will --

DR. GRAIZER: I believe there are some discussions about 10 years period of update of the model. It is not written any places in stone, but seems to be like 10 years period, maybe.

MEMBER SCHULTZ: It seems like there ought to be other drivers than just the event or lack thereof, just to assure that the technology is considered appropriately current. We talked about methodologies and analytical approaches and other features that go into the derivation of the model, and there may be changes there based upon expertise and other things.

DR. DEVLIN: Each application and use of the model has to consider any potential update, so it's not on a regular basis, but every use has to assess that.

MR. CHOKSHI: This is Nilesh Chokshi. There are several aspects of this issue. I think as Stephanie mentioned, our Reg Guide requires that -- you know, the initial Regulatory Guide said to EPRI, and Lawrence Livermore models were the starting point. Now the 2012 is the starting point. But when you come in here and look at the new information, determine whether it's significant to the hazard or not, so every application we look at that.

The issue of periodic assessment, you know, because sort look at cumulative changes rather than, you know, as the model -- each application that runs, is the idea of looking periodically at 10 years or something has been around for a while. Looking what happens with Recommendation 2.2, it may become institutionalized, so we will see.

Another thing is this Generic Issue process when we know something which is going to affect fleet wide like Generic Issue 199, so there is multiple avenues by which we pursue the update of information.

MEMBER SCHULTZ: Thank you.

MEMBER STETKAR: Just out of curiosity, and I don't know this. I should. Does USGS have any set periodicity for updating their seismic hazard maps? I know the 2008 update. I thought that --

DR. GRAIZER: Six years.

MEMBER STETKAR: Yes, I thought the earlier one was --

DR. GRAIZER: They're right now working on the next generation.

MEMBER STETKAR: Okay.

DR. GRAIZER: Which will be 2014.

MEMBER STETKAR: Okay. And it is a 6-year period.

DR. GRAIZER: Correct.

MEMBER STETKAR: Thanks.

DR. GRAIZER: The latest one was 2002.

MEMBER STETKAR: 2002, I thought that there was one about in that, 2001 or `2.

DR. GRAIZER: Original -- what was called original hazard map from USGS was generated in 1996.

MEMBER STETKAR: Okay.

DR. GRAIZER: 2002 and 2008 are considered to be updates.

MEMBER STETKAR: Yes. Okay, thanks.

DR. DEVLIN: Okay. So, some key features of the model we're discussing, the CEUS SSC model, the Earthquake Catalogue covers the entire study region for the period from 1568 until the end of 2008. The earthquake size, the magnitude scale for the CEUS SSC model is in Moment Magnitude, whereas for EPRI it was in Body Wave Magnitude.

The CEUS SSC model uses a system set of alternative sources which are defined with a master logic tree depicting the alternative interpretations of the sources. For distributed seismicity zones, as discussed earlier, there are two approaches, the Bayesian and Kijko approaches for determining Mmax distributions. And the upper truncation for the Mmax distributions were set at 8.25, and the lower truncation for this model was set as 5.5.

In addition, to determine the seismicity rates, the cell sizes for the CEUS SSC model are spatially varying, they vary on quarter by quarter degree, or half by half degree cell sizes; whereas, the EPRI-SOG model used one by one degree cell sizes. Next slide, please.

Here's a portion of the CEUS SSC master logic tree. It shows the three different types of sources, the three different main types of sources used in the model are the Mmax Zones, the Seismotectonic Zones, and then the Repeated Large Magnitude Earthquake Sources, which is the RLME sources. Next slide, please.

Specifically about the Mmax Zones, Mmax Zones are based on average or default characteristics that represent a large area of the CEUS, and are based on historical seismicity and broad scale geologic and tectonic data. There are five Mmax Zones in the CEUS SSC model, three are pictured here, one is the entire study region, and then the other two sources are split in areas of Mesozoic and younger extension to the south and east and areas that did not experience such extension. The alternatives of the boundary between those zones produces the other two alternative sources. Next slide, please.

The Seismotectonic Zones are based on -- also based on historical seismicity, but on regional scale geology and tectonic data, and are characterized at a finer scale than the Mmax Zones. In total there are 17 Seismotectonic Zones, and I think there are 13 pictured on this map. And the other alternatives come up with -- come from alternative geometries of those sources. Next slide, please.

The last type of source are the RLME sources, the Repeated Large Magnitude Earthquake sources. They're defined as having had two or more earthquakes greater than or equal to magnitude 6.5. The RLME sources include sources like the New Madrid Seismic Zone or the Charleston Seismic Source, and other large magnitude sources in the Central and Eastern United States.

That's the Staff's summary of the CEUS SSC model. Next I'll turn it to Vladimir for a discussion of Levy-specific analyses, unless there are further questions on the model for the Staff. Vladimir.

DR. GRAIZER: Thank you, Stephanie. Good morning. Next slide, please.

Now, we are going more into details of site-specific review of the application. On the left side in the bottom you can see again same figure that you saw previously, seven test sites and the Levy site shown together in the study region. And it give you some kind of picture of location of test sites, distribution of test sites, and the Levy site.

As part of our review, we looked at all the test sites at the comparison that applicant provided to us between their calculations of seismic hazard for the seven test sites, and the results published in NUREG-2115. To make sure, again, just to remind you this is the first application with the use of Central Eastern United States new model. This is why we wanted to be sure that everything is fine. And as part of our review, we looked at the comparison of all the seven test sites with the results published in NUREG-2115.

And kind of to give you the overview, we were satisfied because everything that applicant demonstrated to us was within 13 percent differences between their calculation and test site. Add to this, 13 percent was the maximum differences and, actually, in most cases almost everywhere it was less than 5 percent differences, which is usually considered in probabilistic seismic hazard calculations acceptable, or let's say within the error margins.

But again to remind you for the closest site, which is Chattanooga site, sorry, for the similar distance site, Chattanooga, the difference was only 5 percent. Now, on the top you can see the comparison between applicant's calculations and calculations presented in NUREG-2115. And, basically -- and this is actually the worst case scenario, the worst agreement that they choose, but still it was pretty good. It was for Savannah site. Basically, we consider those comparison to be good.

CONSULTANT HINZE: Are these diagrams from their modified source?

MR. HABIB: Yes, it's --

CONSULTANT HINZE: From the distributed source rather than from the faults?

MR. HABIB: Okay, this is all together. This is cumulative results from both distributed --

CONSULTANT HINZE: No, from within the UCSS, the Charleston.

DR. GRAIZER: Okay.

DR. DEVLIN: It includes all of the sources within that updated Charleston Seismic -- excuse me. It includes all the sources from the CEUS SSC model. Charleston RLME, those -- it's all included in --

CONSULTANT HINZE: They had the faults, the first time they did it they had the faults, and then they went -- then the results weren't very good, so then they went to the grid point. You had an RAI on this.

DR. GRAIZER: Yes.

DR. DEVLIN: You're referring to the 80 percent/20 percent orientation of the fault?

CONSULTANT HINZE: Right.

DR. GRAIZER: This will come a little bit later.

CONSULTANT HINZE: Okay, all right.

DR. GRAIZER: If you don't mind.

CONSULTANT HINZE: Sorry, sorry. Okay.

DR. GRAIZER: This is a test site.

CONSULTANT HINZE: Okay.

DR. GRAIZER: It's not Levy. Levy will be next.

CONSULTANT HINZE: Understand.

MEMBER SCHULTZ: With respect to the implementation and the deviation at the Savannah site, is there some explanation that you would propose for the miss -- I understand it's reasonably acceptable, but for the miss at Savannah versus the less than 5 percent, the good application at the other sites?

DR. GRAIZER: Okay. The explanation were given actually by the applicant during our review, and we accepted this explanation. The original test site calculations which are presented in 2115 were performed by one group of people, and basically the applicant in this case tried to replicate same assumptions and produce their own calculations. But just to make it kind of clear, there are many, many pitfalls in this process, and there are many, many steps which can be slightly different. For example, how you model sources, how you model details of rupture process, and all these details can make a difference. This is why kind of as far as we look at this, these are results of details of implementation of the same model.

MEMBER SCHULTZ: Thank you.

DR. GRAIZER: Sure. Can we go to -- okay, next slide, please.

You already saw this slide in the presentation of Dr. Youngs, and -- but it's very important. It's a very important slide because it really shows us the hazard specifically at the Levy site. This is why kind of we don't see any reason why not repeat this. And what are the take off from these slides?

Again, on the left side you can see 10 hertz spectral acceleration. On the right side it's 1 hertz spectral acceleration. And you can see the influence, for example, of New Madrid Seismic Source Zone is very minor. But, again, even it's minor, it's taken into account. And the main -- again, next important fact, what we can kind of extract from these slides, that the main source of hazard is Charleston

Seismic Source Zone.

Now, again, as you can see, results of new application of the new model compared to the old model are pretty close, which is based on -- that basically new model is not much different from updated Seismic Source Model for Charleston. And, again, as Bob already mentioned, we can see the differences in results of application of distributed seismicity. And distributed seismicity effect are the following.

Seismicity rates in the new model are lower but maximum magnitude is higher. This is why kind of cumulative effect is that at high frequencies it's slightly lower the hazard, but at lower frequency it end up raising the hazard. This is -- I'm talking about green lights, lines, sorry. Next slide, please.

Again, this slide shows seismic hazard calculations for 10 minus 3, 10 minus 4, 10 minus 5, and 10 minus 6 frequency of exceedance. And, of course, for our study, for our work the most important are 10 minus 4 and 10 minus 5. And as you can see, the new model practically in most areas provide lower hazard than the old model.

It is not correct, exactly correct for 10 minus 3 where you can see some exceedance which is still not high, but still you can see exceedance at lower frequencies. But, again, what's the kind of essence of this slide, it shows that the hazard at Levy site no matter what you use, new model or old model, is relatively low. Next slide, please.

Okay. We are kind of stepping into the next step. The previous step was rock hazard, or hazard at 2,800 meters per second shear wave velocity. As you probably -- you may not remember, but it's -- there is 4,300 feet of deposits on the top of this shear wave velocity. And we need to propagate this rock hazard to the level of ground motion and foundation response spectra.

This is a very important slide because it shows the aggregation results. And, again, it just confirms what we were saying before, that main hazard is coming from the two sources, and it is Charleston, which is like 450 kilometers away from the site, and the nearby source which is let's say 20 kilometers, or 15 to 40 kilometers away. And, again, just it's very clear, but just to remind, the nearby source is affecting more high frequencies, and Chattanooga, of course, is -- sorry, Charleston is affecting low frequency part of the spectrum.

But what is also important from this slide is that the aggregation results from both previous study, old model and the new model are basically same. This provide us with the very important conclusions that when site response is done, there is no need to redo site amplification functions because site amplification functions are based on the aggregation results and information updates. This is why kind of the applicant did redo and we didn't recheck it again because there is no need. Site amplification functions that were calculated before stays. Next slide, please.

During our review it was generally speaking a little bit more broader review that we usually do for specific application because it's, again as I mentioned before, is first time we see this model. The question or the issue was raised, one of the formula in the NUREG-2115, and the applicant used this exactly the way it's published in the NUREG, the formula shown.

On the left it is relation between source area and moment magnitude. And this probably we can say, there is a minor typo or error in NUREG. Basically, instead of 4.366 it should be 4.35. And, of course, it is pretty clear that the difference is very minor, but we still ask the applicant to confirm this. And the applicant performs sensitivity study, and did calculations using both of these formulas.

Okay, I forgot to say, this formula is based on a combination of formula provided by Hanks and Kanamori, and Somerville formula. And, actually, the applicant performed comparison and found out that basically there is no difference. The difference is less than .2 percent between using the right formula and the slightly mistyped formula.

MEMBER SHACK: We'll assume it was a typo rather than an error.

DR. GRAIZER: Okay. I cannot comment --

(Simultaneous speech.)

MEMBER SHACK: Very precise typo.

DR. GRAIZER: Okay. But there is no difference in the end of results. Next slide, please.

Next issue which was kind of raised during our study, our review is that applicant used only one fault rupture orientations for the Charleston RLME Zone instead of recommended use of 8 to 20 percent depending on the orientation. They used one orientation with weight of one. And we had a concern about this and asked the applicant to perform sensitivity calculations, and they basically demonstrated to us that those differences are minor, and don't affect anything.

Just to add to this, it probably will make a difference if you are located close by, but to remind you, the distance between Charleston and Levy is -- the closest distance is 430 kilometers. This means for this distance it doesn't make any difference. Next slide, please.

Okay, this slide just -- anyway, it's a repetition of what Stephanie presented before. The new requirements are to use different set for CAV filter. And, basically, this is the more strict requirements because before there was no limitations on use of CAV filter. It was only dependent upon the value calculated. Now, in addition to the value there is another set, it's limited to magnitude 5.5 and lower.

And as I mentioned before, the applicant used the new CAV filter and with a combination of the previously calculated site amplification functions because there is no need to redo it. Next slide, please.

This slide demonstrate little bit in more details results of calculation of ground motion response spectra. And as you can see on this figure, what happened ground motion response factor calculated using new model came up higher than the ground motion response calculations using the old model. And this is again, just to remind you, rock hazard is the same or lower at Levy, but this is a result of application of cumulative absolute velocity filter, and is more strict. And as a result of this, to avoid any changes and to be consistent with previous actions, the applicant decided to increase ground motion response spectra calculated using old model to the same number, 21 percent, same number as the increase of foundation input response spectra to satisfy Reg Guide 1.60.

CHAIRMAN RAY: This is the scaling you're talking about.

DR. GRAIZER: Correct. Ground motion response spectra calculated using updated EPRI-SOG model was scaled 21 percent up, and now you can see the comparison that basically this scale updated ground motion response spectra envelope, of course, old one, but also envelopes the new model calculations.

And, again, just to make picture clear, as you can see, all these results are much below the CSDRS. Basically, hazard -- the design is much higher than the ground motion which was calculated using the models. Any questions?

MEMBER SHACK: I'm still puzzled. The reason that they have the -- they dragged in the 1.60 model with the minimum thing is that's a default, that even though you calculate a site-specific thing you also have to meet the Reg Guide 1.60 spectrum with a minimum acceleration. Is that --

MR. TEGELER: Yes, this is because for structural design you want rich energy content in 10 hertz and below, typically, so the Reg Guide spectra assures some minimum maximum acceleration, PGA value and rich frequency response, if you will, in the range of --

MEMBER SHACK: I don't get that out of 1.208. Is that somewhere else?

MR. TEGELER: It's in ISG-17, which was actually published after the Levy application was originally submitted, if you will. So, as part of that reconciliation step the -- we asked a question of the applicant to assess the impact of using the Reg Guide shape. And their calculations, as was presented earlier, showed minimal differences. But it is a -- it's to assure that for a very -- a site with very low seismicity when they're doing site-specific SSI and design of site-specific Category I structures or other significant structures that you have a robust design spectrum.

MR. SHAMS: If I may add -- this is Mohamed Shams. As Bret mentioned, the requirement actually starts with the regulations in Appendix S to Part 52. The requirement for having a sufficiently broad banded adequately shaped spectra anchored at .1 g, that's a minimum for the design. Expanding on it to go to specifically Reg Guide 1.60 is exactly what Bret mentioned with our evolved knowledge of the different sites specifically for the Eastern sites with perhaps the skewed energy towards high frequency, the expansion that we've done in ISG-17 is to sort of focus more on Reg Guide 1.60 to insure sufficient energy in the low frequency context.

MR. CHOKSHI: Let me -- the requirement for minimum have existed since --

MEMBER SHACK: I had assumed that you'd apply it to the site-specific spectrum, just scale it up, but I --

MR. CHOKSHI: The requirement in the regulation itself, which is in the Part 50 Appendix S, that you should have minimum .1 g peak ground acceleration with appropriate spectra. And the spectra was never defined. It was defined now the ISG, but in Reg Guide 1.208, the last paragraph it does talk about that GMRS SSC satisfy minimum requirement. So, there is a short sentence in there. Unless you know where to look, you will miss it. But, yes, this minimum requirement.

MEMBER SHACK: Thank you.

DR. GRAIZER: Can we go further?

CHAIRMAN RAY: Yes.

DR. GRAIZER: Next slide, please. Okay. To summarize seismic part of the investigation, again, what was mentioned before, rock hazard or uniform hazard response spectra came basically at a frequency of exceedance of interest 10 minus 4 and 10 minus 5 came lower or same as previously. And the applicant used new requirements for the use of cumulative absolute velocity filter, and applied to this to the calculations of ground motion response factor. And the conclusion is that scaled updated EPRI-SOG ground motion response spectra scaled 21 percent up basically envelope all this previous calculations, new calculations. I'm sorry.

And, again, the conclusion is that the final GMRS adequately characterizes the ground motion at the Levy site, and the scaled updated EPRI-SOG model GMRS was evaluated in the following areas, liquefaction potential, structural engineering and seismic margin analysis. Next slide, please.

And it was again mentioned before, but we would like to summarize it. Liquefaction is not possible under the nuclear island because nuclear island will be founded on roller-compacted concrete overlying the Avon Park formation. Site-specific liquefaction evaluation was performed for soil beyond nuclear island perimeter. The horizontal peak ground acceleration values at the finished grade ground surface and excavation elevation computed using the scaled updated EPRI-SOG model are higher than that with the Central Eastern United States Seismic Source Model. And using this higher peak ground acceleration from scaled EPRI-SOG source model results in a conservative liquefaction evaluation according to the procedure endorsed by Reg Guide 1.198.

Detailed re-analysis of the soil liquefaction potential is not necessary for the ground motion using the Central Eastern United States model. Liquefiable ground outside nuclear island is either removed or replaced with engineered backfill or stabilized with drains to prevent liquefaction. This concludes my part of the presentation.

CHAIRMAN RAY: Thank you.

DR. GRAIZER: Okay. Next, I'll pass it to Mr. --

CONSULTANT HINZE: Can I ask a question?

DR. GRAIZER: Oh, sure.

CHAIRMAN RAY: Yes.

CONSULTANT HINZE: We're here to evaluate the implications of the NUREG-2115 on the Levy site. One of the most significant things that the new seismic model contributes, that study, is the seismic catalogue. I think Robert did really a sterling job of preparing that and eliminating non-tectonic, and so forth. So, my question is, they have used as we saw earlier today, they have used the seismic catalogue dated up to -- through 2006. And have you as NRC reviewed the seismic catalogue from the CEUS SSC and its implications, and how it differs from that which the applicant has used?

DR. GRAIZER: Okay. The short answer is yes, we did comparison, and we did exactly what Bob mentioned but didn't show. We overlapped the previous with the new one, and main differences are coming from the size of earthquake previously mentioned in MB, and now measured as maximum of moment magnitude.

Now, if you want we have this back up slide, if you would like to see this, we can show.

CONSULTANT HINZE: No, I don't because I think it's hard to see, unless you really plotted them out. What I would have -- what I was expecting to see in your report, which I didn't see, was some statement about this. It's not in there, so the person that sits down to analyze that is left with that omission. And I guess it's because you didn't mention it, it's assumed to be in great shape. But I would have -- I think that would have been better from my standpoint, at least, to have some statement regarding that.

DR. GRAIZER: I don't think that it will —-

CONSULTANT HINZE: Another question -- I'm sorry?

DR. GRAIZER: I don't think it's a problem. We can add maybe, technical -- I mean, but actually we didn't.

CONSULTANT HINZE: I can't tell you what to do. Okay?

DR. GRAIZER: I'm sorry.

CONSULTANT HINZE: We heard that yesterday, I think.

CHAIRMAN RAY: In any event, for the purposes of the record, has this exchange adequately addressed what we would have preferred to see in the ASE?

CONSULTANT HINZE: Yes. Thank you.

CHAIRMAN RAY: Go ahead, please.

CONSULTANT HINZE: Another question that I have is that Bob explained to us how they use the Gulf

Coast version of the EPRI Ground Motion Model for their test sites, and also for their LNP site. Did you evaluate their use of that version and its impact, and were you satisfied with it? I assume you were. Could you explain a bit?

DR. GRAIZER: Yes, the answer is yes. Again, this is -- the approach that the applicant took is considered to be conservative because, again, in case of if wave travel through Gulf Coast area completely, that's the case when they used Gulf Coast attenuation model which produced higher ground motion because of lower attenuation.

Now, in case of mixture, as Bob mentioned in his presentation, they used the conservative. They didn't use a mixture. They just used the conservative approach by applying Central Continental attenuations which produced higher ground motion and lower attenuations with distance. But, again, the short answer yes, we did evaluate this and we found this approach acceptable and reasonably conservative.

CONSULTANT HINZE: Because it was conservative.

DR. GRAIZER: Yes, exactly, because it was conservative. Technically, of course, if I would do a scientific study probably you need to find some kind of weighting function. But we are not in scientific now, we are --

CONSULTANT HINZE: I've got to write that down. Excuse me.

(Laughter.)

DR. GRAIZER: Yes, it was conservative. That's why we found it acceptable, same like with hazard. As you can see, basically, the old hazard envelope -- I mean, the response factor they produced envelope everything which is kind of, again, scientifically, I would like to tweak it and make it lower at some places, but technically from the point of view of safety, it's conservative and it's fine.

There are some other cases when the applicant used this kind of envelope approach. Envelope means they take the highest possible scenario. And this was done also in site response calculations. This is why kind of in practical, all steps that we reviewed we saw that the applicant took conservative approach.

CONSULTANT HINZE: Finally, when the applicant did their evaluation, their sensitivity studies on the seven sites, Savannah was found to be larger than they would like, so they redistributed the rupture zones in that. What is your evaluation of the use of that second approach that they used in terms of the grid of values and the random distribution of rupture on those grid points?

DR. GRAIZER: You know, honestly, it's very hard to judge it because in principle, I would like to have kind of same -- scientifically will be all right to have Bob with his -- all details of his model implementation together with previous calculations performed in NUREG by another company. And, of course, you know the devil is in details. This is why kind of clearly there will be some differences in implementation of the model. And we had this discussion, and it may be that the way that the applicant used it is actually more appropriate than it was in 2115.

CONSULTANT HINZE: Why do you say that?

DR. GRAIZER: Because we continue having discussions, and actually certain things which was done later, of course, don't forget that Bob did it later, he had time to digest more information than what was done during 2115. It may be that some details of implementations are even more correct here.

DR. DEVLIN: I also understand that what Dr. Youngs did concentrated the hazard in the distributed seismicity source for Charleston at the edges, which is for the Levy site more conservative than if you concentrate it further in in the source. So, when you get to the near field effects where you're in the -- you're looking at the Savannah test site, you're going to start seeing those detailed effects. But for Levy being so far away, it's very conservative.

CONSULTANT HINZE: Sure, that's understandable. Really, the problem here is in the testing of the methodology that they used so that it checks out for the sites. Thank you very much, both of you. Appreciate it.

DR. GRAIZER: Thank you.

CHAIRMAN RAY: Proceed.

MR. THOMAS: Thanks, Vlad. Good morning. My name is Vaughn Thomas and to my left is Bret Tegeler and in the audience is Pravin Patel, all structural reviewers in the Office of New Reactors from the safety review related to the applicant's response to Recommendation 2.1.

In the next few slides we are going to present the structural engineering assessment for the Levy response related to Seismic Recommendation 2.1. The staff, for the purpose of safety review of the applicant's response to Recommendation 2.1 to the AP

1000 DCD and the site-specific structures to confirm its validity against Section 3.7, 3.8, and 19.55 of the SER. Particularly the adequacy of the applicant's response to Recommendation 2.1, the Staff considered the applicant's ground motion sensitivity evaluations and effects on the FIRS design of the roller-compacted bridging mat, the seismic interaction between the Seismic Category I and the adjacent Non-Seismic Category I structures, and the applicant's site-specific seismic margin. Next slide, please.

The foundation input response structure is used as an input to the site-specific seismic design for the plan. And as we talked about this morning, it must meet the minimum regulatory requirements. As a matter of fact, 10 CFR Part 50, Appendix S stipulates that the minimum peak ground acceleration should be scaled to at least 0.1 g which the applicant did.

The issue is that the Levy FIRS was developed using the EPRI-SOG model, and as a result Seismic Recommendation 2.1, the applicant was requested to re-evaluate the site-specific seismic hazards against NRC requirements and guidance. And to resolve this issue, the applicant compared the FIRS using the EPRI-SOG model to the Central Eastern United States Seismic Source Characterization model to evaluate the site-specific hazards. The applicant demonstrated that its site-specific horizontal and vertical FIRS developed from the EPRI-SOG model scaled to 0.1 g envelope the CEUS SSC FIRS.

Staff compared the Levy site-specific FIRS to the AP 1000 certified seismic design response spectra and noted that acceptable margin exists to the AP 1000 CSDRS. As a result, the Staff concludes that the information presented by the applicant demonstrated the Levy site-specific FIRS is acceptable, and that the applicant's design input ground motion reviewed in Section 3.7 of the SER remains valid. Next slide, please.

As previously shown by applicant and discussed by members of Staff, this slide shows the comparison of the nuclear island FIRS in both the horizontal and vertical directions with the EPRI-SOG and the CEUS SSC models. Again, the results show that the AP 1000 CSDRS envelopes both models with acceptable margin there.

CONSULTANT HINZE: The vertical was just obtained by a ratio?

MR. THOMAS: Yes.

CONSULTANT HINZE: And did you look at that ratio at all as to the uncertainty in it, or any of that? Is there any uncertainty in this?

DR. GRAIZER: No, it's not an uncertainty. What was -- what happened, the foundation input response spectra was calculated and I don't have exact number but it was approximately .08 g. And to achieve the level of .1 g they just divided .1 per whatever, .08.

CONSULTANT HINZE: Scale --

DR. GRAIZER: Exactly, and scaled, basically moved it up, 21 percent up.

CONSULTANT HINZE: Thank you.

MR. THOMAS: Next slide, please. Thanks. The RCC bridging mat is classified as safety-related to provide support to the nuclear island basemat. And, additionally, the RCC bridging mat is designed for the soft rock site conditions considered in the AP 1000 standard design. The seismic demands for the bridging mat are based on the AP 1000 certified seismic design response spectra with a peak ground acceleration of 0.3 g, not the Levy site-specific demands with a PG of 0.1 g.

Again, the issues at the Levy FIRS which is based -- which is used as input to the seismic design for the Levy site-specific structures was previously developed using the EPRI-SOG model. And as a result of the Seismic Recommendation 2.1 the applicant was requested to provide a site-specific hazard against current NRC requirements and guidance. And to resolve this issue, the applicant concluded that because AP 1000 generic site analysis are based on the AP 1000 CSDRS, the design of the RCC bridging mat is conservative. The Staff compared the Levy site-specific FIRS to the AP 1000 CSDRS and found acceptable margins between the Levy FIRS and the AP 1000 CSDRS.

Additionally, the Staff reviewed the applicant's response and found the seismic demands used for the bridging mat to be conservative and satisfied the requirements of Appendix S to 10 CFR Part 50. On this basis, the Staff concludes that the information regarding RCC bridging mat design described in Section 3.8 of the SER remains valid. Next slide, please.

The Seismic Category II and Non-Seismic structures, you know, we referred to the turbine building, the Rad Waste building, and the Annex building adjacent to the NI are supported on drilled shaft foundations, and the applicant used the performance-based surface response spectra, PBSRS, approach to compute the maximum related displacement of the adjacent structures. Again, the issue is that the Levy PBSRS which is being used as input to the seismic design for the site-specific structures was previously developed using the EPRI-SOG model, and as a result of Seismic Recommendation 2.1, the applicant was requested to evaluate the site-specific seismic hazard against current NRC requirements and guidance. The result is the applicant compared the PBSRS developed using the EPRI-SOG to the CEUS model to evaluate the site-specific seismic hazard. The applicant demonstrated that the Levy PBSRS developed from the EPRI-SOG model enveloped the previous PBSRS developed using the CEUS model.

The Staff compared the Levy PBSRS to the AP 1000 CSDRS and noted that acceptable margin exists to the AP 1000 standard plan CSDRS. The Staff concludes that the information provided by the applicant demonstrates that the seismic graph provided in the standard plan are adequate to prevent interaction between the NI and the adjacent structures. On this basis, the Staff finds that the conclusion regarding the seismic interaction of the Seismic Category I and Non-Seismic Category I structures described in Section 3.8 of the SER remain valid. At this time I will turn it over to Bret

Tegeler to discuss the applicant's site specific seismic margin.

MR. TEGELER: All right. Thank you, Vaughn. Good morning.

As Vaughn mentioned, I performed the safety evaluation of the seismic margin for the Levy application. This slide describes the key aspects of that review.

Combined License applicants are expected to demonstrate that the site-specific seismic margin is greater than or equal to 1.67 times the ground motion response spectra peak ground acceleration. This expectation provides assurance that SSCs important to safety remain functional for beyond design basis seismic events.

The applicant's analysis shows that designs of the bridging mat and structures adjacent to the nuclear island are conservative --

MEMBER SHACK: Does it make a difference if I make that 1.67 -- when they use GMRS it hasn't got the performance shaping factor in it, and 1.208 GMRS puts a design factor in. And does it make a difference here whether I'm using the PV or the GM?

MR. TEGELER: Certainly, with respect to where your structure is, it would. The nuclear island would be interested in the FIRS at the elevation of the basemat. There, if you're close to GMRS, those two—--

MEMBER SHACK: Well, no. I meant whether I put the design factor in or not before I start doing the 1.67 multiplication; that is, do I add the -- does it make a difference if I do the 1.67 after I do the performance -- the design factor, or before, or is it the same?

MR. TEGELER: No, actually, I think it's —-- if I understand the question correctly, the design response has the factors built in, and that is cranked in, if you will, into the development of both the FIRS and the GMRS. The margin --

MEMBER SHACK: Well, I'm not sure in their notation that it is in the GMR. They distinguish between GMRS and PB.

DR. GRAIZER: Because it's different elevations. GMRS is defined at the elevation of 36 feet, and PBSRS is defined at the elevation of 51 feet.

MR. TEGELER: They're actually both performance-based.

MEMBER SHACK: They're both performance-based. They're --

(Simultaneous speech.)

DR. GRAIZER: Different level.

MR. TEGELER: Yes, for a surface founded structure like the turbine building, the aux building you use the -- that's defined as the PBS -- the performance-based surface --

MR. CHOKSHI: This is Nilesh Chokshi again. If I understood your question whether the usual margin assessment before applying or after. I think because the requirement is that you have to show margin with respect to the design basis, so 1.67 is applied to the design basis. So, that --

MEMBER SHACK: Okay, got it. Okay, so I'll have to go back and look at that again.

MR. TEGELER: When we talk about the PBSRS we're really talking about the foundation in response spectra to surface structures like I mentioned, the turbine building, annex building.

The applicant's analysis shows that the —-- which Vaughn showed earlier on Slide 25 shows the designs of the bridge mat and structures adjacent to the nuclear island are conservatively based on the AP 1000 certified seismic design response spectra demands which were, if you recall, anchored at .3 g PGA and the Levy site is approximately .8 scaled to -- .08

scaled to .1. It's these conservative assumptions that contribute to the increased seismic margin for the site-specific structures.

Staff review of the Levy site-specific seismic demands concluded that the AP 1000 standard plan demands envelope at the site ground motion response spectra and the performance-based response spectra at all frequencies with margin, and provides assurance that the standard plant design will remain functional under beyond design basis loadings.

For the evaluation of the Seismic Category II structures adjacent to the nuclear island, the applicant evaluated the lateral displacement of the foundation piles supporting the adjacent structures and assessed the potential for liquefaction.

The Staff confirmed that the applicant's input ground motion bounded the 1.67 times the GMRS and the PBSRS thereby demonstrating acceptable margin, seismic margin. The results of the analysis showed that the maximum relative displacements of these adjacent structures to be less than the AP 1000 design gaps which range from 2 to 4 inches, depending on where you are in the foundation elevation, and that liquefaction potential did not increase beyond the isolated pockets outside of the nuclear island footprint. And as we learned earlier, in those pockets or in the vicinity of these pockets there'll be horizontal and vertical drains to mitigate potential liquefaction.

Staff review finds that the applicant's seismic margin analysis would consider liquefaction effects, was performed in accordance with relevant regulatory guidance in sections of the Standard Review Plan, and is sufficient to demonstrate that the seismic gaps are adequate to prevent interaction between the nuclear island and the adjacent structures on their beyond design basis seismic loading.

Based on the above, the Staff finds that the conclusions pertaining to the Levy Nuclear Plant Seismic Margin Analysis described in Section 19.55 of this SER remain valid. So unless there are further -- that concludes my presentation on seismic margins. And now I will recap the conclusions of the structural review.

The AP 1000 standard plant continues to envelope safe shutdown earthquake demands at the Levy Nuclear Plant site. The applicant's design for site-specific structures are based on conservative assumptions and, therefore, do not require changes due to an increase of the GMRS at the site. The Staff's conclusions in SER Sections 3.7, 3.8, and 19.55 remain valid. So, that concludes the structural engineering evaluation of the Levy site. And with that, I will turn it over to --

MEMBER STETKAR: Bret, one quick question on the slide, just a point of clarification on 28.

MR. TEGELER: Yes.

MEMBER STETKAR: The next to the last bullet, your conclusion that the gaps are adequate to prevent interaction under beyond design basis loading. You mean up to 1.67?

MR. TEGELER: Yes, so --

MEMBER STETKAR: Not necessarily beyond that.

MR. TEGELER: Well, the expectation is that you show for 1.67 that you're not going to have interactions. However, in the case of the applicant's analysis, they did their evaluation actually more than that. They did -- they assessed their ground -- they performed -- the input into that analysis was based on the 10 to the minus 5 Uniform Hazard Response Spectra, which is --

MEMBER STETKAR: Okay, so if I took it up to 10 to the minus 7, which might be about 8 or 10 times --

MR. TEGELER: Actually, there'll be a point you'll probably --

MEMBER STETKAR: Okay. Just want to make sure, if I was going to do a real seismic probabilistic risk assessment that conclusion might not necessarily --

MR. TEGELER: Yes. You're right, at some point there is a point where you'll --

MEMBER STETKAR: Okay, thanks.

CHAIRMAN RAY: Before we go to the last slide, are you ready to talk about -- this really hasn't stretched our -- challenged us here very much as we apply all this. What's in the future, if I can ask, if anybody can tell us about other sites coming in with similar reviews, but maybe more -- under more challenging circumstances. Do we have any outlook on that that you can share with us? We may just not know anybody here in the room, but --

MR. TEGELER: I can speak for the engineering side. With respect to why it's not that exciting from a -- looking at exceedances in the design and so forth.

CHAIRMAN RAY: Yes, yes.

MR. TEGELER: The applicant made very conservative assumptions at the front end, the initial design process.

CHAIRMAN RAY: Yes, but I'm talking about a different site.

MR. TEGELER: I understand. I just --

CHAIRMAN RAY: I'm just asking is there something more in the pipeline or is this all we can expect for the foreseeable future?

MR. SHAMS: This is Mohamed Shams. We do have bits and pieces of information but we're not necessarily ready to sort of share that at this point.

CHAIRMAN RAY: Of course.

MR. SHAMS: So, we know of certain sites that they're redoing their seismic analysis based on the change in the model, but we certainly haven't seen the information yet. And we learn information from drop-ins and requests for changes, scheduled delays and RAI responses which would give an indication that there are perhaps some additional efforts that are taking place with regard to the evaluation.

CHAIRMAN RAY: So, this would be just a warm up but we're not really having to --

MR. SHAMS: This is a warm up. I can share that with you, yes.

(Laughter.)

CHAIRMAN RAY: All right. Well, you know, it's -- the timing has been perfect and the results are certainly welcome. Go ahead with your final comment then.

MR. HABIB: This slides addresses how the applicant plans to use inclined or slanted bore holes as part of their subsurface grouting program. This is implemented to inhibit groundwater inflow during construction. It's not part of the seismic re-evaluation, but it is a topic that was specifically discussed at the November ACRS Subcommittee meeting, November 2011 for Levy.

In that meeting, the discussion indicated that the inclined bore holes would be initially used in the grouting program. And since then, the applicant has clarified that the inclined bore holes would be used if deemed necessary. That would be based on the grout uptakes that would be monitored by the applicant.

The Staff accepts this approach for the following reasons. First, the field data do not indicate the presence of any large subsurface dissolution cavities at the site, and the grouting is not needed for stabilizing bedrock, foundation bedrock. It is instead intended for dewatering, support the dewatering during construction. And, finally, that the grout uptake data will be assessed by the applicant to insure that no large subsurface dissolution cavities are intersected at the site location. And this concludes the Staff's presentation.

CHAIRMAN RAY: Very good, okay. First of all, we'll have a round of -- trying to gather any broader comments, but does anybody have any questions for the Staff before they're excused? We will open the bridge line again, and I ask Peter to remind me, but that's not for the purpose of asking questions of the Staff.

So hearing none then we will move to open the bridge line to see if there's any comments that members of the public have. And while we're doing that, is there anyone in the audience that would like to make a comment? If not, we'll ask that same question of those on the bridge line, if there are any. And then we'll move to wrap-up.

It's open. I understand the bridge line is open so if there's anyone listening in who would like to make a comment here at this second opportunity please speak up now and identify yourself.

(No response.)

CHAIRMAN RAY: Hearing none, we'll assume then that that's not -- there's no one who wants to comment to us, and we'll move to gathering any comments that are -- those here at the table have. And I'd like to start with Bill to see if there's anything left open in his list of issues.

CONSULTANT HINZE: Well, first of all, I think the applicant and the Staff have done more than an adequate job of their tasks. The major concern that I have is that I had hoped to see the FSAR brought up to date based upon the broad study of the CEUS SSC, and it's not. It's very -- it has some changes but it's inconsistent, and I don't think it's current. I think this could lead to some misunderstandings of people that obtained the FSAR. I guess that's where I end up.

CHAIRMAN RAY: Yes, and Bill has shared with us and the Staff the specific examples of where he thinks the record as it would exist for those reviewing the FSAR would be incomplete or perhaps not clear enough, the Staff may wish to share those same insights with the applicant. But updating the FSAR is something we just observe but it's not our thing to decide when and how that needs to be done.

Okay. Anything else, Bill?

CONSULTANT HINZE: No, that's it.

CHAIRMAN RAY: All right, then the other

Bill?

MEMBER SHACK: No, I've learned a lot today. It was an interesting presentation. As you say, really not too exciting.

CHAIRMAN RAY: That's the way we like them, isn't it? That's the way we like it.

MEMBER STETKAR: This isn't science. Right, Bill?

(Laughter.)

CHAIRMAN RAY: Mike?

MEMBER RYAN: I second Bill Shack's comments. I think it was a very good briefing and thanks for the update. Appreciate it.

CHAIRMAN RAY: Steve?

MEMBER SCHULTZ: I appreciate the update very much, and it was clear both from the applicant's presentation and the description of the work they have done as well as the Staff's review of that work that even though the results may not have changed much, and that might lead someone to conclude there's lack of excitement, the level of detail in the investigation of this, if you want to call it first of a kind application being very thorough was an excellent approach and result. So, thank you very much for all the details that have been put into the re-analysis because I think everyone has learned a lot from it. And we need that for what's coming with regard to the Fukushima further reviews and the other applications which are going to be coming in. Thank you.

CHAIRMAN RAY: Dr. Powers.

MEMBER POWERS: My tendency is to echo what Dr. Hinze said, that things still appear to be unstabilized. When you bring up things that you have to ready very carefully or you might miss a critical requirement, we find references to presentations before the Geological Society as critical to the analysis there, I think that's not good regulatory practice, and I think that needs all to be much better stabilized and codified.

CHAIRMAN RAY: All right, sir. Well, that's potentially an important thing. I think that perhaps we should reflect on whether there's anything we want to opine on as a Committee in that regard, but for now I'll assume not. I mean, it's an important observation and consistent with what Bill said, so I don't want it to be lost is my point. Dennis.

MEMBER BLEY: Sorry, I'm having trouble speaking. I certainly agree with what everyone else has said here besides enjoying the presentations and learning something, but really need to become conversant with NUREG-2115 --

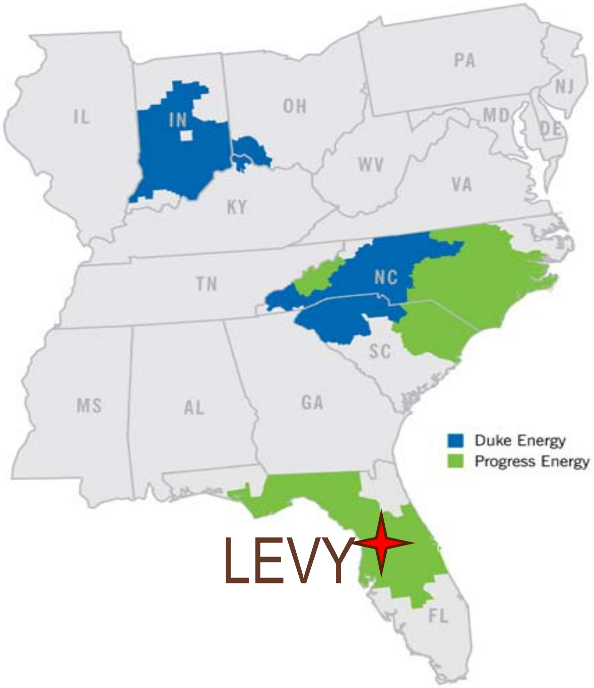
CHAIRMAN RAY: Well, as Dana says it's more complicated than it seems to those of us who are more distant from the process, and when you finally get involved in it you find that there are rules about it that are just known by the insiders, it's a little disconcerting. John.

MEMBER STETKAR: I don't have anything to add. Thanks.

CHAIRMAN RAY: Okay. All right, thanks to everyone for all the good work. And at this point, at least, I don't foresee that we will, unless asked by the Staff, be taking this to the Full Committee or having a letter issued. Thank you.

(Whereupon, the proceedings went off the record at 11:31 a.m.)

LNP COLA
Seismic Update



January 18, 2013

Agenda

- Intro & Agenda Overview – Bob Kitchen
- Review of CEUS Update – Bob Youngs
- Actions based on results – AK Singh
- Grout Program Clarification – Bob Kitchen

NRC RAI Letter 108 – Fukushima Recommendations Seismic Evaluation Update

- Conduct seismic portion only of Recommendation 2.1 - Enclosure 7 of SECY-12-0025
  - Evaluate the seismic hazards against current NRC requirements and guidance
  - If necessary, update the design basis and structures systems and components important to safety to protect against the updated hazards

Previous ACRS Presentation
Vibratory Ground Motions Evaluation

LNP Vibratory Ground Motions evaluation complies with RG1.208

- Updated EPRI-SOG model was used with earthquake catalog updated through December 2006
- The EPRI (2004, 2006) ground motion models were used
- The Updated Charleston Seismic Source (UCSS) per the Vogtle ESP was used
- Gulf of Mexico seismicity was added to the Updated EPRI-SOG model
- The CAV filter was used for surface UHRS and performance based GMRS

Previous FSAR Presentation
Vibratory Ground Motions Evaluation Conclusions

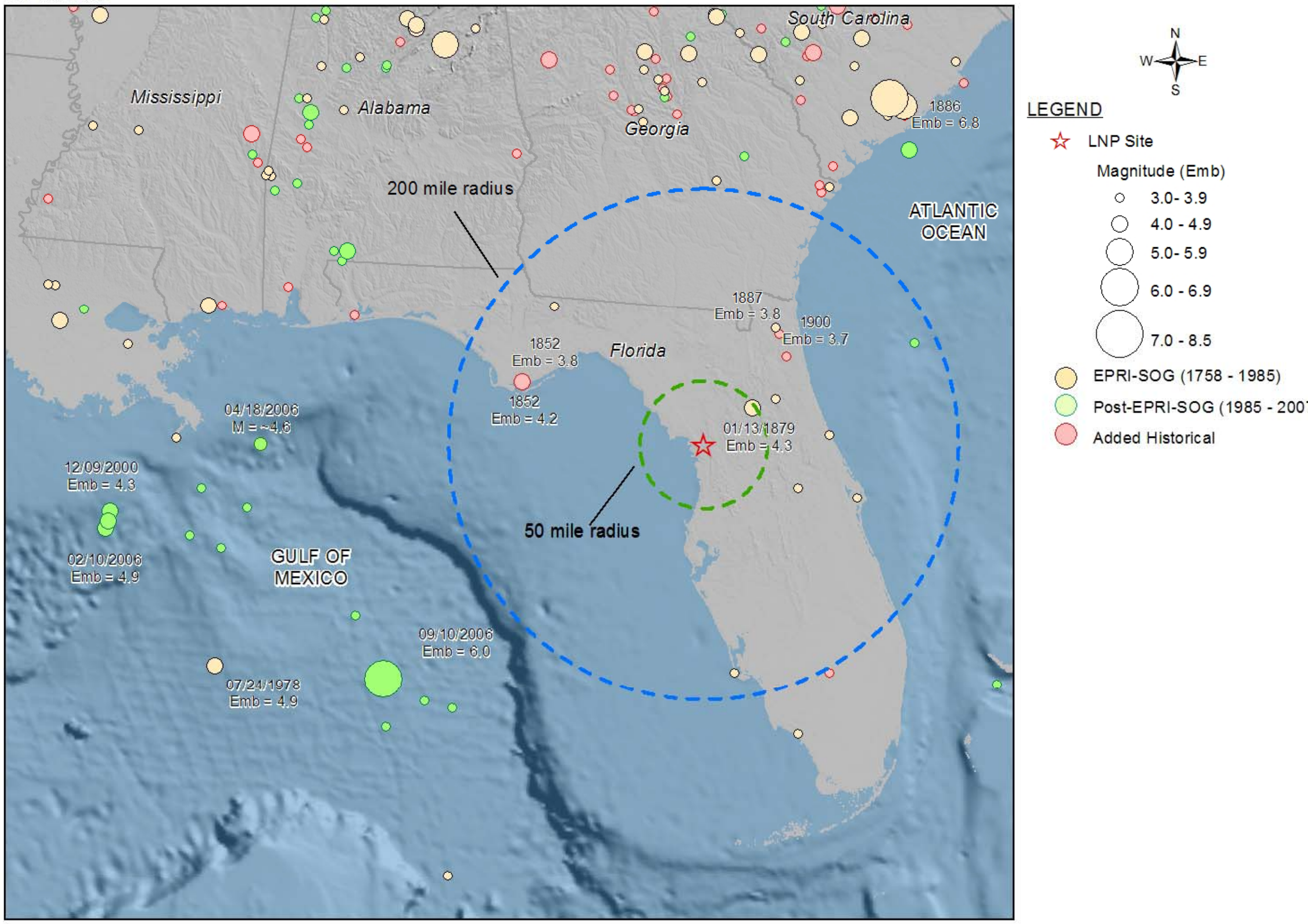
- Largest contributor to the site hazard is the Charleston, SC source

- The Updated Charleston Seismic Source as described in the Vogtle ESP was used for the LNP evaluation
  - In response to ACRS request, the USGS 2008 model was reviewed
  - The model used for the LNP evaluation was determined to be closer to the Levy site than the USGS 2008 model for the Charleston source

- Levy GMRS, PBSRS and FIRS are enveloped by the CSDRS

Locations of Earthquakes in the Site Region

LNP COL 2.5-2



Summary of Seismic Hazard Calculations for LNP Site Using CEUS SSC Model

Outline

1. Summary of CEUS SSC model
2. Hard rock hazard results for LNP site using CEUS SSC model
3. Comparison of GMRS, PBSRS and FIRS based on CEUS SSC model and Updated EPRI-SOG model

1. Summary of CEUS SSC Model

- Study jointly sponsored by EPRI, US DOE, and US NRC
- New Seismic Source Characterization (SSC) model for the Central and Eastern United States (CEUS) published in NUREG-2115
- Intended as a replacement for the EPRI-SOG (1989) model
- Conducted as a Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 study
  - Represent the center, body, and range of technically defensible interpretations of the available data, models and methods for characterizing future seismic activity

CEUS SSC Model Developments

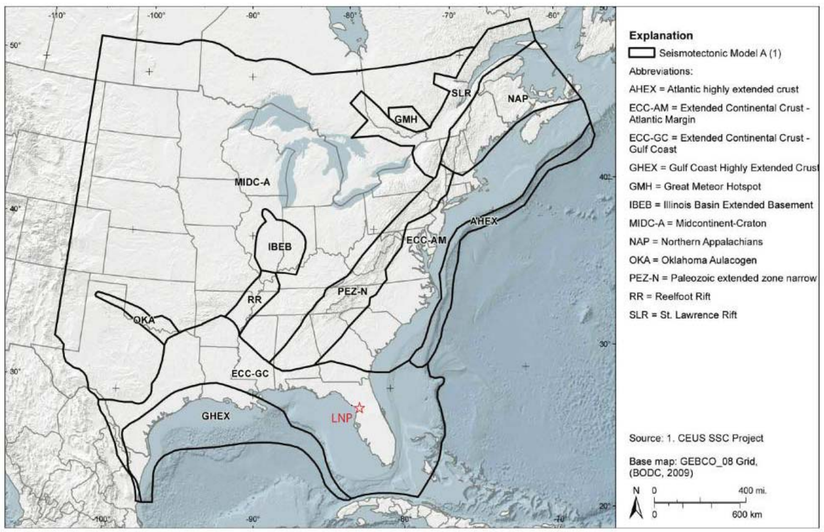
- Updated earthquake catalog through 2008
  - Earthquake size defined in terms of moment magnitude (**M**)
  - Developed new conversions to **M** from other size measures
- Updated seismic source representations
  - Alternative regional source zones to represent distributed seismicity
  - Repeated Large Magnitude Earthquake (RLME) sources
- Updated method to assess earthquake recurrence rates
  - Treatment of effect of magnitude uncertainty
  - Characterization of the spatial variability in recurrence parameters and their uncertainty
- Applied alternative statistical approaches to assessment of Mmax
  - Updated stable continental region (SCR) earthquake database
  - Used Bayesian (Johnston et al., 1994) with updated prior distributions
  - Used statistical method developed by Kijko (2000) when applicable

Overview of CEUS SSC Model

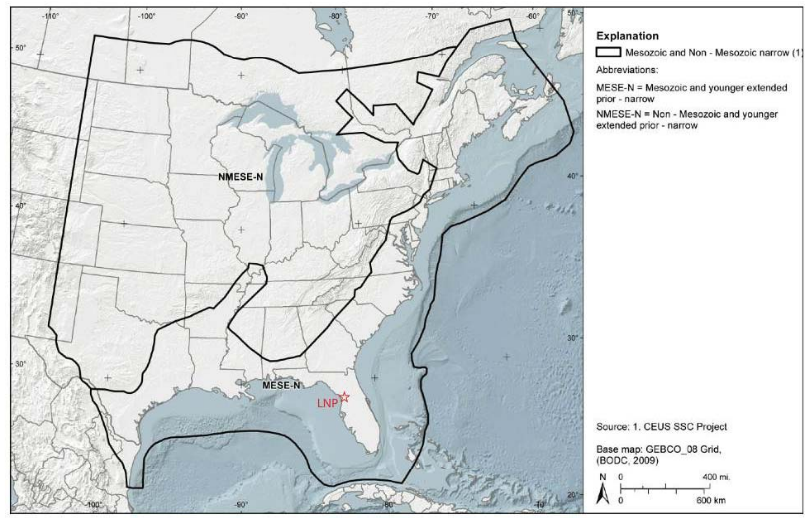
- Two types of seismic sources
  - Source zones model distributed seismicity throughout the CEUS
    - Seismotectonic Source Zones – Zonation based on differences in geology and tectonic history
    - Mmax Source Zones - Zonation based only on differences in maximum magnitude
  - RLME sources model the recurrence of repeated large magnitude earthquakes at specific locations
    - 10 locations identified in the CEUS

Examples of Seismic Source Zones

Seismotectonic Source Zones

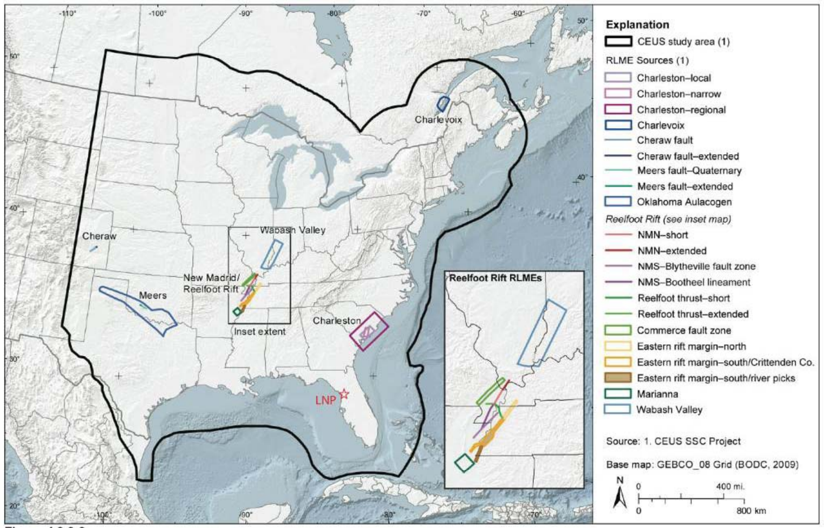


Mmax Source Zones



RLME Sources

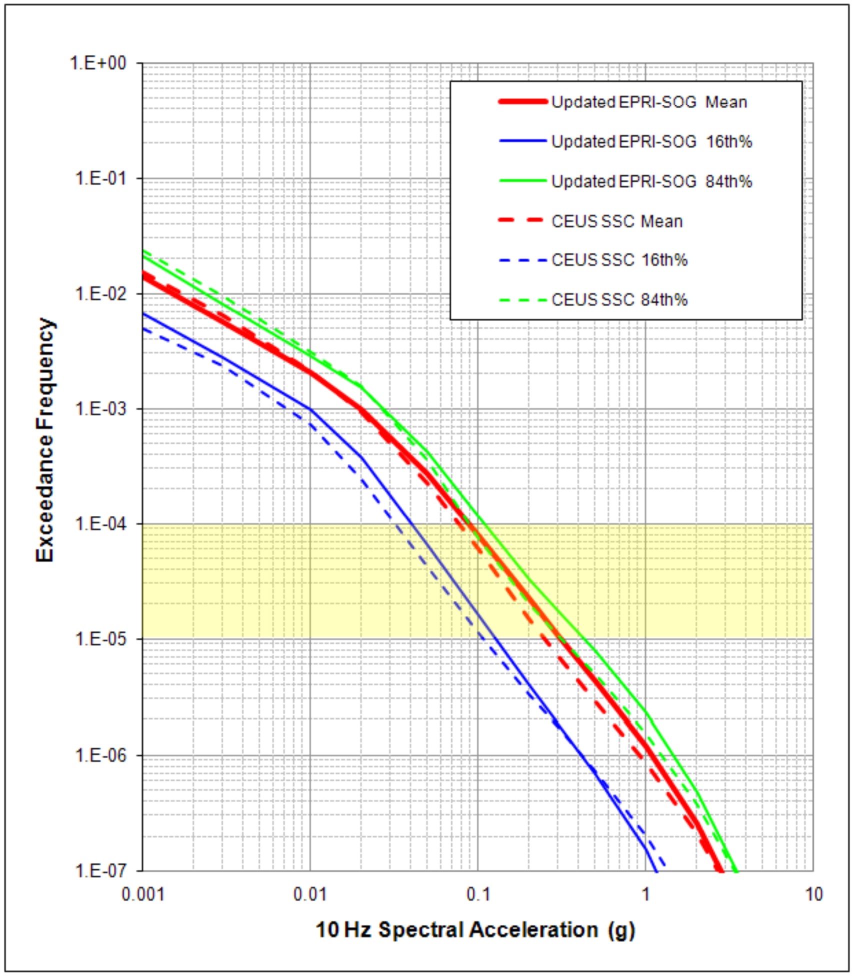
- 10 RLME sources
- Modeled variously as faults, zones of faults with preferred orientations, or zones
- Uncertainty distributions specified for average RLME magnitude
- Recurrence parameters based on paleoseismic data

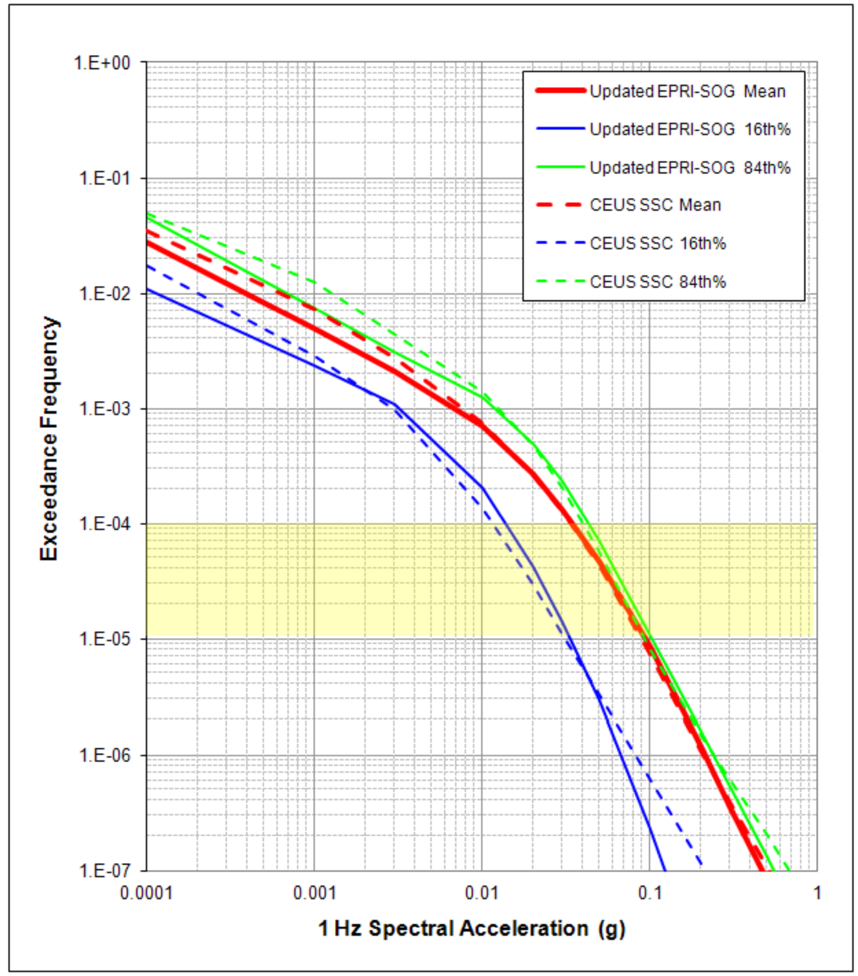


2. Hard Rock Hazard at LNP Site

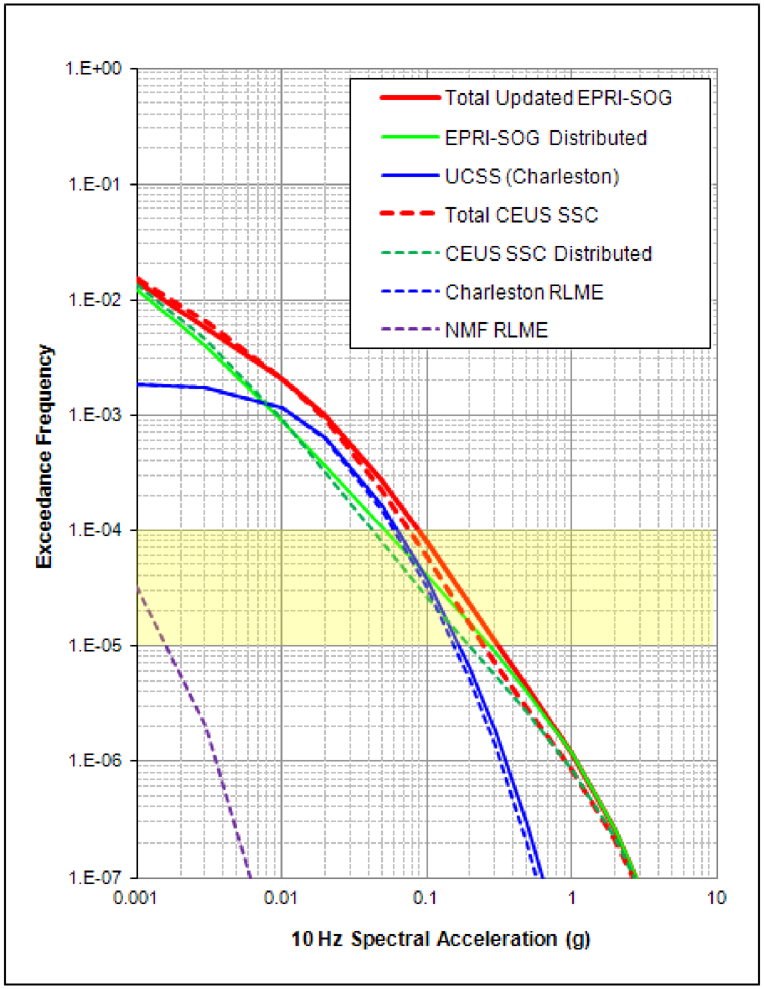
- Included those portions of the distributed seismicity source zones within 1,000 km of LNP
- Included Charleston RLME
  - New Madrid Faults RLME included to test possible significance
- EPRI (2004, 2006) ground motion models were used

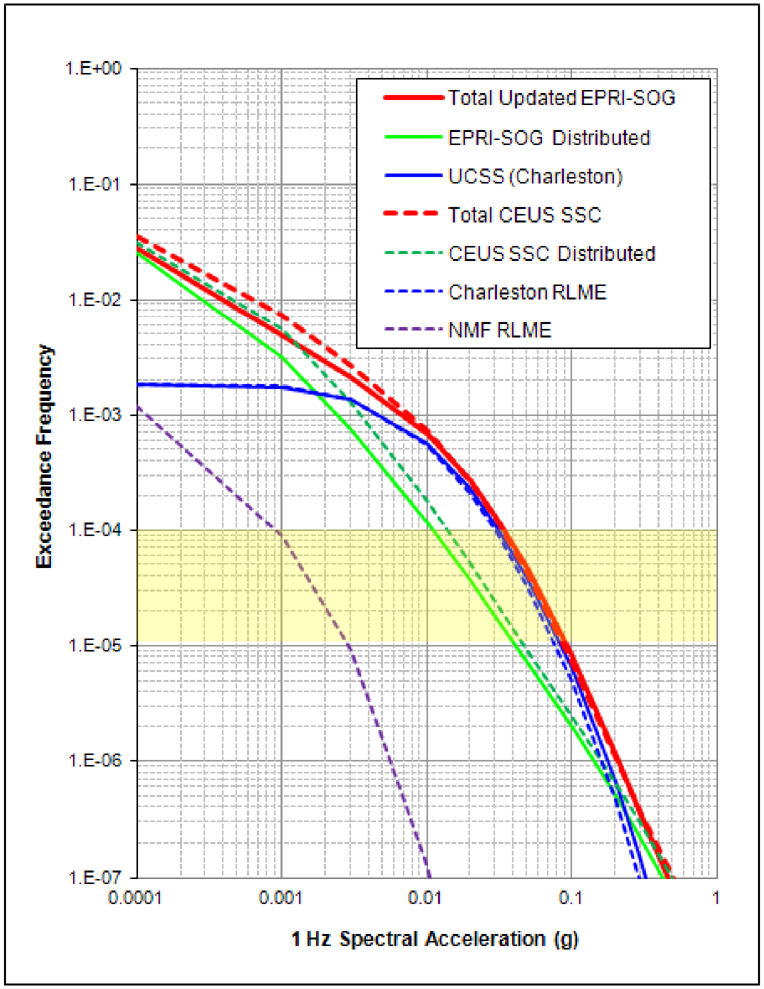
Comparison of Hard Rock Hazard Results





Comparison of Source Contributions





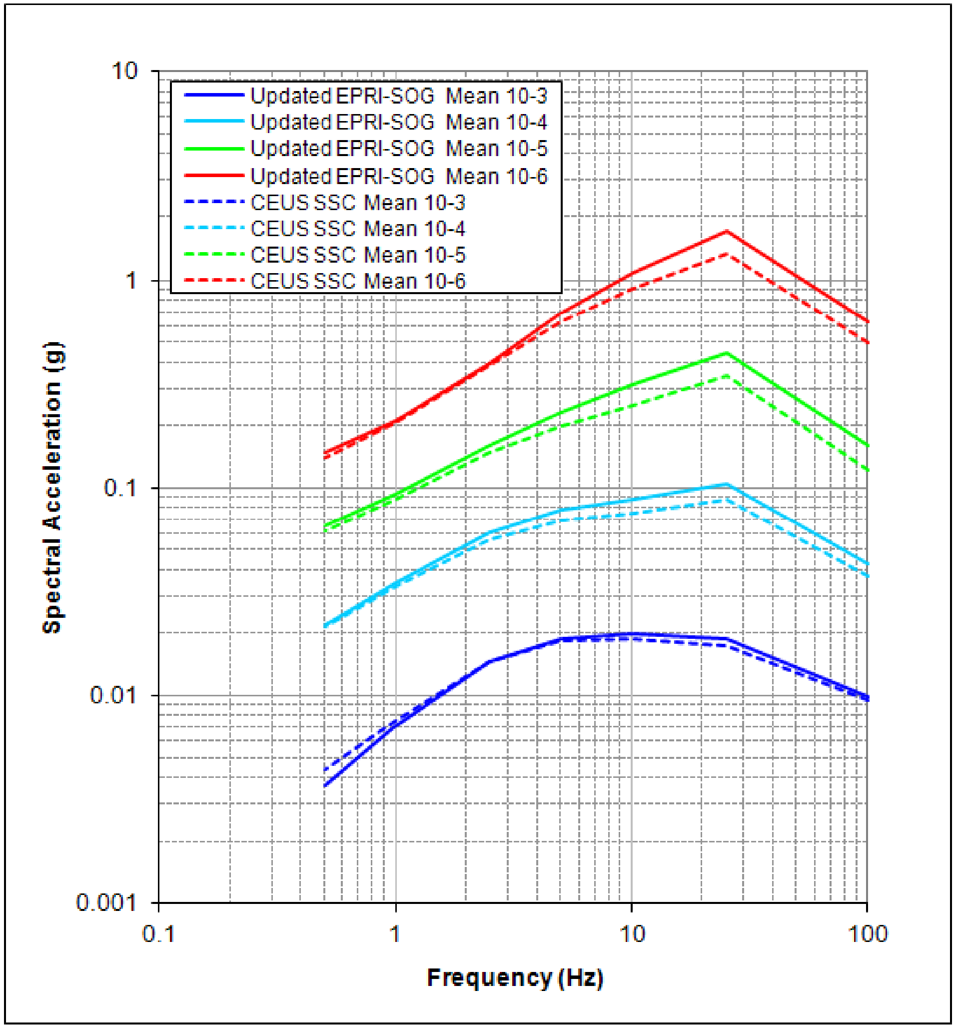
Summary of Comparisons with Updated EPRI-SOG Hard Rock Hazard

- Hazard for 10 Hz spectral acceleration is lower for CEUS SSC model than for Updated EPRI-SOG model because predicted frequency of local earthquakes from CEUS SSC model is lower

- Hazard for 1 Hz spectral acceleration from distributed seismicity sources is higher from CEUS SSC model due to larger Mmax values

- Hazard for 1 Hz spectral acceleration is dominated by Charleston source, which has very similar characterizations in Updated EPRI-SOG and CEUS SSC models

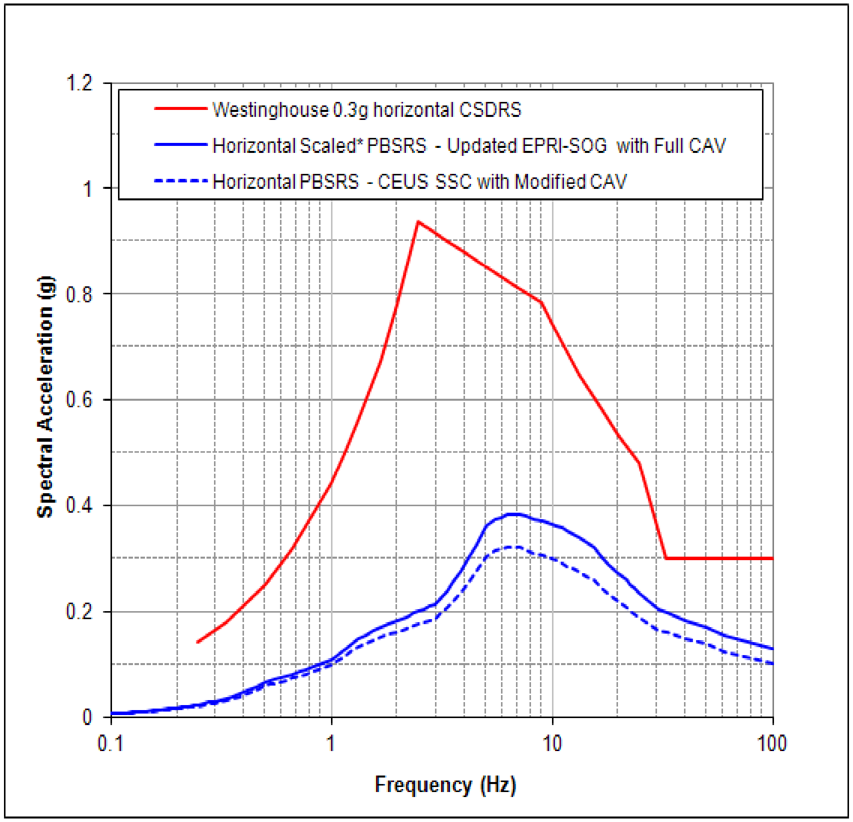
Comparison of Hard Rock UHRS

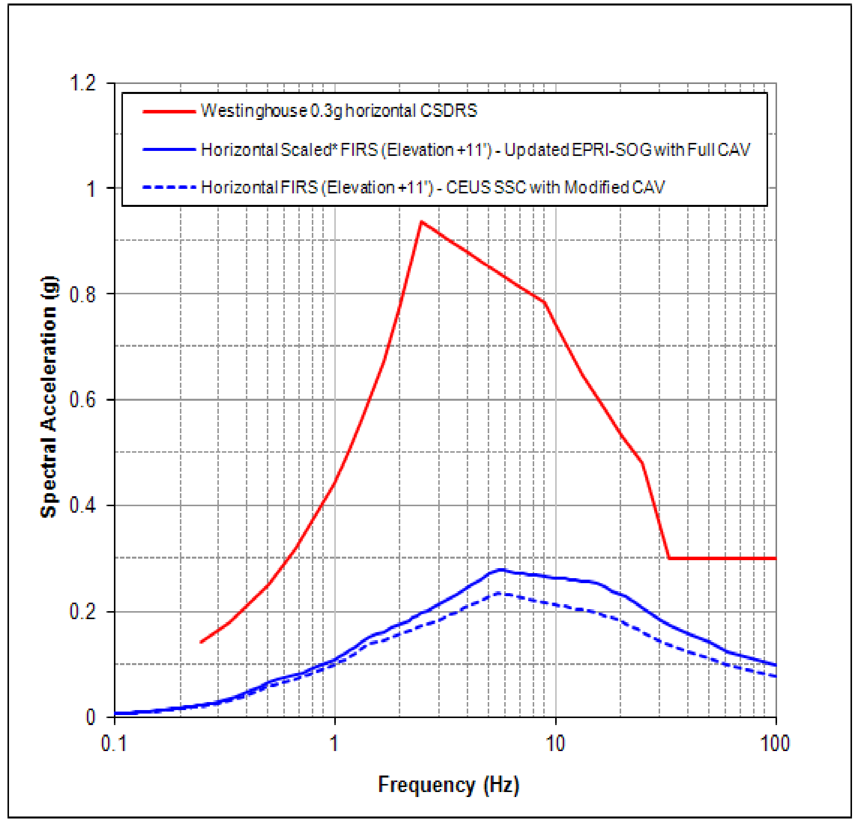


3. GMRS and FIRS Calculations

- Calculated Ground Motion Response Spectra (GMRS) at elevation of first competent layer, Performance Based Surface Response Spectra (PBSRS) at plant finished grade elevation, and Foundation Input Response Spectra (FIRS) at reactor foundation elevation
- GMRS, PBSRS, and FIRS based CEUS SSC model were calculated using EPRI (2006) CAV filter applied only to magnitudes < **M** 5.5 based on NRC requirements
- GMRS, PBSRS, and FIRS based on Updated EPRI-SOG were calculated using EPRI (2006) Cumulative Absolute Velocity (CAV) filter applied to all magnitudes

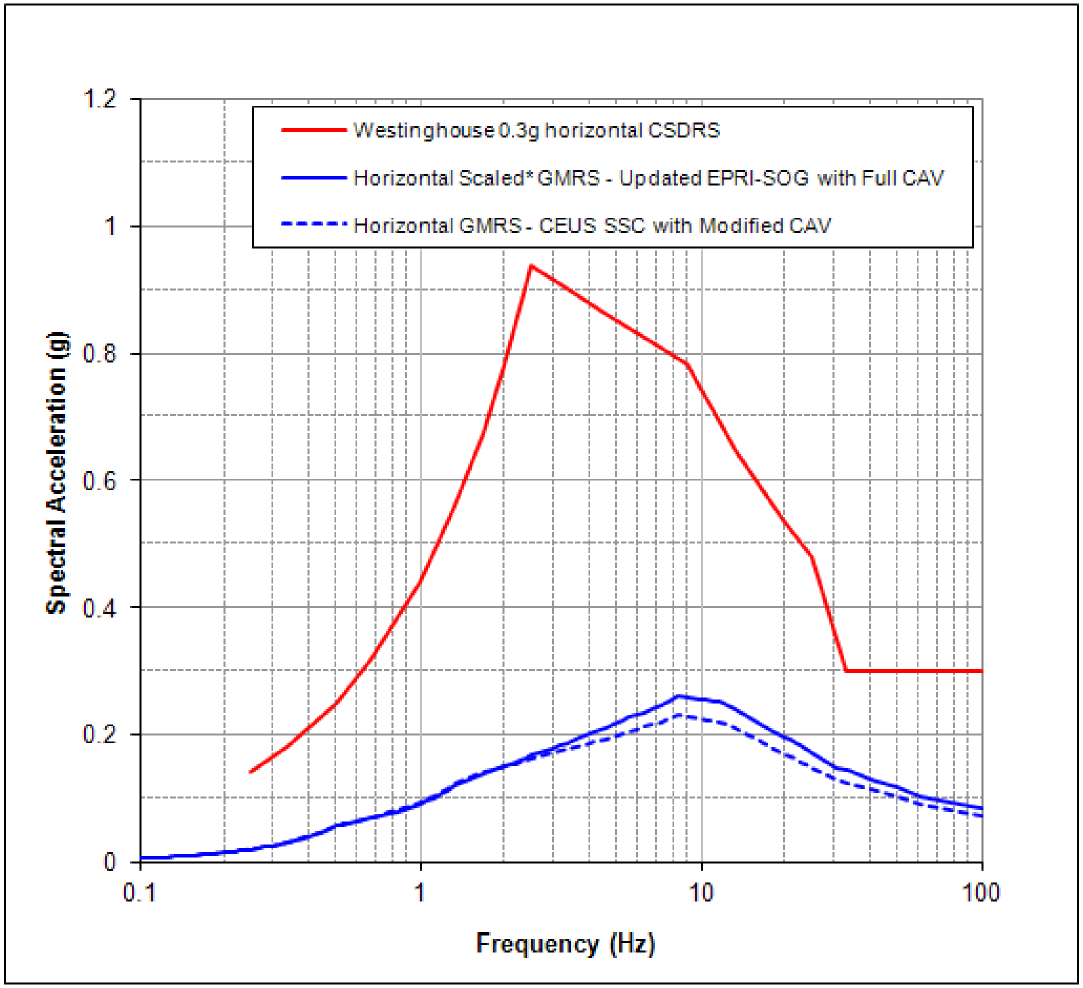
Comparison of CEUS SSC and Updated EPRI-SOG Results





*Scaled to Meet 0.1g PGA Requirement at Foundation Level

Comparison of CEUS SSC and Updated EPRI-SOG Results



*Scaled to Meet 0.1g PGA Requirement at Foundation Level

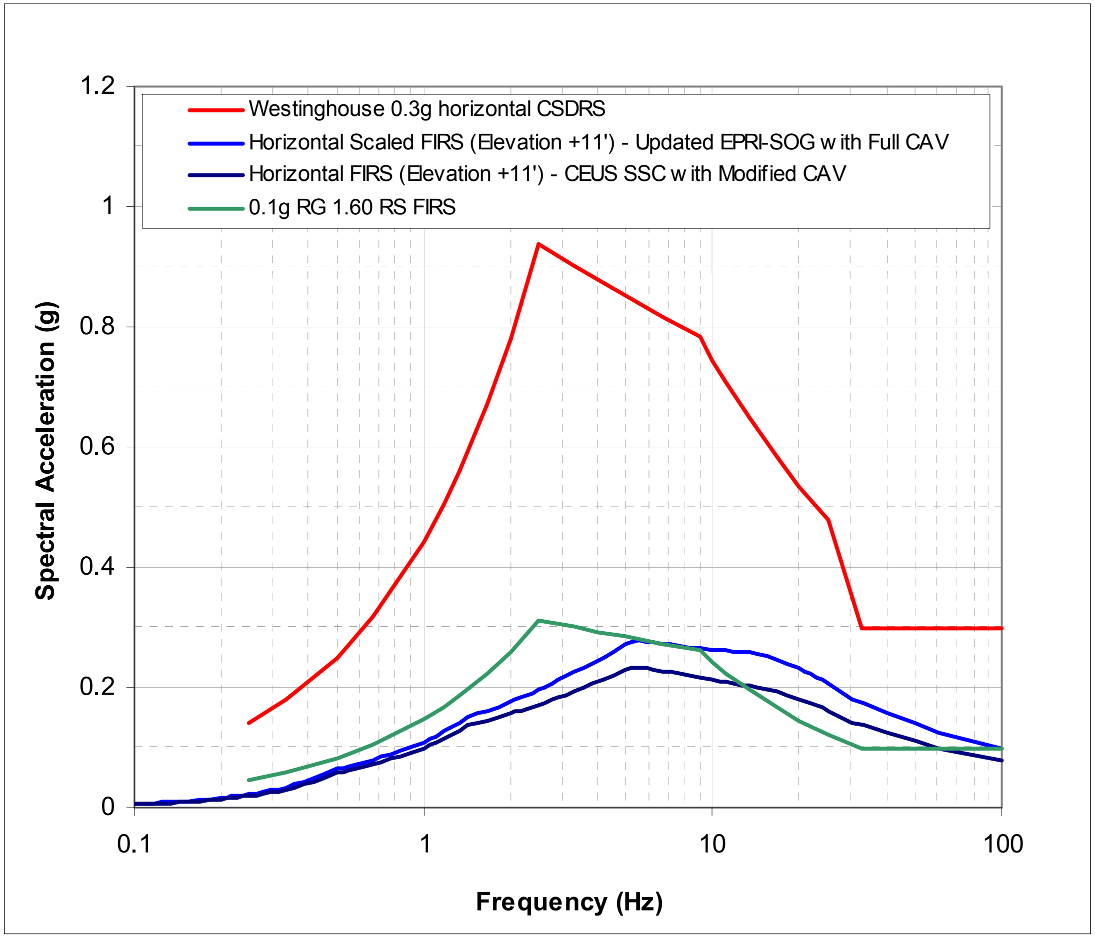
Summary of GMRS, PBSRS, and FIRS Comparisons

- PBSRS and FIRS based on CEUS SSC model and modified CAV are enveloped by spectra based on Updated EPRI-SOG model

- GMRS based on CEUS SSC model and modified CAV are enveloped by spectra based on Updated EPRI-SOG model except for minor exceedances (up to 4%) near 1 Hz

Evaluations for CEUS SSC and Reg Guide 1.60 Response Spectra

CSDRS, CEUS FIRS, EPRI SOG FIRS, and 0.1g RG 1.60 RS FIRS



Evaluation of Seismic Design

- AP1000 DCD FRS at 6 key locations bound FRS based on CEUS SSC FIRS

- RCC Bridging mat design, NI and Adjacent Buildings seismic II/I Interaction evaluations, and Liquefaction mitigation design are conservative for CEUS SSC ground motions

Evaluation of Seismic Margins

- CEUS SSC FIRS does not lower the Standard plant High Confidence, Low Probability of Failure (HCLPF) capacities
- HCLPF values are greater than 1.67 x CEUS GMRS for
  - RCC Bridging mat
  - Liquefaction mitigation design and
  - NI and Adjacent Buildings seismic II/I interaction

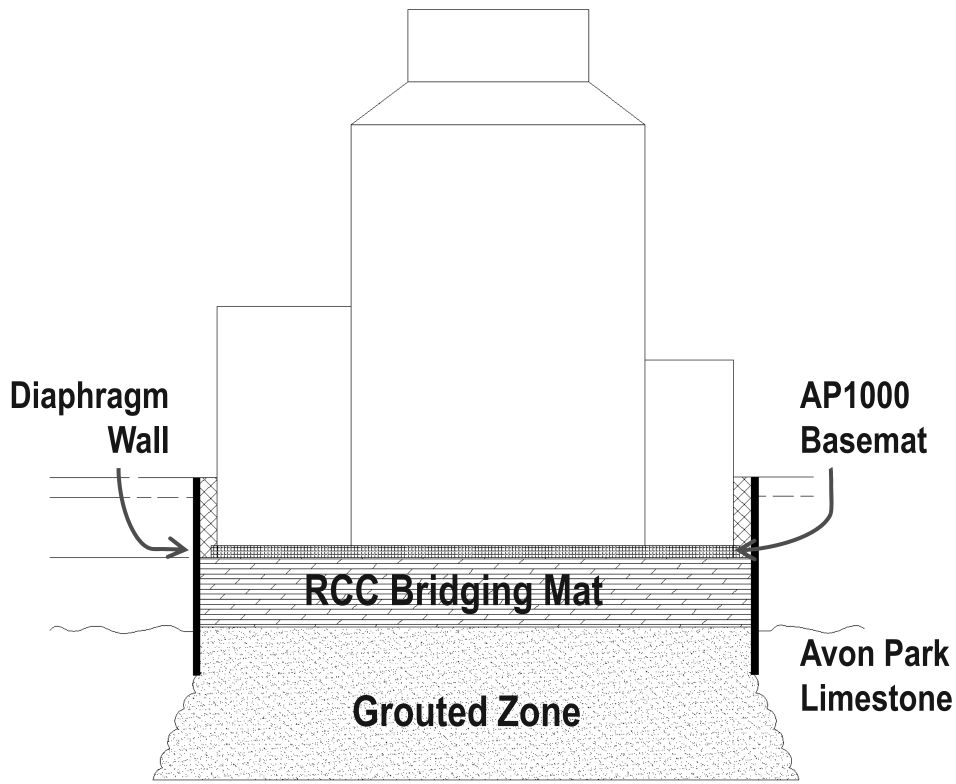
Evaluation of Seismic Design for 0.1g RG 1.60 Response Spectra FIRS

- AP1000 DCD FRS at 6 key locations bound FRS based on 0.1g RG 1.60 RS FIRS
- Design loads for RCC Bridging mat design bound design loads calculated based on 0.1g RG 1.60 RS FIRS
- Evaluations show no seismic II/I interaction between the NI and the Adjacent Buildings for 0.1g RG 1.60 RS ground motions

Grout Program Clarification

Nuclear Island Foundation Design Concept

- Diaphragm Wall
- 75-foot thick Grouted Zone
- 35-foot thick RCC Bridging Mat
- AP1000 Basemat



Grout Program
Use of Vertical Vs. Inclined Holes

- Primary grout holes to be installed vertically at 16-foot spacing
- Secondary grout holes to be installed vertically by split-spacing to create a network of grouted holes at 8-foot centers
- If the target hydraulic conductivity cannot be reached using vertical holes, the use of tertiary or inclined grout holes will be considered
- The decision to install tertiary, vertical grout holes and/or inclined grout holes will be made during production grouting based on the results of the production grouting program

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Protecting People and the Environment

Presentation to the ACRS Subcommittee

Levy Nuclear Plant Units 1 and 2
COL Application Review

Fukushima Near-Term Task Force Recommendation 2.1: Seismic Reevaluation

January 18, 2013

Background

- ACRS Interaction for Levy COL
  - Subcommittee (Oct. 2011) and Full Committee (Dec. 2011) Meetings
  - Letter to Commission (Dec. 2011) and Staff Response (Jan. 2012)

- Additional Requirements
  - Fukushima Near-Term Task Force recommendations applicable to Levy COL (SECY-12-0025)
  - Staff review of Levy seismic reevaluation (Recommendation 2.1) appears in Chapter 20 of Advanced Safety Evaluation

Staff Review Team

- Technical Staff
  - Geosciences and Geotechnical Engineering Branch
    - Dr. Vladimir Graizer, Geophysicist
    - Dr. Stephanie Devlin, Geophysicist
    - Mr. Zuhan Xi, Geotechnical Engineer
  - Structural Engineering Branch
    - Mr. Pravin Patel, Structural Engineer
    - Mr. Vaughn Thomas, Structural Engineer
    - Mr. Bret Tegeler, Senior Structural Engineer
- Project Manager
  - Mr. Don Habib

Fukushima RAI Seismic Request

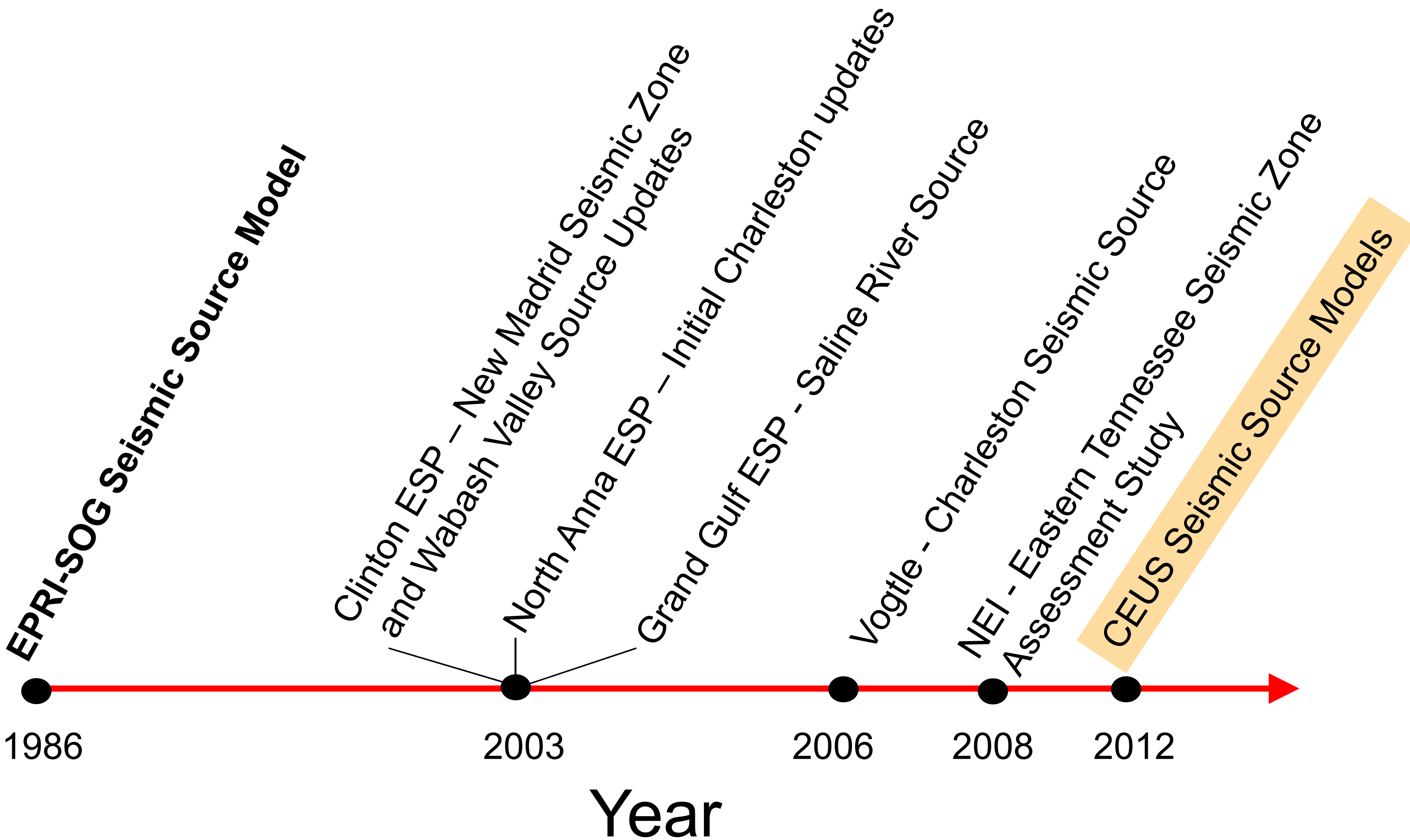
- Evaluate the seismic hazards at the site against current NRC requirements and guidance.

- Use methodologies detailed in Recommendation 2.1 of SECY-12-0025.

  – Plants located in the Central and Eastern United States (CEUS) use the **CEUS Seismic Source Characterization (CEUS SSC) model** (NUREG-2115) and the appropriate Electric Power Research Institute (2004, 2006) ground motion prediction equations.

  – If used, **the cumulative absolute velocity (CAV) filter should be limited to moment magnitude (M) less than or equal to 5.5.**

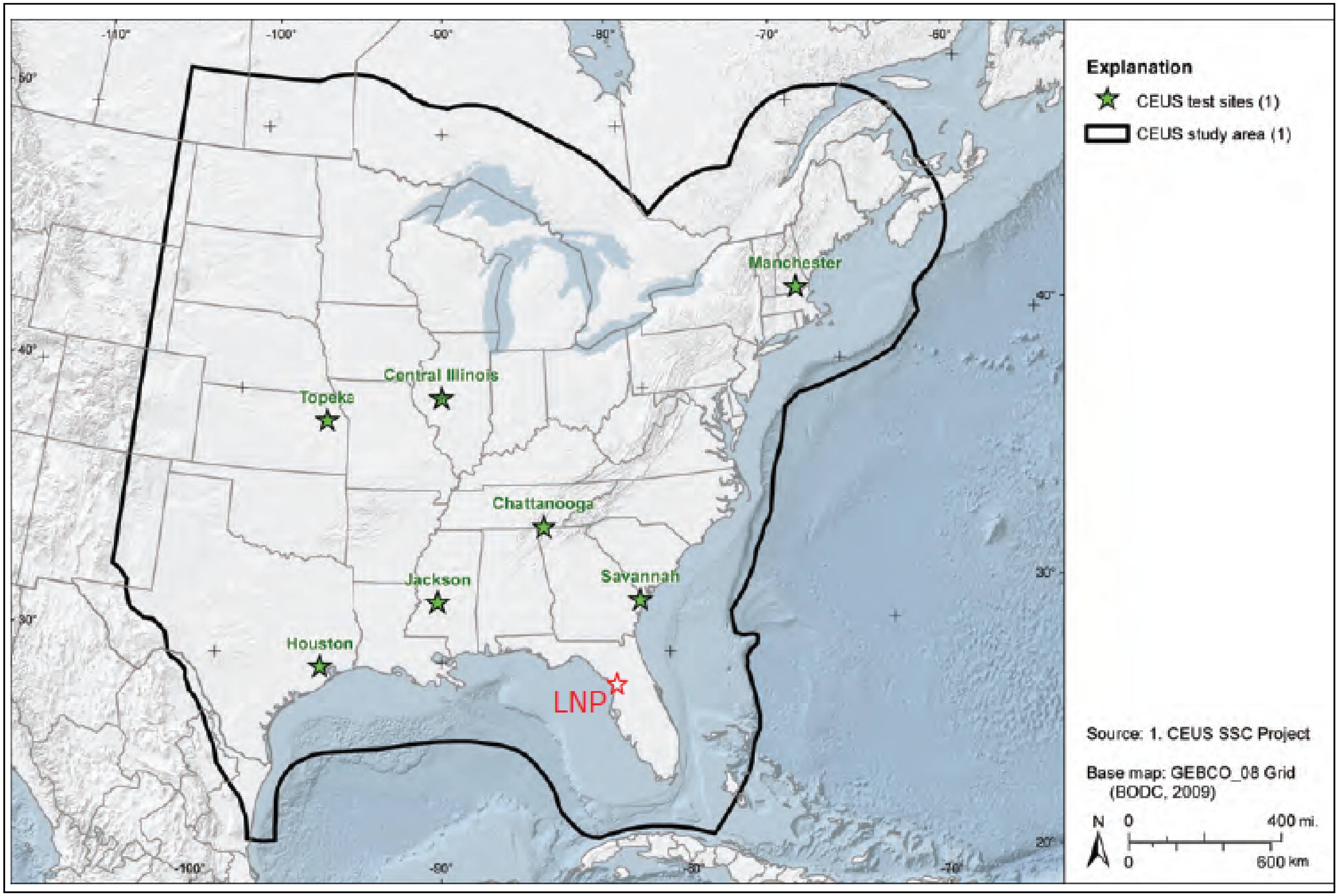
Timeline of Seismic Source Models



CEUS Seismic Source Model

- Published as NUREG-2115 in January 2012.
- Joint effort by NRC, DoE, and EPRI.
- A regional model applicable to any CEUS site.
- Incorporates most recent scientific information on seismic sources capable of producing earthquakes in the CEUS.
- Composite model with varying alternatives.
- NPP licensees will also use this model as part of the NTTF Recommendation 2.1.

CEUS SSC Model
Study Region, Test Sites, and LNP



Key Features of the CEUS SSC Model

- Earthquake catalog covering entire study region for the period of 1568 till the end of 2008.

- Earthquake size is defined in terms of moment magnitude (**M**).

- Consist of single set of alternative sources with defined master logic tree depicting alternative interpretations.

- For distributed seismicity source zones two approaches (Bayesian and Kijko) were used for the Mmax distribution.

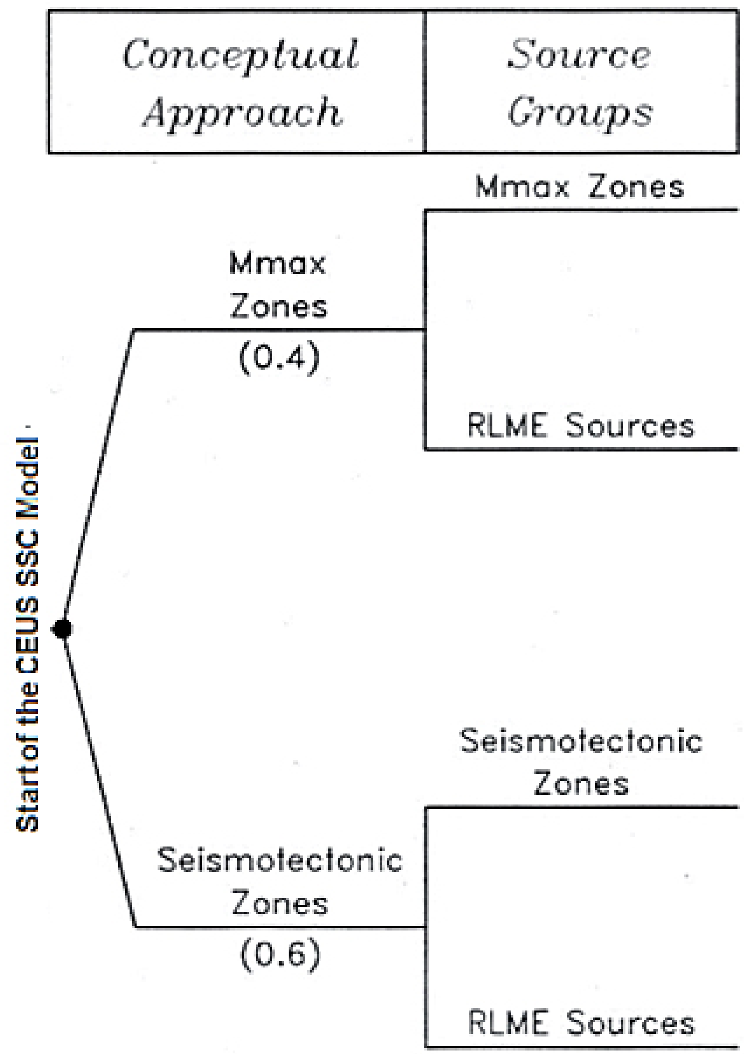
- Upper truncation to all Mmax distributions is 8.25 and lower truncation is 5.5.

- Smaller cell sizes of 1/4x1/4-degree to 1/2x1/2-degree.

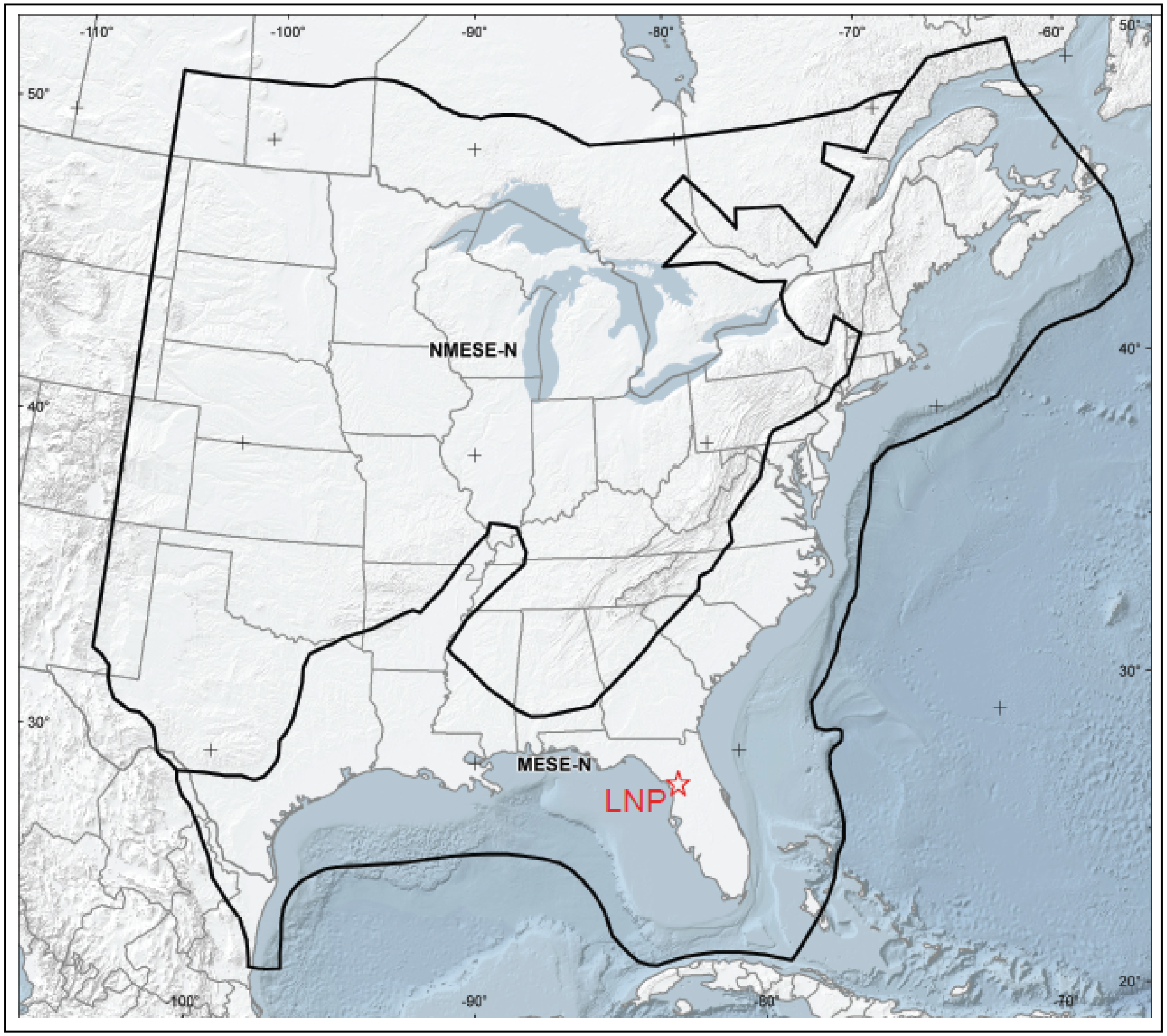
CEUS SSC Model – Logic Tree

Three types of seismic sources models:

- Mmax Zones
- Seismotectonic Zones
- Repeated Large Magnitude Earthquake (RLME) Sources

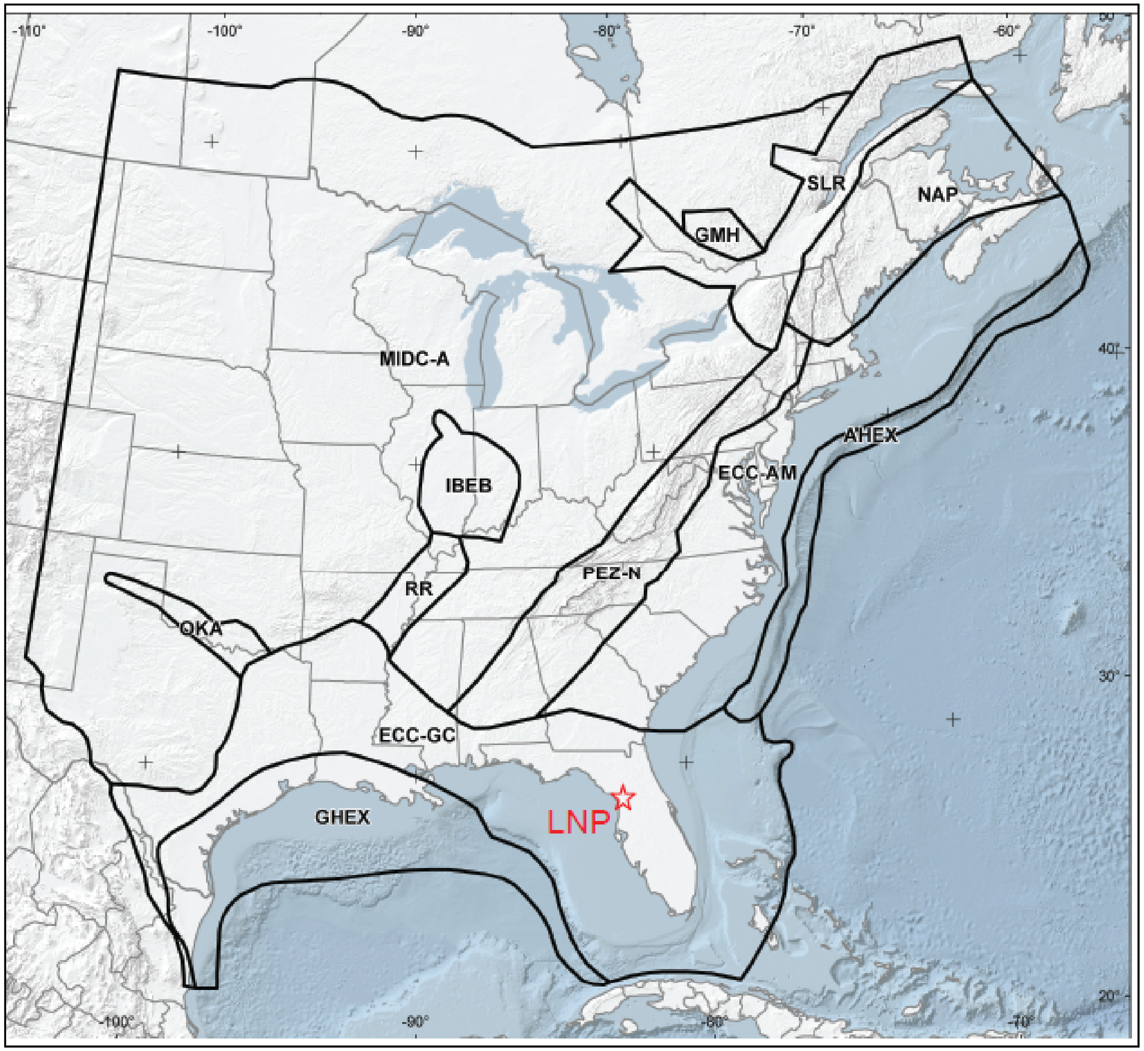


CEUS SSC Model – Mmax Zones



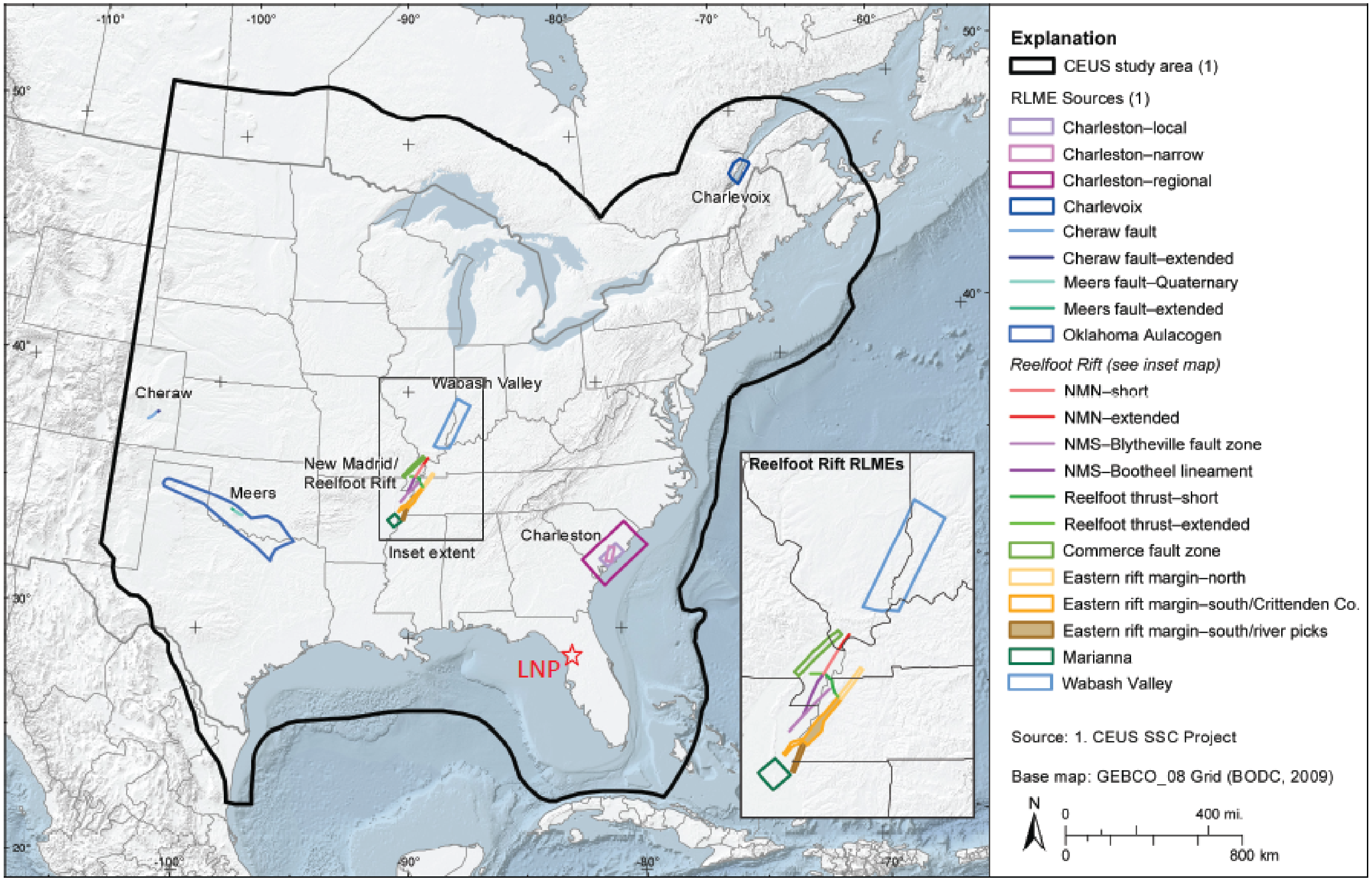
Mmax zones are based on average or "default" characteristics that are representative of large areas of the CEUS and are based on historical seismicity and broad-scale geologic and tectonic data.

CEUS SSC Model – Seismotectonic Zones



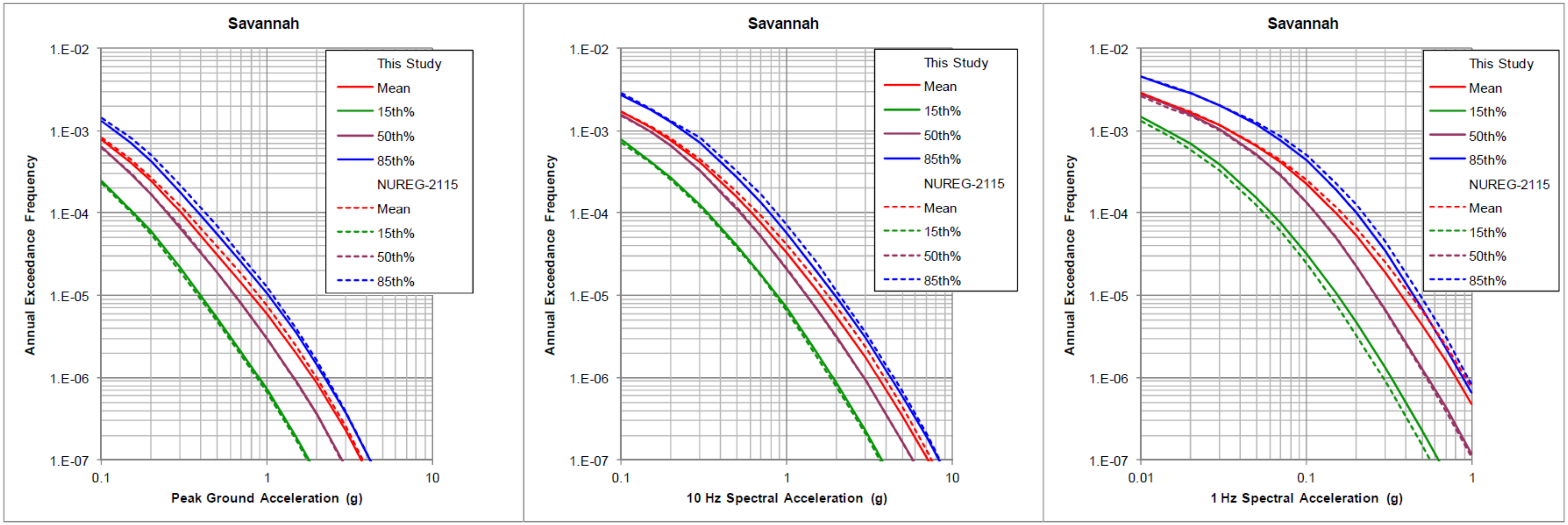
Seismotectonic zones are based on historical seismicity and regional-scale geologic and tectonic data to characterize seismic sources zones at a finer scale than the Mmax zones model.

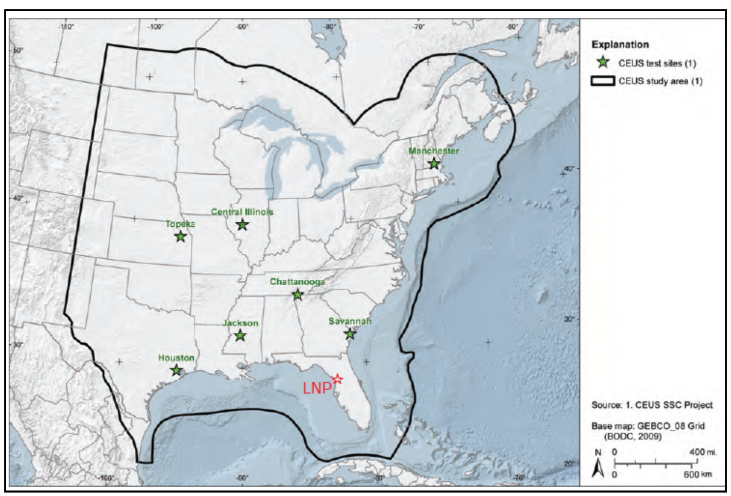
CEUS SSC Model – RLME Sources



Repeated Large Magnitude Earthquake (RLME) Sources are defined as having had two or more earthquakes with **M** ≥ 6.5.

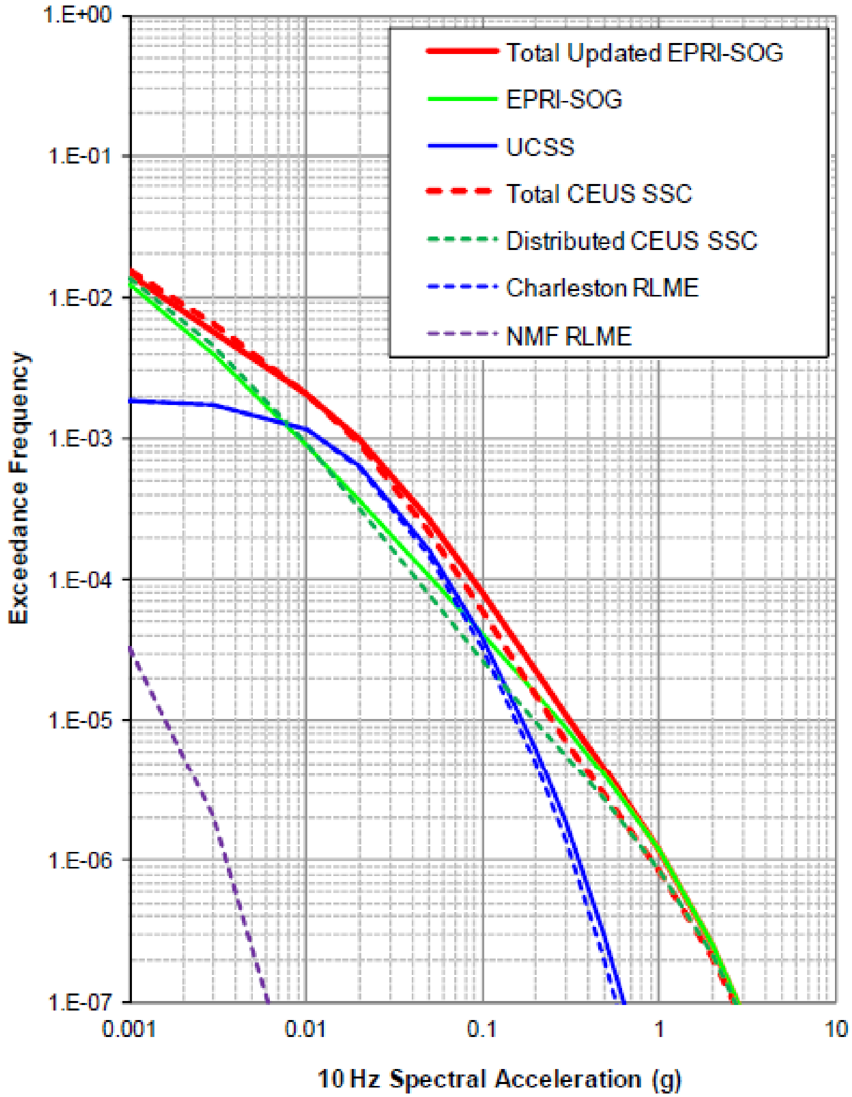
LNP’s Validation of CEUS SSC Software

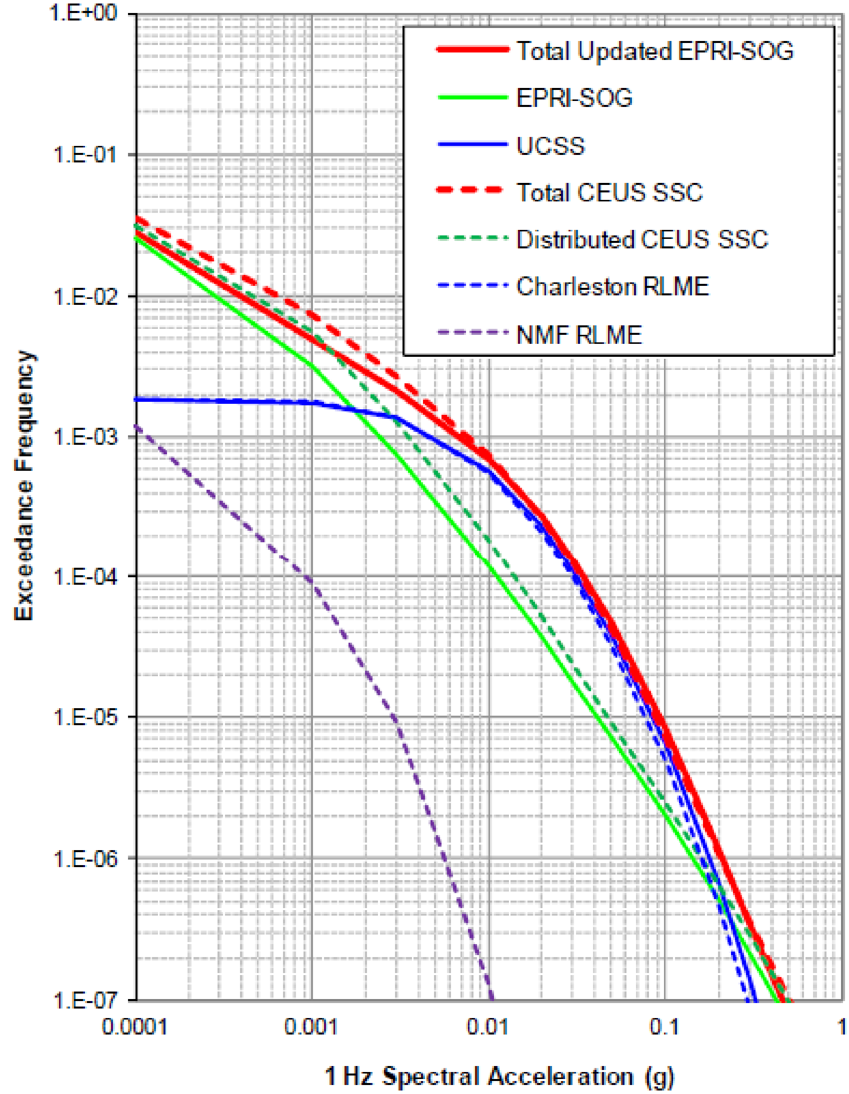




- Applicant tested its implementation of CEUS SSC model against each NUREG-2115 test site.
- Differences in spectral acceleration values were generally < 5%, except for at the Savannah site where differences were up to 13%.
- In the staff’s judgment, differences of 13% are within the accuracy of the PSHA model. Additionally, the Chattanooga site, which is a similar distance from Charleston as Levy, is modeled with < 5% differences.

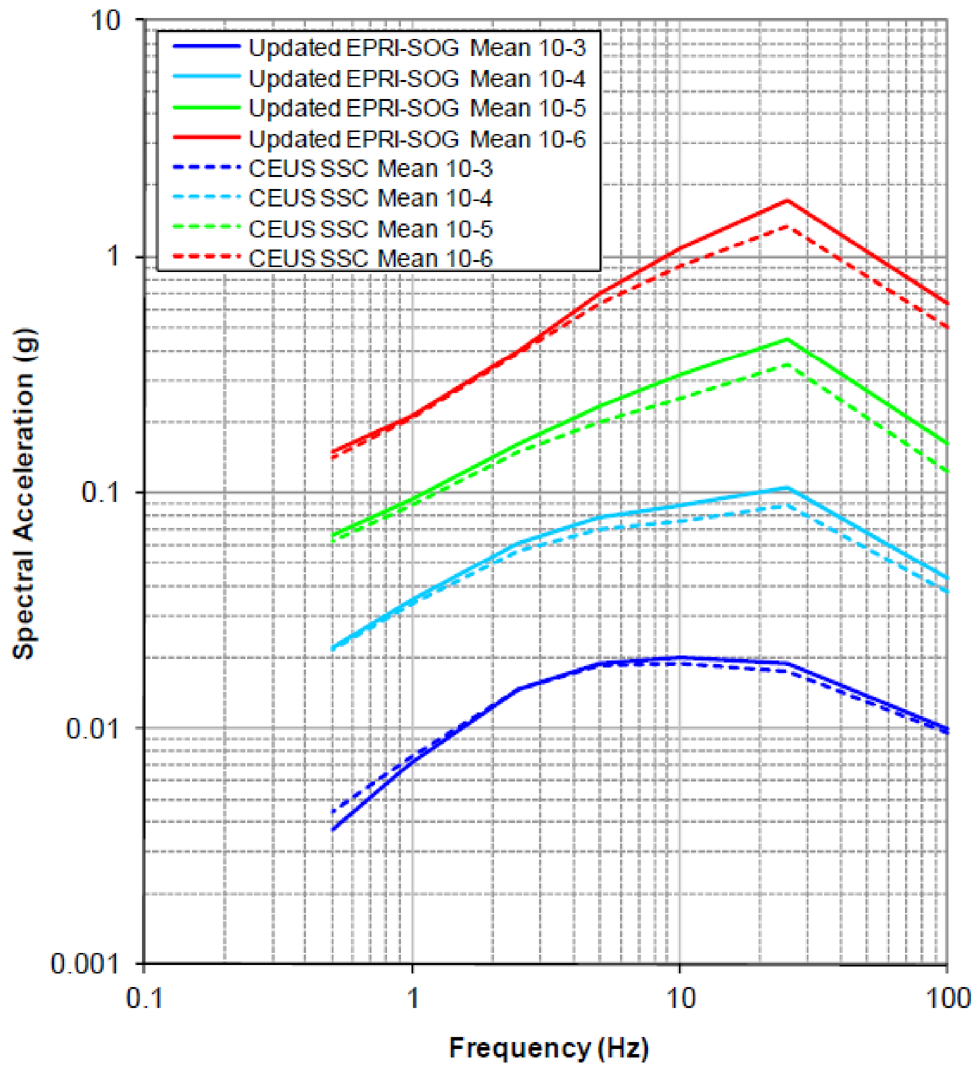
Contribution of Different Sources to Total Hazard – Updated EPRI-SOG Model vs. CEUS SSC Model





Hard Rock Uniform Hazard Response Spectra (UHRS) – Updated EPRI-SOG Model vs. CEUS SSC Model

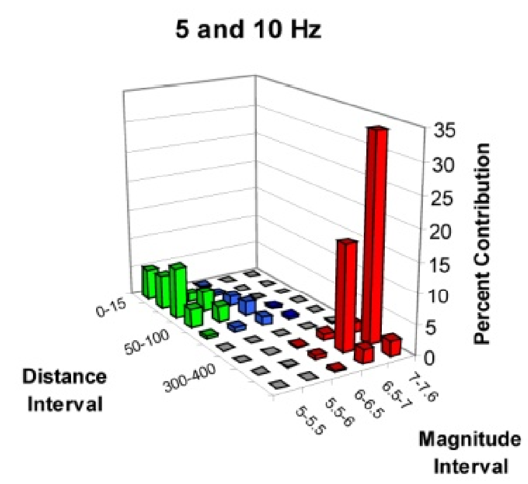
- The use of NUREG-2115's CEUS SSC model resulted in lower or equal hazard at the hard rock level (UHRS) for the frequencies of exceedance of interest (10^{-4} and 10^{-5}).
- Rock hazard at LNP site is relatively low.

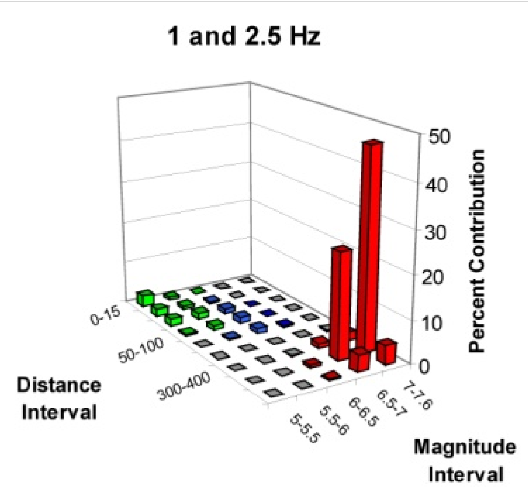


Deaggregation Earthquakes – Updated EPRI-SOG Model vs. CEUS SSC Model

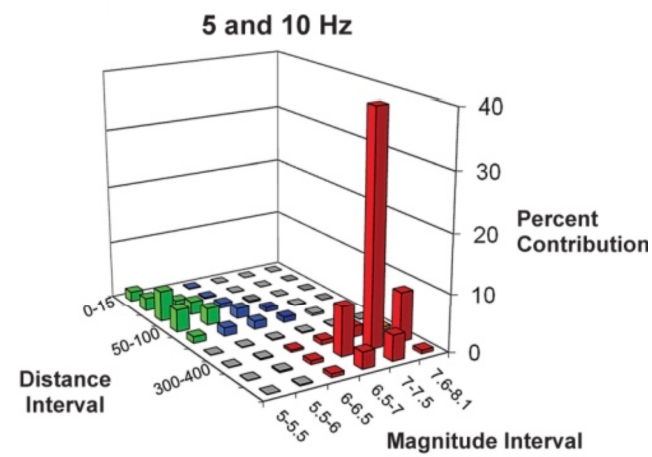
- The earthquakes controlling the UHRS are similar when using either the CEUS SSC or updated EPRI-SOG models.
- Main hazard source is Charleston north of LNP at a distance of more than 430 km.

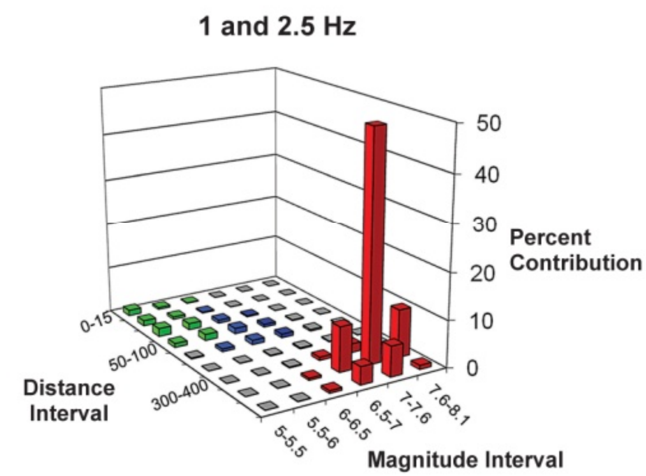
EPRI SOG, 10^{-4}





CEUS SSC, 10^{-4}





Calculation of Fault Rupture Area from Seismic Moment

- Issue: NUREG-2115 Equation H-1 shows the relationship between seismic moment and fault area rupture and, as shown in NUREG-2115, has a minor error.

$$\log_{10}A = \mathbf{M} - 4.366 \quad \text{vs.} \quad \log_{10}A = \mathbf{M} - 4.35$$

(NUREG-2115)

- Resolution: The applicant tested the effect of using the incorrect and correct equations on the rock hazard. The effect was less than 0.2 percent differences at spectral frequencies of 0.5, 1.0, 2.5, 5, 10, 25 and 100 Hz.

Charleston Regional RLME Source Rupture Orientations

- Issue: The Charleston regional RLME source, as specified in NUREG-2115, contains two alternative fault rupture orientations: (1) fault ruptures are northeast parallel with a weight of 0.80, and (2) fault ruptures are northwest parallel with a weight of 0.20. The applicant implemented only the (1) orientation in its final hazard calculations with a weight of 1.0.

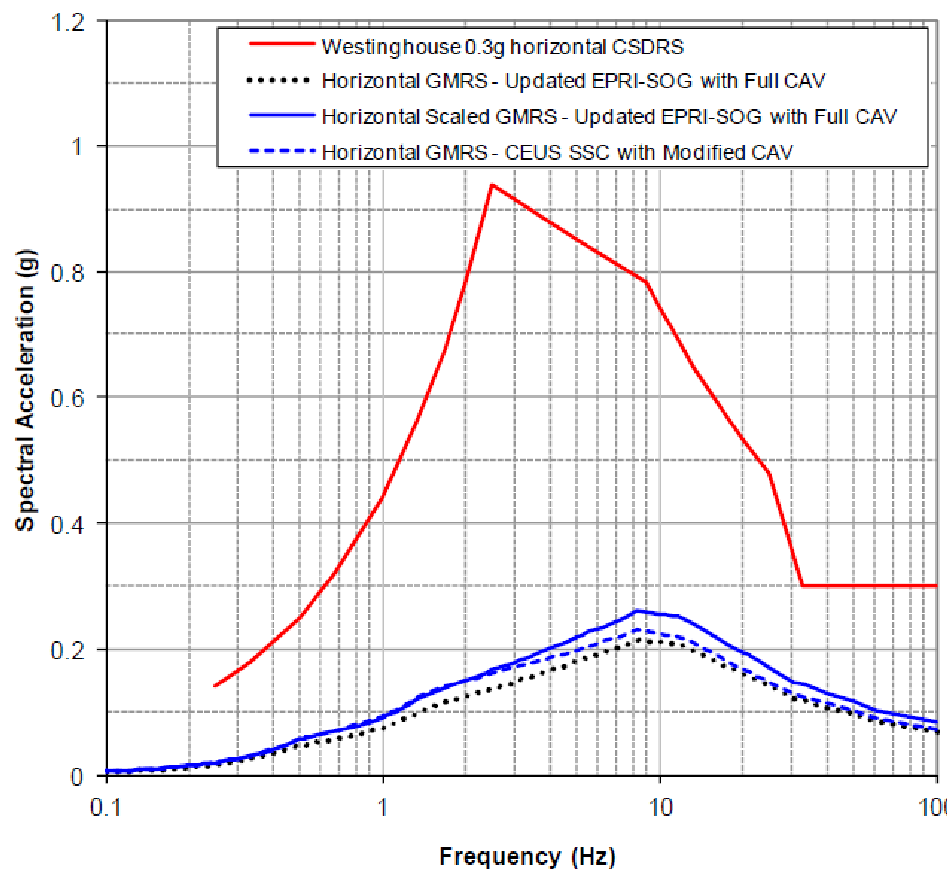
- Resolution: The applicant performed sensitivity calculations testing the use of both rupture orientations versus using only (1) with a weight of 1.0. The calculations showed that hazards for the 10^{-4} and 10^{-5} annual exceedance frequencies at 1 Hz spectral accelerations differ by approximately 0.04%.

From UHRS to GMRS – CAV Filter and Site Response

- With the updated EPRI-SOG model, the applicant implemented the CAV filter by performing the hazard integration using a minimum magnitude of **M** 4.0.
- With the CEUS SSC model and following the guidance in SECY-12-0025, the application of the CAV filter was limited to magnitudes less than or equal to **M** 5.5.
- Applicant used identical site response functions for both CEUS SSC model and with the updated EPRI-SOG model.

Comparison of GMRS with CSDRS – Updated EPRI-SOG Model vs. CEUS SSC Model

- Due to the use of the CAV filter, the CEUS SSC model GMRS is higher than the updated EPRI-SOG model GMRS.
- Applicant applied 1.212 scaling factor (consistent with FIRS scaling) to the updated EPRI-SOG model GMRS.
- After scaling, the updated EPRI-SOG model GMRS is generally higher than CEUS SSC model GMRS.
- Scaled updated EPRI-SOG model GMRS is the applicant's final GMRS, as presented in FSAR and SER Section 2.5.2.



Conclusions from the Fukushima RAI Seismic Request and Testing the New GMRS

- The applicant's use of NUREG-2115's CEUS SSC model resulted in lower or equal hazard at the hard rock level (UHRS) for the frequencies of exceedance of interest (10^{-4} and 10^{-5}).

- The applicant's use of the updated CAV filter requirements resulted in an increase in the GMRS. The applicant scaled it's updated EPRI-SOG model GMRS by 1.212 to accommodate for the increase in ground motion due to the CAV filter.

- The applicant's final GMRS, the scaled updated EPRI-SOG model GMRS, adequately characterizes the vibratory ground motion at the LNP site.

- The scaled updated EPRI-SOG model GMRS was evaluated in the following areas:
  - Liquefaction potential
  - Structural engineering
  - Seismic margins analysis

CEUS SSC Liquefaction Potential Evaluation

- Liquefaction is not possible under the nuclear island (NI) because the NI will be founded on roller-compacted concrete overlying the Avon Park formation. Site-specific liquefaction evaluation was performed for soil beyond the NI perimeter.

- The horizontal PGA values at the finished grade, ground surface, and excavation elevation computed using the scaled updated EPRI-SOG model are higher than that with the CEUS SSC model.

- Using higher PGA from scaled updated EPRI-SOG source model results in a conservative liquefaction evaluation according to the procedure endorsed by RG 1.198.
  - Detailed reanalysis of the soil liquefaction potential is not necessary for the ground motions using the CEUS SSC model.
  - Liquefiable ground outside NI is either removed or replaced with engineered backfill or stabilized with drains to prevent liquefaction.

Structural Engineering Assessment

- Staff focused the review of Recommendation 2.1 response on the AP1000 standard plant and site-specific structures to confirm the validity of prior findings (both seismic design and margin).

- Particular emphasis on:
  - Nuclear island (NI) floor response spectra (FRS)
  - Roller compacted concrete (RCC) bridging mat design
  - Seismic interaction (II/I)
  - Seismic margin

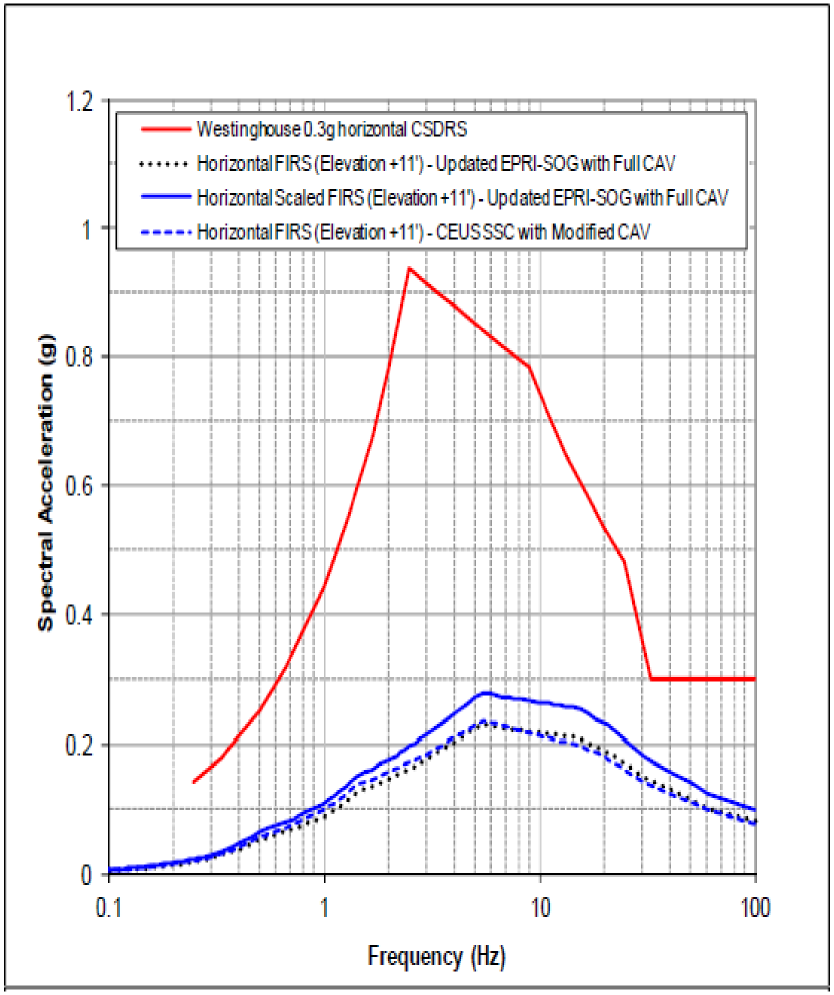
Foundation Input Response Spectra (FIRS) for the Standard Plant

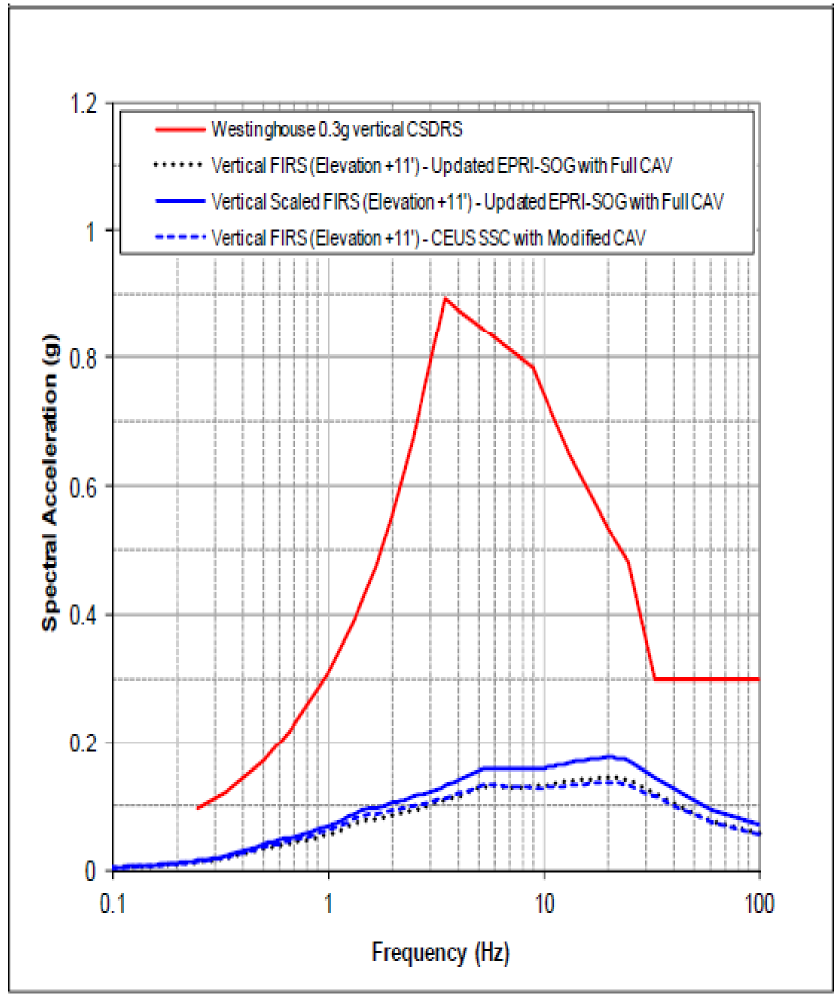
- The FIRS is used as input to seismic design and must meet minimum regulatory requirements in 10 CFR Part 50, Appendix S (0.1 g PGA).

- <u>Issue</u>: The LNP FIRS was previously developed using the EPRI-SOG model.

- <u>Resolution</u>: Comparison between the EPRI-SOG and the CEUS SSC models.
  - The applicant demonstrated that the LNP site-specific FIRS developed from the EPRI-SOG model and scaled to 0.1g PGA envelope the CEUS SSC FIRS.
  - The staff compared the LNP site-specific FIRS to the AP1000 certified seismic design response spectra (CSDRS) and notes that acceptable margin exists to the standard plant CSDRS.
  - The staff concludes that the information provided by the applicant demonstrates that the LNP FIRS is acceptable and that the applicant's design input ground motion, reviewed in Section 3.7 of the Safety Evaluation Report (SER), remains valid.

Comparison of CEUS SSC and Updated EPRI-SOG FIRS





Roller Compacted Concrete (RCC) Bridging Mat Design

- RCC bridging mat provides support to the nuclear island basemat.
- Bridging mat is designed for the soft rock site condition considered in the AP1000 standard design.
- Seismic demands are based on the AP1000 CSDRS, with a PGA of 0.3g, not the LNP site-specific demands (~0.1g).
- Issue: The LNP FIRS was previously developed using the EPRI-SOG model.
- Resolution: The applicant concluded that because the AP1000 generic site analyses are based on the CSDRS, thus, the design of the RCC bridging mat is conservative.
  - The staff compared the LNP site-specific FIRS to the AP1000 CSDRS and finds acceptable margin between the LNP FIRS and the CSDRS.
  - The staff finds the seismic demands used for the bridging mat design to be conservative and satisfies the requirements of Appendix S to 10 CFR Part 50.
  - On this basis, the staff finds that the conclusions regarding the bridge mat design, described in Section 3.8 of the SER, remain valid.

Seismic Category I and II Interactions

- The seismic Category II and non-seismic structures adjacent to the nuclear island are supported on drilled shaft foundations.

- The applicant used the performance-based surface response spectra (PBSRS) approach to compute the maximum relative displacement of the adjacent structures.

- Issue: The applicant's PBSRS was developed using the EPRI-SOG model.

- Resolution: Comparison between the EPRI-SOG and the CEUS SSC models.
  - The applicant demonstrated that the LNP PBSRS developed from the EPRI-SOG model envelope the PBSRS developed using the CEUS SSC model.
  - The staff compared the LNP PBSRS to the AP1000 CSDRS and noted that acceptable margin exists to the standard plant CSDRS.
  - The staff concludes that the information provided by the applicant demonstrate that the seismic gaps, provided in the standard design, are adequate to prevent interaction between the NI and the adjacent structures.

Site-Specific Seismic Margin

- NRC regulation requires COL applicants to demonstrate that their seismic margin assessment to be greater than or equal to 1.67 x GMRS.
- The LNP analysis shows that the designs of the bridge mat and adjacent structures are based on CSDRS demands (0.3 g) and not LNP site-specific demands (~0.1g).
- Staff review concludes that the CSDRS demands envelope both the LNP GMRS and PBSRS at all frequencies with acceptable margin.
- The applicant evaluated the lateral displacement of the foundation piles supporting the adjacent structures and also assessed the potential for liquefaction. Results showed the maximum relative displacements to be less than the AP1000 design gap and that liquefaction potential did not increase beyond the isolated pockets outside of the nuclear island footprint.
- Staff review finds that the applicant's seismic margin analysis, which considered liquefaction effects, was performed in accordance with relevant regulatory guidance and SRP sections, and is sufficient to demonstrate that the seismic gaps are adequate to prevent interaction between the nuclear island and the adjacent structures under beyond-design-basis loading.
- Based on the above, the staff finds that the conclusions pertaining to the LNP seismic margin analysis, described in Section 19.55 of the SER, remain valid.

Structural Review Conclusions

- The AP1000 standard plant design continues to envelope the safe shutdown earthquake (SSE) demands at the LNP site.
- The applicant's design for site-specific structures are based on conservative assumptions, and therefore do not require changes due to an increase in the GMRS at the LNP site.
- The staff's conclusions made in SER Sections 3.7, 3.8, and 19.55 remain valid.

Change in Applicant's Initial Plans for Inclined Grout Holes

- Applicant no longer plans to initially use inclined holes for grouting foundation bedrock to inhibit groundwater inflows during construction, as reported to the Subcommittee in October 2011.

- Grout uptakes will be carefully monitored by the applicant and inclined holes will be placed if deemed necessary based on excess grout uptakes.

- The staff accepts this approach for the following reasons:
  - No field data (i.e., borehole data and grouting test results) indicate the presence of large subsurface dissolution cavities at the site location.
  - Grouting is not needed for stabilizing foundation bedrock.
  - Grout uptake data will be assessed by applicant to assure no large subsurface dissolution cavities are intersected at the site location.

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Protecting People and the Environment

Presentation to the ACRS Subcommittee

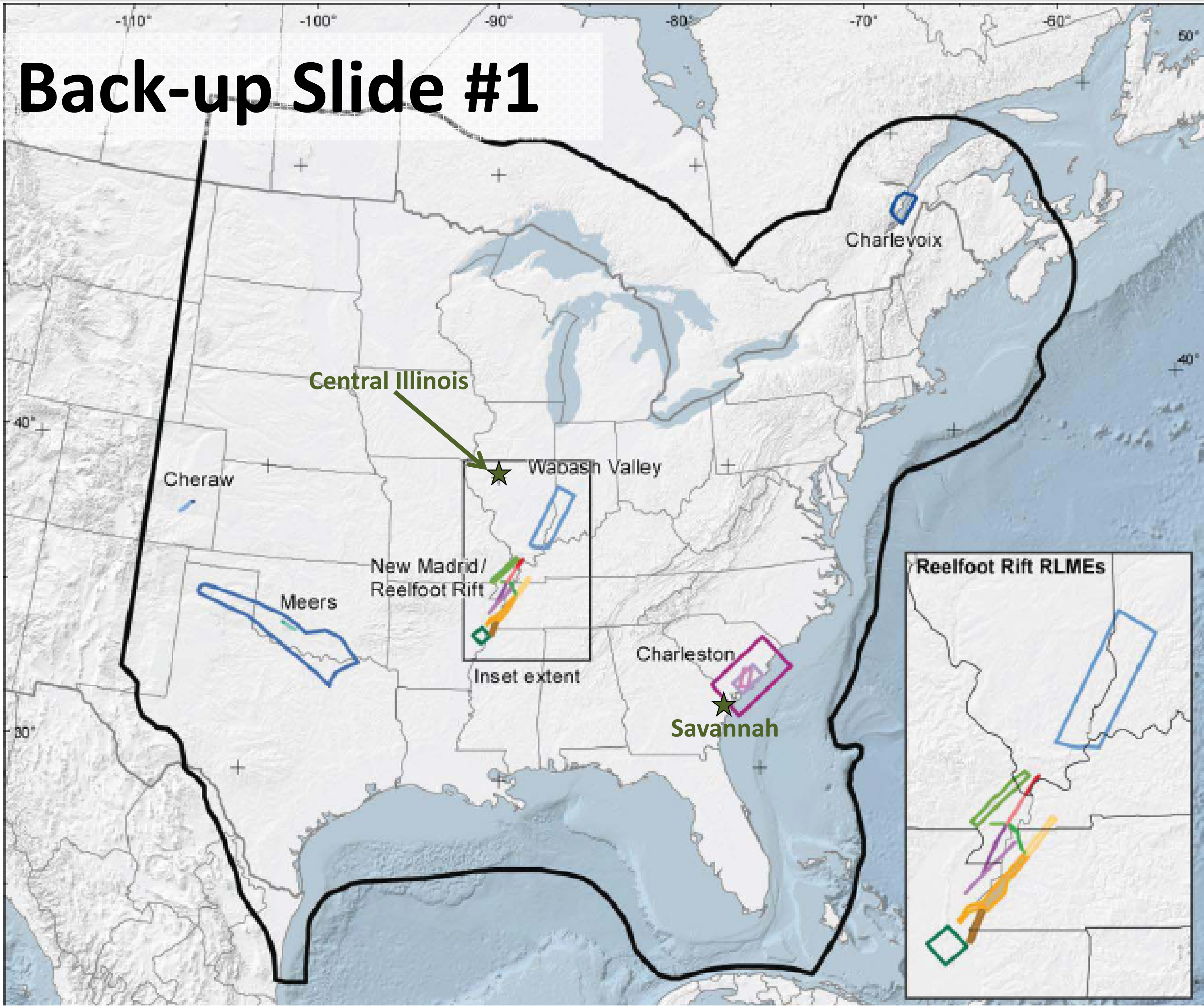
BACKUP SLIDES

Levy Nuclear Plant Units 1 and 2
COL Application Review

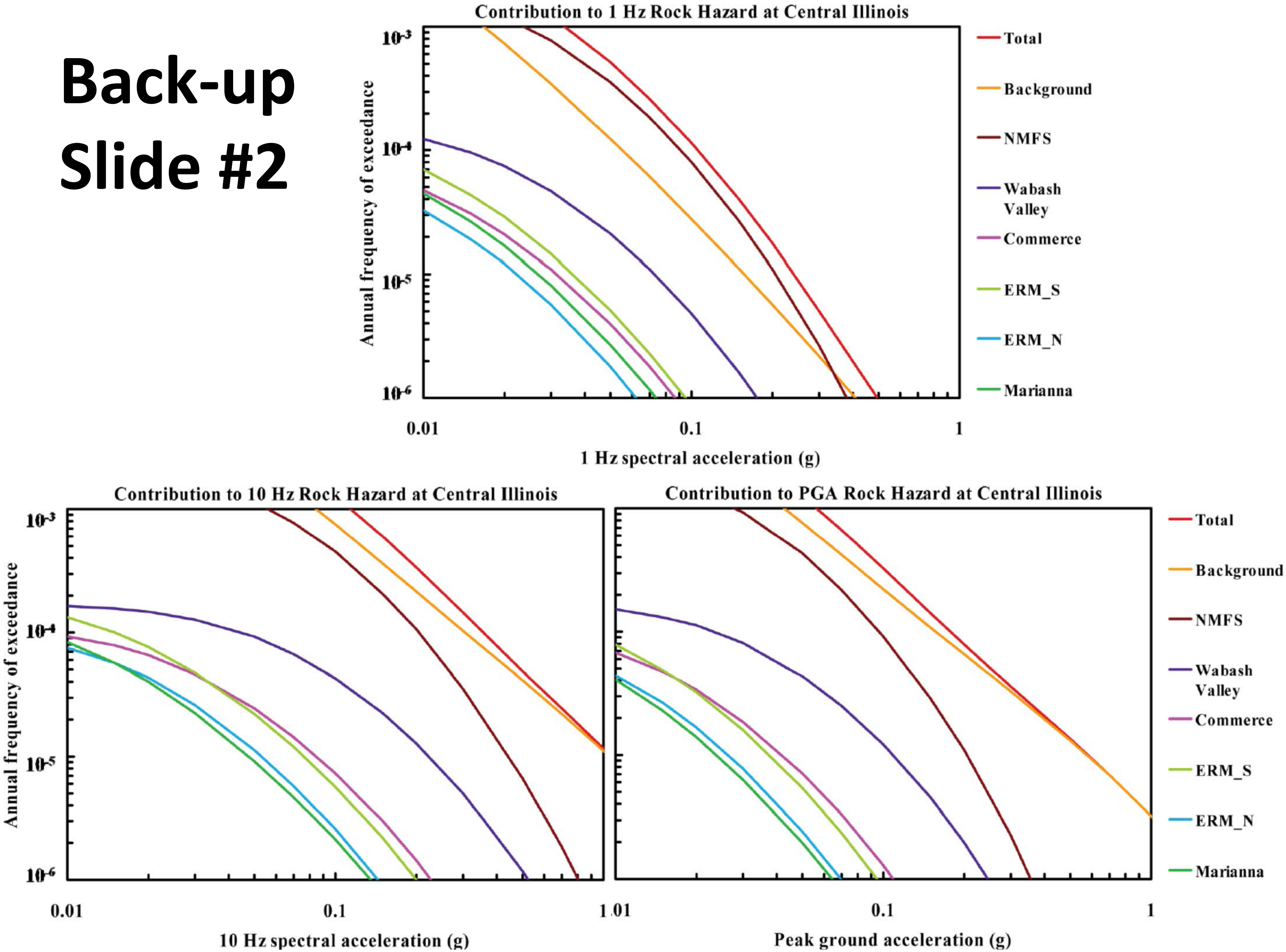
Fukushima Near-Term Task Force
Recommendation 2.1: Seismic Reevaluation

January 18, 2013

Back-up Slide #1



Back-up Slide #2



Back-up Slide #3