UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON THE STATUS OF NEAR-TERM TASK FORCE RECOMMENDATION 2 FOR SEISMIC HAZARD REEVALUATIONS

PUBLIC MEETING

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TUESDAY,

OCTOBER 7, 2014

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The public meeting was convened in the Commissioners= Hearing Room, One White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 9:00 a.m., Allison Macfarlane, Chairman, presiding.

PRESENT:

ALLISON M. MACFARLANE, Chairman

KRISTINE L. SVINICKI, Commissioner

WILLIAM C. OSTENDORFF, Commissioner

EXTERNAL PANEL:

DAVID APPLEGATE, U.S. Geological Survey

DAVID HEACOCK, Dominion Nuclear

GREG HARDY, Simpson Gumpertz & Heger

MARTIN McCANN, Jack R. Benjamin & Associates; Stanford University

JOHN ANDERSON, Nevada Seismological Laboratory; University of Nevada-Reno

NRC STAFF:

MARK SATORIUS, Executive Director for Operations

JENNIFER UHLE, Deputy Director for Reactor Safety Programs, NRR

JACK DAVIS, Director, Japan Lessons Learned Division, Nuclear Reactor Regulation (NRR)

SCOTT FLANDERS, Director, Division of Site Safety and Environmental Analysis (DSEA), Office of New Reactors (NRO)

CLIFF MUNSON, Senior Level Advisor for Siting, DSEA, NRO

P R O C E E D I N G S

8:57 a.m.

CHAIRMAN MACFARLANE: Okay, Good morning.

All right, so while you're getting settled, I'd like to welcome everybody to this morning's session. We're going to have a briefing on the status of actions that have been taken in response to the Near Term Task Force Recommendation 2 with a focus on the Reevaluated Seismic Hazards at U.S. Nuclear Power Plants using current methods and guidance.

So, the briefing today is going to provide perspectives on the lessons learned from the Fukushima accident and implementation of improvements related to seismic hazard reevaluations.

We're going to also hear, I think, a bit about industry progress since the March 2012 request for seismic hazards information.

So, the first panel is going to be an external panel which includes Dr. David Applegate from the U.S. Geological Survey. Mr. David Heacock from Dominion Nuclear, Greg Hardy, Dr. Greg Hardy, Mr. Greg Hardy, sorry, from Simpson, Gumpertz & Heger, Dr. McCann, Martin McCann from Jack Benjamin & Associates and Professor, Dr. John Anderson from the University of Nevada, yes, Reno.

Okay. So, we'll hear from you guys first, ten minutes each. Keep the acronyms to a minimum, watch the time so we stay on time. And then we have a five minute break and then we'll have our internal panel after that.

All right, so would any of my fellow Commissioners like to say anything? Okay, with that, I'm going to turn things over to Dr. Applegate.

DR. APPLEGATE: All right, is this, yes, on?

Great, well I want to thank the Commissioners for the opportunity to participate in this session and certainly applaud the Commission for its attention to the lessons learned from Fukushima and particularly those relating to the reevaluation of the seismic hazard, the effort to keep safety at U.S. plants up to date with the latest understanding that we have in the earth sciences and the process used to create earthquakes.

I think we all recognize that at the same time we approach earthquakes and their cascading consequences with a sense of dedication, but we also need to approach them with a sense of humility simple in terms of what we know and what we understand. And I think we have processes in place that can help us do that.

Our two agencies have a shared interest in seeing the seismic hazard in the U.S. well characterized and in having robust situational awareness following potentially damaging earthquakes here and abroad. And we do this at the USGS under a mandate from the Earthquake Hazard Reduction Act, we're part of the four agency National Earthquake Hazard Reduction Program with FEMA, the National Science Foundation and the National Institute of Standards and Technology.

So, with the second slide, I don't know it -- there we, excellent.

I just wanted to touch on a couple of the areas where I think we both benefitted from a long standing collaboration between our technical experts in both agencies and noted a few of the areas in this slide.

We participate in the Combined Operating License Reviews for seismological and geological issues with the Office of New Reactor. We provide ShakeCast estimates of -- rapid estimates of strong shaking at U.S. nuclear power plants, work together to evaluate seismic monitoring needs in the Central and Eastern U.S. in support of nuclear plant safety, research on ground motions, and with respect to tsunami hazard assessment, you know, I think we work together on a number of different hazards.

First, this is a key one related to the earthquake issue and well before Tohoku and the Fukushima event, we were partnering with our coastal marine scientists to look at those potential black swans that may lay off our East Coast in terms of submarine landslides, the Northern Cuba Thrust Belt and then other far field landslides and earthquakes.

All of this feeding into the techniques for a probabilistic tsunami hazard assessment. So, I think this is very important ongoing work and ongoing effort.

The next slide shows the ShakeCast results from the Virginia earthquake and U.S. NRC has been an important partner in the development of ShakeCast which enables critical infrastructure and other users to be able to take the shaking intensity that we're able to rapidly generate after an earthquake and translate that, bring it back within their firewall to look at the vulnerability of their own systems to be able to prioritize the response for their own facilities.

What's shown here is the estimate of shaking that was generated. So, within 20 minutes of that event, there was the indication that there had been an exceedance of the design basis at the North Anna Power Plant.

That was ultimately confirmed by onsite equipment, but because of the obsolete data format, it was four weeks before that could happen. This was information, this was situational awareness that was available right away and that's, I think, going to be important going forward.

And that's true, not just domestically thinking about U.S. nuclear power plants, but we also collaborate with the International Atomic Energy Agency and the U.S. NRC. So that's available, that situational is available for power plants around the world, including research reactors.

The next slide, you know, as we think about the issues that we face in this country and particularly the prevalence of power plants on the Eastern part of the U.S., you know, following the Virginia earthquake, what this shows are the did-you-feel-it reports. We had 140,000 human seismometers come and tell us what they experienced in that earthquake from Maine to Georgia all the way out to the Mississippi.

And what this really conveys, and this is a comparison of similar sized earthquakes on the East and West Coast, is that a attenuation of the energy is really a different ball game in the East and that's why the, I think, the Next Generation Attenuation project, NGAE's project, the U.S. NRC leads is so important.

And certainty in the ground motion prediction equations is one of, if not the largest source, of uncertainty and probabilistic seismic hazard assessment.

So, I commend the Commission for undertaking development of these next generation ground motion models as well as the next generation seismic source model for the Central and Eastern U.S.

And the next slide shows our National Seismic Hazard Maps. Our technical experts participated in the development of that of seismic source model and that, in turn, has now informed our latest release which just came out of the National Hazard Map.

We update these maps every six years and we do that because we have an evolving understanding of the hazard. And this is really the heart of the NEHRP partnership that I mentioned. This is all of the -- really everything that we know.

We don't just take one stream of data or hang our hat on one type of information but bring together geologic, geophysical, seismological, geodetic data and information, put that into logic trees that really form the framework of the probabilistic seismic hazardous assessment methodology. It allows us to incorporate new information in a coherent, structured, reproducible and transparent fashion.

One of the challenges -- next slide -- one of the challenges particularly in the East is for both for hazard characterization as well as for situational awareness, is the lack of monitoring data.

You know, new knowledge continues to pour in, some of it's driven by application of new technologies, some by new investments. And in this case, the National Science Foundation has invested in its Earthscope project, a giant rolling sort of cascade of seismic sensors deployed across the country. They've now come to the Eastern part of the U.S. where we have particularly sparse coverage.

The Office of Management and Budget recognized this as a good government opportunity to keep those stations in these areas for a variety of purposes. And they brought together the NRC, Department of Energy, USGS, NSF and others to look at what should be the priorities for maintaining these stations on a permanent basis. And that is a process that's now -- the deployment is underway, the long term issues of maintaining it sort of are the outstanding challenge.

To be able to have this network and combine that with the having improved at-site monitoring in nuclear power plants would be, I think, a powerful combination.

The next slide talks about induced seismicity. This is a major focus for our earthquake program. It draws on decades of expertise both in seismology and hydrology to come together to deal with this detective story.

The figure shows the number of magnitude three-plus earthquakes in Oklahoma which is overtaken California as the most active of the lower 48. I think the Napa quake can be viewed as California's attempt to retake the lead in this.

But quantifying the associated hazard, seismic hazards, is a major challenge for us and I think also a matter of significant interest to the U.S. NRC as well and it's an area that's ripe for additional collaboration.

And right now, the focus is on high-pressure wastewater injection associated with enhanced oil and gas recovery, but in the future, the potential for geologic sequestration of carbon could dramatically expand this as an issue.

The next slide on earthquake early warning, you know, in the wake of tragedy like Fukushima, we rightly focus on the lessons learned form what did not work. But we also learn from what did. We know the value of tsunami warnings, there was a quarter of million people in the inundation zone, the loss of life of 20,000 is way too high but it could have been so much worse.

Likewise, the number of fatalities from the shaking from the earthquake were on the order of maybe less than 200 and that reflects building codes, that reflects preparedness, but it also reflects an in-place earthquake early warning system.

We have a prototype for the West Coast. The Napa earthquake was a major and I think successful test of that.

For the utilities, this can mean faster alerting of strong shaking, more time to react and to take steps before the shaking arrives.

The next slide is, and this is the last sort of topic I'll raise as, I think, an opportunity going forward as we think about reevaluation of earthquake hazards, is we have found that scenarios to be a very powerful tool for trying to look at, not just the event itself, but all of those consequences.

And we've worked with very broad partnerships of engineers, emergency managers, utility operators, planners and other to work through the cascading effects of catastrophic events, whether the southern San Andreas earthquake or a major severe storm in California or a tsunami that affects our port infrastructure.

It's a way to create a platform for dialogue to think about those perhaps unintended consequences and downstream effects that ultimately can be so important for the overall hazard.

So, again, thank you for the opportunity to be here. At the USGS, we welcome the opportunity to build on our existing cooperative efforts and work together to address critical earth science, earthquake science needs both in the research realm as well as in the monitoring arena.

So, thank you for your attention to this issue.

CHAIRMAN MACFARLANE: Great, thank you.

Mr. Heacock?

MR. HEACOCK: Thank you very much. Good morning.

What I'm going to do is take what you heard and try to apply it to what the plants have done in response to the Tohoku earthquake.

Let's go on to the first slide, the overview slide.

There's been a quite a bit of operating experience around the country. One the previous visits I came up here and talked about the North Anna earthquake and that earthquake was about, at the peak ground acceleration, was about two and half times the safe shutdown earthquake for North Anna. And we found no damage to safety related equipment at the site.

To kind of put it in perspective, if you look at the Kashiwazaki-Kariwa earthquake in 2007 in Japan, that earthquake had an energy level of about 2.6 times the earthquake at North Anna. And really, there was no damage to safety related equipment there.

We got some interesting data form the USGS website, actually. It showed the energy level of multiple earthquakes.

The Onagawa which saw the same earthquake essentially as Fukushima Daiichi and Daini, 7,317 times the strength of North Anna earthquake to kind of put it in perspective.

So, you kind of see that, and Onagawa was a good case study because there wasn't significant tsunami damage there. You can go and kind of see what the earthquake did relative to the tsunami and maybe the hydrogen explosion damage that you saw at Daiichi. So, it's a little bit better of case study there.

So, to see plant that essentially survived intact with no safety related equipment being damaged with 7,000 times the energy level of the North Anna earthquake which, in itself, was two and a half times the design basis of the plant kind of puts it in perspective how much margin these plants have designed into them.

Now, obviously, each of these plants are designed for different seismic hazards, so there are different supports and so forth. But it kind of puts it in perspective. That's a pretty big difference in those plants.

Back in 2010, the NRC looked at Generic Issue 199 and this was due to the seismic hazard the USGS came out with in 2008. They also looked at some previous EPRI and Lawrence Livermore National Lab data and compared those and determined that the fleet of plants in the U.S. was still safe with a higher hazard in 2008.

That's been redone, I'll talk about in just a minute, by EPRI in 2013 and 2014 with essentially the same results with the new hazard that was just generated.

I do want to mention the last item here, mitigating strategies. North Anna Unit 2 is currently in a refueling outage and as of Sunday, it is the first plant in the United States to be in full compliance with all the mitigating strategy requirements in the Order.

Now, we'll notify the NRC within 60 days as required by the Order but we have reached compliance. All the equipment has been purchased, it's onsite. We have a two foot thick concrete dome encompassing a 10,000 square foot storage facility with all the N equipment, a number of equipment is in that. We have n+1 stored separately, physically separate location.

All the physical tie ins are done. All the training's done and the procedures are in place to invoke that and approved by the Plant Safety Committee. So, North Anna 2 is the first one in that category.

All plants have ordered the equipment. The vast majority, if not all the equipment's already onsite at all the plants but the storage facilities and all the tie ins, training and procedures aren't done in all cases.

But we do have that equipment, it's very similar to the previous Security Order, the B5b equipment and that has procedures in place to use that.

Next slide, please?

I'm not going to spend much time on this. I just want to kind of point out the time line here from the Near Term Task Force Evaluation on through to current day processes.

The NRC staff and industry have been very busy working on public forums. There's -- Mike can probably know the numbers, probably 70 or 100 public meetings have occurred in the last couple of years. A tremendous amount of effort went into this on all parties, a lot of stakeholders involved. And I think we've reached a pretty good position here. I'll talk more about some of the other acronyms on here and try to avoid talking about those as acronyms.

Let's go on to the next slide, please.

EPRI did this core damage frequency really a follow-up on the methodology that the NRC established during Generic Issue 199 and repeated that methodology with the 2012 Central/Eastern United States Hazard Source Term that was created.

The attenuation model was modified with all the parties that were involved in it in 2013 and to kind of put this simply, the source term is the initiation of the event at the location of the earthquake. The attenuation model takes it from there to the hard rock at the location of the power plant in this case.

And then the simpli cation model, the third model takes it up to a control point in the surface. Then from there, we have to translate it into buildings and then in structure response spectrum takes it to individual floors where safety related equipment is located.

So, it takes it takes a combination of at least four to five models to get it from the source of the earthquake all the way through to where the equipment's being effected.

So, all these things have to happen. It's a very, very complex thing and the other gentlemen on this panel here can answer all the technical questions about how that happens. But the kind of simple terms is how I look at it.

The NRC independently looked at these same data and did their own calculations and came up with essentially the same point. And I'll get to some differences at 15 plants in just a minute.

But the bottom line is that, as a fleet, all the plants in the U.S. came out essentially where they were in 2010 when the NRC did their evaluation on Generic Issue 199. The curves look very similar, in fact, the vast majority of plants have a lower seismic hazard than they did in 2010. A few plants have a higher seismic hazard.

The next slide talks about this and ultimately the plants were grouped by the NRC into three groups.

Group 1 are those plants that the ground motion response spectrum, the new hazard at the plant is essentially significantly larger than the old hazard at the plant. So those are plants that require the most prompt action.

Group 2 have a smaller exceedance and Group 3 have either a very small exceedance or no exceedance perhaps. There's other issues with those plants.

Then there's really fourth group which is screened out, that the new hazard is less than or equal to the old hazard and there's no additional actions required.

Some plants require additional hazard analysis beyond what they've already done.

And on the next slide, I'll talk about the expedited seismic evaluation process. We call this the ESEP.

What we thought here is that we've already analyzed all the plants as a group and determined that overall, the fleet is safe. However, the plants that have the largest seismic exceedance, we thought we'd have additional assurance that those plants were safe by looking at what we call FLEX Phase 1.

The flexible equipment has installed plant equipment that has to operate. For a pressurized water reactor it's pretty simply the storage tank for emergency water, a pump to deliver that water to the steam generators and a flow path to get the steam back out again. So, it's sort of that cooling loop to keep the core cool, the primary loops by natural circulation.

So, that's the FLEX Phase 1 equipment that's being evaluated with expedited seismic evaluation process at all plants that have this exceedance. And that was scheduled to be done by the end of the year. There are some plants that were conditionally screened in that are sort of in limbo right now until that gets resolved whether they have to do the ESEP or not do the ESEP. So, this is linked to FLEX.

The second phase of FLEX is the portable onsite equipment we've talked about previously. And the third phase is regional response centers which are both now in service.

We had a drill at our Surry plant recently where we simulated bringing a piece of equipment by air from originally a Memphis facility was the one that it was requested from, that facility was deemed to be unavailable and we simulated bringing up from Phoenix out to Surry and deliver it within 24 hours to the site.

We can deliver pumps, one set of equipment is 20 tractor trailer loads of equipment, that's one set and there's five sets at each of these response centers.

In addition, each site has n+1 sets of equipment that we can borrow. And what we've done across the industry is made this equipment all the same connection. So, all the pumps, all the electric connections are identical across the fleet. So, you can take a pump from Calvert Cliffs and bring it down to North Anna and the fittings will all hook up and match. So, that's been from the very beginning we wanted to make these interchangeable.

So, this Expedited Seismic Evaluation Process is an interim measure until the seismic PRAs can be done. And these were grouped into categories because the amount of resources available to do that is limited within the NRC and within the industry.

So, we'll work through those that are most critical first by June 30th of 2017 and they'll be done. North Anna happens to be one of the plants in that category in Group 1.

And I will say for North Anna, we did the Expedited Seismic Evaluation Process. I asked my folks to do it prior to the

March submittal of our new seismic hazard. And we did a high level review of that, we're finishing that out right and we'll submit it by the end of the year in accordance with the requirements. But we found no reason for additional modifications as a result of that evaluation. So, the good news is there is significant margin available at North Anna and I expect other plants will find very similar results.

The next slide is the next steps. The expedited evaluations, as I mentioned, will be done by the end of the year. And then there's three time zones for Group 1, Group 2 and Group 3 plants, 2017, 2018 and 2020 for those three groups respectively.

High frequency evaluations, there are some exceedances above 10 hertz that affect things like relays and contactors and so forth. And I think Greg is going to refer to some of that information. I'm not going to go into detail on that. But many plants require a high frequency evaluation.

Shaker tests have been done on over a 150 components and the results look pretty favorable to date and I'll let Greg talk more about that.

The last item here is -- two more items -- the mitigating strategies, we have to look at a new seismic hazard, new flooding hazards, et cetera and how they might affect the mitigating strategies already in place. If find the hazards higher than we assumed, we're going to have to go back and make provisions for that.

The last item here is some of the Tier 2 and Tier 3 in Near Term Task Force items. These are things like the ten year review of plants and what do you do when the new attenuation models called NGA-East comes out. Next year it'll be out in April and the NRC will review that probably by the end of 2015, early 2016. That will be the new attenuation model.

So, we have to figure out how to deal with this emerging information whether we need to do a overall new seismic PRA, what we need to just kind of look at a sensitivity analysis on the whole industry.

And the bottom line is we believe that the nuclear fleet is seismically robust and we have provisions in place to invoke many, many new requirements already.

That concludes my remarks. Thank you.

CHAIRMAN MACFARLANE: Great, thank you.

Mr. Hardy?

MR. HARDY: Thank you. I guess it's on now. Thank you, appreciate the opportunity to talk to the Commission.

I was asked to talk a little bit about improvements and challenges related to the 2.1 Seismic. It's going to be hard to do in a ten minute period because there's been quite a variety of improvements post-Fukushima as well as remaining challenges, I think, left to us.

I've had the opportunity to investigate several recent earthquakes that have occurred that affected nuclear plants, Kashiwazaki 2007, Fukushima-Daini, North Anna. Dave brought me over the day after the earthquake. And even Onagawa had two previous earthquakes pre-2011 that exceeded their design basis.

So, we think we understand a little bit about where the thresholds are, what happens in these earthquakes, but it's an evolving science. So, we do what we can to put together a program to evaluate these nuclear plants.

We go the next slide, maybe the starting one.

We've skipped one, but basically, we're going to talk about the improvements and look at guidance documents that we've developed, EPRI research tasks and training for the industry.

We've got some challenges ahead of us. The schedule that Dave mentioned, limited expertise. We've put together these training programs and we're going to try and increase that. And we've got an evolving set of understanding of the hazard and the tools we use to evaluate them.

So, the regulatory stability issue, I guess, is something worth -- we're going to have to jointly think about over time.

Next slide, please?

Dave mentioned the so-called SPID, it's a Screening Prioritization and Implementation Details document. It's a pretty extensive document we put together, published 2013 and it addresses the long term program of how we evaluate the seismic safety. So, it is fairly detailed and goes into much of the kinds of elements I've listed here.

Seismic hazard, it talks about how you develop it. What the appropriate methods?

Something called the GMRS that Dave has referred to, Ground Motion Response Spectrum, and it is kind of akin to a design level based probabilistically. Screening prioritization and Seismic Risk Evaluation are all elements of that.

Next slide, we talk about this ESEP, that again Dave has mentioned. But in parallel to this longer term program put together a shorter term evaluation that would be able to produce kind of a quick look at what might be the most important items and quickly see if we can't upgrade those. And, indeed, that program is scheduled to be completed by the end of the year in which time submittals will be made and modifications will be submitted.

So, we're finding that there are, indeed, some areas, top supports for some electrical cabinets, some things that are being planned for some of these utilities, but again, it's ongoing.

Okay, next slide?

So, in parallel to what I'll call these more programmatic efforts of the SPID and ESEP. These were going on, some of these at the time of 2011 earthquake, but certainly, it's something that has increased the relevance.

We have a number of research projects and I won't go into a lot detail because these are probably, so to speak, down in the weeds a little bit.

But there are certain elements you've got to use as part of this Seismic Safety Review and we have ongoing efforts to try to improve our tools, so to speak.

Ongoing effort we're involved with in terms of how you model the structurals. All these structures require a math model. You can either use what was done in the past, something called the Lump Mass or Stick Model or you can do what modern kind of new plants will do a finite element characterization.

The question on the table would be, are the current Lump Mass models that were used in the design basis acceptable for risk studies? So, we've got quite an effort going on to evaluate the two, show the differences and give guidance on them.

High frequency, Dave mentioned, for hard rock sites we are finding the new hazards are rich in high frequencies and, indeed, we never looked at that in past. We've been doing seismic PRAs for 30 years, but most of them have been in what we call a California Earthquake Lower Frequency Input.

Now, we're finding for these hard rock sites, in the East we see some high frequency energy and, indeed, we had to do some testing to evaluate what the effects might be.

So, you can take a fist and pound it on the table and put a high frequency load, but the question is, what kinds of components will it really affect? That's the question on the table which we're doing a little work on.

Seismic hazards, you'll hear more about it from both ends of the table on what's going on and, indeed, they are fairly exhaustive studies that were ongoing at the time of the earthquake. They've progressed to the point where we've got much better characterization of what the seismic hazard is. And, but again, it's ongoing, there are current studies ongoing that will refine them even more.

And then there are certain more narrow issues with how strong a bolt is. Some of the deeply imbedded bolts, there's a current research project to try to refine that to see what kinds of capacities these have.

A lot of the safety related equipment are anchored to the concrete floors and, indeed, getting good capacities for those. There's something that's an ongoing study.

So, the next slide has just a quick characterization that shows you a cartoon of what a finite element versus a stick model is. Again, we're completing that study and will have it done by the end of the year.

The intent is to provide guidance to practitioners both industry and NRC alike on when you might use each of these models, when it would be acceptable, what kinds of structures you might be able put and use the response from these Lump Mass Stick models.

The next slide is, as Dave mentioned, this high frequency program. Again, we are finding a lot of the new hazards have energy in the high frequencies. The question then come, what do we do with it? What does it mean? How do we evaluate components?

We did a study and produced a list of items that might be on your safe shutdown list that could be sensitive potentially to high frequencies. This would include things like switches and relays typically that have a failure mode that might be sensitive.

We studied the effects of some blast loads years ago on relays, got some capacities from those, but certainly an earthquake's a different animal even though the frequencies might be the same.

So, we're doing quite an exhaustive set of about a hundred components that we're doing tests on specifically to understand what levels they will actually get in what they call chatters. So, it might change state.

That's an ongoing program and found quite high capacities of most of these components, not over yet. We should have a meeting with the NRC coming up in a few weeks to kind of give them some of the early results.

Next slide?

This just shows the shake table we used. A lot of these components are smaller components. They are what we call the switches, the relays, those kinds of items. We do quite a bit of different types of testing on them but, again, to evaluate how high the high frequency input could be before they have problems. We should be finishing that up, as I said, by the end of the year.

Next slide?

Now, in addition to all the -- talked about a bit of all the programmatic topics we've done. Some of the EPRI research projects, I didn't list them all.

But training has been an important element also. We have an ongoing pretty impressive list of training going on to try to increase the expertise within the industry and the NRC.

Specific training to support NTTF 2.1, we put on several sessions of how you do these approaches? The SPID ESEP specific training to the industry.

Seismic Hazard Workshops, there's a new technique that's been used and understanding the results and how you use it on the hazard, we've had several sessions and workshops throughout the last year and this year.

I apologize for this next acronym HCLPF. I don't think Dave introduced it. It's a High Confidence and Low Probability of Failure and you might think of it as the level that would be similar to what a structural code would be. So, it's an allowable type load probabilistically based and it is the basis for using these evaluations, both ESEP and the SPID.

So, we put on several training courses, there's probably three on the techniques that are used to develop these values that you use for your seismic safety reviews.

We've had ongoing SPRA courses. I think we've got on next week in our office. It's a week long course and we have more NRC people than industry people at this course coming up. So, it's been well attended.

And early practitioner workshops. Some of the utilities are going through these seismic risk assessments now. We've taken lessons learned from those and have ongoing meetings to try to share those lessons learned throughout the industry.

Okay, so now, what's left? Go to the next slide, please and you can follow-up with the next one.

Schedule has been a real challenge. I don't expect you to be able to look at this thing, but these are all parallel efforts going on that the industry's had to take and the NRC has had to kind of dovetail into those. So, it's been aggressive, made a lot of kind of headway on these. If you flip through those, I think it'll show kind of a highlight each of the elements, ESEP, site specific subsurface materials.

Go ahead, you can flip through, just site specific GMRS, seismic risk assessment and high frequency confirmation. These are some of the researchy things. Spent fuel pool has been a special topic and keep going. That's it.

So, what are the remaining challenges? I just listed a few here but there are significant resources being used to develop these SPRAs and they are multi-year efforts I can tell you. To put all the elements into place and complete one of these, do the appropriate sensitivity studies is a major effort.

While those are ongoing, as I mentioned, there are research efforts, early movers. We are developing better methods as we speak on how to perform these risk assessments.

The resulting seismic risk values have very high uncertainties as you'll find in these extreme events, external events. Uncertainty assessments are key.

Changes in the key elements that drive the seismic risk. The seismic hazard being one of the fundamental ones. As I mentioned, there are ongoing studies that might change the seismic hazards.

And then just this element of acceptable risk versus modifications versus the development of more accurate seismic risk methods.

So, you come up with a seismic risk estimate, you can refine that estimate or you can do a modification. Giving guidance on how to do that is one of the key elements.

Capabilities to support peer reviews, Dave mentioned we need more expertise in order to do this program on an industry wide basis.

And then managing periodic updates to the hazard. We'll talk a little more about the hazard.

Thank you.

CHAIRMAN MACFARLANE: Great, thank you.

Dr. McCann?

DR. MCCANN: Thank you. Good morning. Thank you for the opportunity to be here today.

As Greg mentioned, I'll be talking a bit about seismic hazard.

Next slide?

As you know, the Task Force Recommendation 2 suggested that licensees be required to reevaluate the seismic and flood design bases for operating reactors. And in the Seismic 2.1 part of the 50.54(f) letter, what the licensees were expect to do was laid out.

What I've been asked to talk about today is the lessons learned from this implementation as it applies to seismic hazard, in particular relative to Western plants but seismic hazard doesn't quite live by all those boundaries--East versus West. So the lessons will be somewhat drawing more broadly from East and West.

Next slide? Next slide?

Just as an overview, the seismic hazard is being reevaluated using probabilistic seismic hazard methods as was referred to earlier.

The diagram simply shows the standard four part picture cartoon, if you will, of how the seismic hazard analysis is done.

The first two parts of the analysis evaluate the likelihood of earthquake occurrences both in terms of their location relative to a plant, what faults the earthquakes might occur on or what areas they might occur in, what their size might be and what their annual frequency of occurrence could be.

The next part, as also was mentioned, is the ground motion modeling part of the process which estimates given the occurrence of an earthquake of a given magnitude at a given location, what the level of shaking would be at the plant. That also is probabilistic in the sense that we cannot even knowing the characteristics of the earthquake in detail, predict exactly what those ground motions will be.

We combine those parts of the seismic hazard analysis, the source characterization, the ground motion and we come up with an estimate of a seismic hazard curve that tells us the annual frequency of exceedance of ground motions.

And, as you know, there's considerable uncertainty in all of those steps in the analysis. So, we don't end up with one estimate of seismic hazard, we end up with an estimate of many seismic hazard curves representing our scientific uncertainty in what the ground motions might be.

Those analyses are typically carried out for rock site conditions. And for plants that are not founded on rock, we have to take into account the effects of soils, the near surface geology, often referred to as the site response analysis. And that's kind of the final step.

It's within the context of this standard process of seismic hazard analysis that we evaluate our uncertainties. Both regard to the randomness of ground motions as well as the knowledge based or epistemic uncertainties.

And we use a process referred to as the SSHAC process where SSHAC stands for the Senior Seismic Hazard Analysis Committee, a group of folks who were put together partly by the NRC and others.

That process evolved from the need to evaluate information that is often nondiscriminatory in terms of where earthquakes might occur, how large they might be and how often they might take place and also what the ground motions might be.

It's a very structured evaluation and it is very formal in terms of the roles and responsibilities of those who are doing the evaluations.

The 50.54(f) letter, the 2.1 Recommendation suggested that utilities need to implement the SSHAC process to evaluate the seismic hazards at the plants. How it's done in the East was different than in the West.

In the West, they have to be site specific studies. In the East we had a program where the USGS, the Department of Energy, the NRC and industry worked together to develop a seismic source model for the East and, as you've already heard, developing a new ground motion model also for the East.

It's also interesting to note that this process has been applied in nuclear and non-nuclear circumstances in the United States and in other countries and it has become the standard for performing probabilistic seismic hazard analyses.

Next slide?

The process is a fundamentally sound approach to dealing with problems where we have considerable uncertainty and where we use or, more realistically speaking, have to use experts to perform evaluations.

It is unique in the sense that its goal is to evaluate and integrate often different interpretations of the same information into a model so that all of the uncertainties are captured. That's a difficult thing to undertake but is a goal that is, I think, been well achieved in both the site specific as well as the regional studies that have been performed.

It also provides, I think, not only technical stability over a period of time, ten to 15 years, but also regulatory stability from both the perspective of the regulator as well as the licensee.

Another key element is the fact that it requires participatory peer review such that the process, the SSHAC process is being carried out faithfully as provided in the available guidance.

Next slide?

Now in terms of lessons from implementation, one of the unique aspects of the project we find is none of them are the same. Each set of circumstances is different both in terms of the information that's available, the tectonics that are being evaluated, the issues that have to be addressed in each of these.

And we invariably find that you have to be adaptable to dealing with that information so that the modeling that's done is faithful to our state of knowledge at the time and in those circumstances.

We found out in the BC Hydro Study which did a SSHAC Level 3 study for all of the dams in British Columbia where we had deal with geodetic data, we had to develop a new ground motion model and we had to develop new ways of actually modeling seismic sources to be faithful to the information that was available.

We're seeing this with Diablo Canyon and Palo Verde where they're developing a new ground motion model to be reflective of our current state of knowledge in that part of the country.

And in the study for the northwest DOE sites as well as the commercial nuclear power plants, we're seeing advances in the analysis of earthquake catalogues and the representation of uncertainty.

Next slide?

As I said, the last part of the process for non-rock site conditions is the site response analysis where we have found that site response can often have a significant impact on the ground motions that are input to a plant. We can see reductions in ground motion. We can see significant increases in ground motion based on the site characteristics.

The diagram on the left just gives an example of a case where we see both reductions and increases in ground motion of considerable levels recognizing that the scales are logarithmic. So, 20, 30, 50 percent changes in ground motion are not uncommon when we do a site response analysis.

What's interesting is -- next slide -- is that the site response analysis, even though it can have a significant impact on the ground motions at a plant, is not done within the context of the SSHAC process. And so, an argument can be made that the evaluation of site response ought to be considered in a SSHAC manner just as the source characterization in the ground motion is.

Next slide?

Now, if we step back for a second and take even a bit higher view with regard to process, I think we can make an argument that the NRC strategy whether designed in the beginning or whether it was evolutionary of how seismic hazard was being addressed, I think is a good template for looking at other issues.

The NRC was fundamental as was other agencies in supporting the development of the SSHAC process. They have also been fundamentally involved in the seismic source characterization and the ground motion, as you've already heard. And, of course, they are requiring that SSHAC Level 3 studies be performed for the western plants which have to be site specific.

That process, I think, is a template for dealing with other issues that are also covered in the 50.54(f) letter. And the reason is, it brings a high level of technical quality. It brings regulatory stability on behalf of the regulator and the licensees and it deals with what are often technically complex if not controversial issues. And as a result, the process deals with that and brings stability to those circumstances which was not the case for many of the plants when they were originally licensed.

Thank you.

CHAIRMAN MACFARLANE: All right, thank you.

And, last but not least, Professor Anderson?

DR. ANDERSON: Thank you. So, first, I'd like to thank you very much for inviting me to talk about this topic, lessons learned from Fukushima. It's a daunting topic and it's hard to say anything new with three and a half years passed since that earthquake.

I'd like to begin with my second slide with a quick look at the Tohoku earthquake from the seismic hazard perspective.

So, Frame A shows a part of the prior Japanese hazard map. And the coast region around Tohoku has been separated into seven small source elements where the Japanese were anticipating events with magnitude up to about 8.2.

The second Frame B is showing immediate aftershocks indicating the parts of all seven of those elements broke in 2011.

Frame C is showing the horizontal motions of the geodetic stations with the longest specter up there if you can see it being about five meters of static motion.

Frame D is showing contours of source slope based on geodesy into the low frequencies of these ground motions.

This many not completely explain the tsunami, though. A news report in Science Magazine this week suggests that a submarine landslide also might have contributed to the total height of the tsunami in Tohoku.

Frame E is showing the accelerations emphasizing high frequencies of ground motion.

And Frame F is showing what's referred to as strong motion generating areas where those high frequencies originated. And you'll notice that they are not the same places as where the tsunami was generated.

So, one of our lessons is primarily discussed by Hiroo Kanamori and colleagues has shown that there are sort of characteristic domains of the earthquake with different parts of the subduction zone radiating different styles of energy.

Finally, Frame G is the peak acceleration as a function of distance and I have that to focus on the large range of uncertainty in the ground motions up to a factor of ten variation at any one distance.

The next slide, I'd like to talk about the Task Force Recommendation 2 to regularly reevaluate the seismic design basis.

And so, I think Recommendation 2 is great and Recommendation 1 that refers to -- recommends risk-informed decision making. And the seismological input to this is the hazard curve as Martin McCann just described in more detail.

And I guess the one point I'd add is that this hazard curve is let's say conceptually observable. If we could measure it -- if we could record the ground motion at a single site for 100,000 years, then conceivably, we could measure it.

So, at least our goal is to predict something that is the outcome of a conceptual observation.

The next slide adds another step. These hazard -- to make the USGS maps, these hazards are calculated at a grid of points and then the level shown by the red line is contoured throughout the nation.

The next slide is summarizing the inputs. Martin McCann just had a summary of this as well.

On the left a source model which is part of the 2014 model for the USGS National Maps. On the right, a ground motion prediction equation and then these are combined using a well established technique.

So, improvements in our hazard curve come from improving the ground -- the source models, these two different input models.

So, now I'd like to, with the next slide, I'd like to mention a couple of lessons from Japan or start to.

I noted that the magnitude 9 earthquake was not in their seismicity model, but rather included rupture of a number of fault segments. And so the lesson for us is to include fault linkages in our hazard analyses.

And for the 2014 U.S. map, we do that in California and we need to extend that to the rest of the western U.S.

On the next slide, I mentioned that in Japan probabilistic methods lost a lot of credibility for not including this magnitude 9 earthquake. And the critics also thought that probabilistic maps were poor in the areas that were struck by the Haiti, Wenchuan and Christchurch earthquakes.

And while I think that their attack on probabilistic methods was misplace. There is still a lesson for us to get from that because those hazard analyses were not always well done as others. They were not a SSHAC process.

And, I think that the lesson is to be sure that there is an open two way communication with the global seismic community and to get it -- keeping the community engaged to be sure that the input for these analyses is as good as possible.

And also, a clear pathway for getting new information or the implications of new discoveries into our seismic hazard analyses with all deliberate speed.

The next slide.

So, I think the U.S. national hazard model is on the right track for achieving that. Their process is quite open. I'm on a steering committee for this particular model and I think that they do a good job. Their model, as David Applegate mentioned, is updated every six years and we're talking about a pathway for getting new developments to be incorporated even faster such as the NGA-East when it comes out.

The next slide has a list of some of the issues our steering committee is thinking about right now.

Okay, and so, better models of uncertainties, as you've heard, better approaches to selecting ground motion prediction equations, the use of synthetic seismograms, longer periods, testing the models, time dependence and to induce seismicity.

So, I have a couple of -- I have slides to look in a bit more detail on four of these.

The next one is the uncertainties and, as we've already heard this morning, at low probabilities, uncertainties have a big impact on these hazards. And the pathway to improving that is better instrumentation, more instrumentation getting data.

The next slide, it mentions synthetic seismograms that are increasingly being used to fill in data gaps and I think you'll see more of that coming from an IAEA committee where I've participated.

Again, data from small earthquakes can help considerably to validate these synthetic seismograms and validation is an important thing that needs to be done.

The next one mentions time dependence. Should the hazard estimates be adjusted if we know, for instance, that the time since the most recent event is so long that the next large earthquake on the San Andreas Fault is very likely to occur within the next 30 years.

And finally, the next one mentions induced seismicity showing the cumulative number of earthquakes for a region in Oklahoma. And this is sort of a wild card since it depends on industrial processes so that formerly quite seismic areas can suddenly become very active and there's really still a lot to be learned about that.

So, I can stop here and thank you again.

CHAIRMAN MACFARLANE: All right, thank you.

Okay, now we go to questions and I will start.

So, let me start with a general question and I'll first ask Dave Applegate and then whoever else wants to jump in.

But, John, you already sort of weighed in on this, but one of the recommendations that the Near Term Task Force made was that seismic hazards be revisited, seismic hazard analysis for nuclear power plants be revisited on a periodic basis, probably about every ten years.

And seeing how you guys do a six year revisit, I'm wondering if you think that that's a good idea and that's a good time period?

DR. APPLEGATE: Well, absolutely. I think this is a, you know, as we think about particularly the time frame, you know, when some of these plants were built, you think about what our state of knowledge was then compared to now.

It is evolving as you've heard from a number of these comments.

For us, the six year time frame reflects the time frame for updating the building codes, the model building codes. So, we are -- there's nothing magic about the six years but it is what the engineering community has settled on for these updates and that ultimately, you know, you're talking about a trillion dollars in new construction. This is a very important application for us.

So, certainly this notion that revisiting, whether it's through, you know, sensitivity analysis, as was mentioned. How do you, you know, incorporate this new information or full reevaluations I think is very important.

And simply, again, it's another aspect of that. You know, I mentioned at the outset, that's sort of that sense of humility in the face that we know what we know, but we know there's a lot --

CHAIRMAN MACFARLANE: We don't know.

DR. ANDERSON: -- is still emerging.

Yes, I'm not going to try to not say known unknowns.

CHAIRMAN MACFARLANE: Yes. Okay, great, anybody else want to weight in?

DR. MCCANN: Yes, just add that there is experience and sort of beating the SSHAC drum again, that when you do evaluate the uncertainties and recognize that there are interpretations today based on the current state of knowledge that are somewhat supportable by the evidence and you incorporate them in the assessments that dynamic changes that do take place often don't move the needle a whole lot, meaning that the mean hazard curve does not move a whole lot within in a given time period.

Numbers like ten to 15 years seem to be reasonable. That's not to say change hasn't taken place, but it is to say that not a lot of change takes place that throws out the recently completed hazard and says we've got to do it all over again in three or four or five years.

So, there is stability even within the context of change.

CHAIRMAN MACFARLANE: Maybe.

DR. MCCANN: But it does have to be reevaluated, there's no --

CHAIRMAN MACFARLANE: Maybe.

DR. MCCANN: -- doubt about it.

CHAIRMAN MACFARLANE: And you know, I actually have a different point of view. I think that the science changes sometimes. You know, it doesn't change on a regular basis periodically.

But, in the 1980s and the 1990s, we did not expect magnitude -- we did not expect mega quakes on all subduction zones. Right? We really didn't expect mega quakes.

When I learned geology, which was of course, in the dark ages, but nonetheless, there weren't any mega quakes, right, and the seismologists reevaluated and rethought and, okay, now there were mega quakes in the past.

And then after the 2004 tsunami and Sumatra quake, all of a sudden it dawned on the seismological community that maybe there could be mega quakes on subduction zones of sufficient length.

And interestingly enough, the Earth has, you know, been nice and it's proved that out in a fairly rapid manner with the Tohoku quake that the Christchurch quake.

So, I think that there are changes that happen in the science itself that have to be acknowledged. It's not just the, you know, slow collection of data that goes on.

DR. APPLEGATE: And actually, if I could comment on that.

I mean, this is one of the reasons why I think we feel that the way we approach the national seismic hazard maps in the U.S. is robust in that, you know, you look at, for example, the situation with Haiti where it was the global maps were only based on seismicity. They were thinking of one thing and you end up with hazards that are perpendicular to the faults.

Or you think about the situation and where you, in a sense, you may over think things in terms of segmentation.

We tried to make these maps literally bring together everything we know so that we're not just hanging our hats on the seismicity or the geodesy. You know, we're heard about the importance of paleoseismology. I mean this is a huge area and --

CHAIRMAN MACFARLANE: Which really didn't exist when we were in grad school.

DR. APPLEGATE: -- and it has been so crucial to provide that, you know, that time piece to it.

So, you know, I think we absolutely, it is evolving but on the other hand, I think we've put ourselves in the best place we can by trying to have our eyes, you know, as open as possible.

CHAIRMAN MACFARLANE: Right.

DR. APPLEGATE: And that comes back to that open process that was described by both of the last two speakers that, you know, we're not just sort of closed ourselves off to that.

CHAIRMAN MACFARLANE: So, speaking of the Caribbean area, you mentioned the North Cuban Thrust Belt and the production of tsunamis in that region that might affect the southern U.S.

Do we understand that very well?

DR. APPLEGATE: That is an area, you know, Puerto Rico Trench as well and these are issues that, you know, they are under -- it's an area of active research and absolutely, we're, you know, I think we have a basic handle in terms of the maximum magnitude that you could simply, in terms of looking at the length, where, you know, not doing the segmenting issue.

But, no, it's an area of very active research. And again, one where I think the U.S. NRC has really played a critical role in, you know, working with our offshore marine geophysics capability and that of others and where I think we need to continue to push.

CHAIRMAN MACFARLANE: Okay. Just in terms of updating models, et cetera, John, you mentioned that fault linkages. Were they done for the CEUS model?

DR. ANDERSON: I don't think we know enough about where the faults are --

CHAIRMAN MACFARLANE: Are -- right, right.

DR. ANDERSON: -- in the CEUS --

CHAIRMAN MACFARLANE: Exactly, you know.

DR. ANDERSON: -- to even begin to do it.

CHAIRMAN MACFARLANE: Right, right. Okay. I know.

DR. APPLEGATE: Yes, and many things because California sort of leads the way. And also, for example, in California where we generate not just a time independent map, but we also generate time dependent. We're really looking at that issue that John brought up of, you know, for example, the insurance sectors, they want hazard that is constantly changing. They don't want that stability, they want to see anything you know that's new, they want that incorporated.

CHAIRMAN MACFARLANE: Interesting, okay.

Dave Heacock, the mitigating strategies equipment that you described for North Anna and whatnot, the buildings that you are building there, are they going to be to code or to meet the design basis of the existing -- the safe shutdown earthquake or are they design based on what we now know from our experience with the Mineral, Virginia earthquake?

MR. HEACOCK: That's a bit of trick question. The design criteria is for the safe shutdown earthquake for that location, but in our case, we did build the storage facility at North Anna to respond to the new GMRS, Ground Motion Response Spectrum, as defined in 2013/2014 here.

The building might move a little bit, but it's still going to remain intact on the foundation. So, we did design it for the higher implication and then, in fact, we took that same design, we used a blow-up dome with a rubber membrane you inflate and then you spray concrete on the inside much like a pool liner and then add layers of rebar as you do that. And their general constructions may be 12 inches to 16 inches. We went two feet on that concrete dome.

So, it's like a miniature -- that's the same thickness of the dome on the containment, for example. It's two feet.

CHAIRMAN MACFARLANE: Well, okay.

MR. HEACOCK: Now, there's a steel liner inside that but the structural elements are smaller in this dome, the steel is smaller. But we did design it for a more robust earthquake, yes.

CHAIRMAN MACFARLANE: Yes. And what about at the other plants? I don't know or recall which other Dominion plants that --

MR. HEACOCK: For us, for Surry and Millstone we used the same design on all three. So, we put a two foot thick dome on all three.

Now, the attachments to the foundation are different in our design for the seismicity at that location.

CHAIRMAN MACFARLANE: Okay. Thanks.

MR. HEACOCK: But we used the higher of the two earthquakes that we found to do the design work.

CHAIRMAN MACFARLANE: Okay. I think this high frequency issue is important especially as a lot of the -- we have all the new curves here. A lot of them do cross into the reevaluated curves cross into the high frequency area.

So, we have some understanding of the high frequency impacts on power plants, do we?

MR. HARDY: We certainly do from the standpoint of research into it. I mean high frequencies aren't new in terms of impact loads, other things. There are other things that produce high frequencies.

This earthquake high frequency issue has been around for a while. In general, our feeling is it's not damaging except for a few components we need to look at, chatter relays being the classic example.

So, that's the purpose of this test program and I think what we're finding at least now is we don't see any unique high frequency sensitivities. We don't find things failing at the same acceleration levels in high frequency as we might find in low frequency. So, there's nothing that says once you hit this frequency, all of a sudden this thing has a very low capacity. That's the good news. It still means we've got to do that evaluation, but it's looking promising I guess is what we're finding.

CHAIRMAN MACFARLANE: Okay, interesting.

All right, I will stop there and turn things over to Commissioner Svinicki.

COMMISSIONER SVINICKI: I want to thank each of you for your interesting presentations this morning. We've heard a lot of common identification of the challenges and maybe some gaps that still exist, areas that need more work, more research. So, I appreciate it. Also, the consistency in what you've identified here.

A number of you identified some challenges and when we have, perhaps, a regulatory deadline in acquiring and applying enough seismic expertise, I might ask Mr. Heacock specifically, speaking on behalf of the industry wide experience.

When NRC has a deadline for seismic evaluations, we've done some tiering for the subsequent submittals which I think will help. But what was the industry experience in terms of acquiring seismic expertise to meet the submittal due dates?

MR. HEACOCK: I think there's a couple of layers to that. The expedited seismic evaluation process at ESEP requires essentially the same type of resources that seismic PRA would require.

So, we used those resources up quite a bit this year and many more plants were affected by the interim analysis, this ESEP analysis.

In fact, we did ours early intentionally to get them out of the way, let's keep our plants off those resources even though we have internal seismic resources, we still use Greg and people like him in the industry that are experts to either do peer reviews or to second check our work to make sure we're on the right path on these things.

So, the resources have been bounding in several cases and I think these Phase 1, Group 1, Group 2, Group 3 approach is appropriate to put the most significant plants in the first group. But I think there are some people that believe even that's going to be a challenge by June 30th of 2017 to complete all the Group 1 plants.

One thing we didn't really talk about is that there were some utilities that chose to do seismic PRAs independent of this most recent evaluation and they were in process with those resources when the Fukushima event occurred.

So, they have been consuming those resources. They may not be highest priority, but they're doing them anyway. So those resources are unavailable to the industry. It is a challenge.

COMMISSIONER SVINICKI: Thank you.

Mr. Hardy, I didn't find a number on this particular slide, but you had your second to the last slide was you indicated it was kind of busy and you didn't expect us to really look at it. But you stepped us through the left hand side of a number of the components of the ongoing or overall program of work that is planned on seismic.

And I wanted to react to it a little bit. I know you didn't intend for it to be a specific point of discussion. But as you stepped through the left hand side, one of the late items or towards the bottom, there's further work planned. You said it was in a focus area on spent fuel pool evaluations.

I had a general question for you on whether or not it would be advisable to inform the overall program of work by early activities? And by that, I mean when you have such an expansive program to look at an area like seismic, it would seem to me that in your early work, you may decide or discover that subsequent areas that you were going to look at may or may not be as risk significant.

And so, my concern in general in an intricate area like this is if we lock in to a planned set of actions, often we're not informing the subsequent emergent work by the early results.

And so, I think NRC and industry have done a lot of looks at spent fuel pool response to seismic. And if it emerges early on that that simply is not a risk significant area and not those seismic scale sets and other things would be better applied to other emergent findings.

I guess I'm framing this question in a way as to make the answer kind of obvious, but do you think that we're at some peril of kind of locking in too early to what the subsequent work should look like?

MR. HARDY: If I understood your question, certainly we try to look at everything and do exactly what you said. We try to identify where the targets for risk significants are so we can put those resources into it.

Spent fuel pools themselves are fairly rugged. They're designed for radiation shielding and they are massive reinforced concrete structures. We have done several what we call seismic fragility assessments for spent fuel pools in the past for previous PRAs and the NRC completed a study or two on their own.

Consistently, we've seen fairly high capacities on the pool itself and so our immediate guidance to the NRC was this probably was not the area deserving the most attention, did not represent an area where we saw a significant potential risk. And we looked at a variety of different configurations in that regard.

So, overall, and this is true of all reinforced concrete structures, when you look at the seismic PRAs and what the dominate risk contributors are, we really don't find those to be the case.

So, I think the question you're asking, have we look at that and do we have an opinion? Yes, indeed, and I don't think that's the area we think is worth the time right now. There are plenty of other issues.

We fully agreed with the high frequency testing because we didn't understand it. But the reinforced concrete spent fuel pool is something we can understand and the past evaluations can guide us in that regard.

COMMISSIONER SVINICKI: In that response, you've hit upon essentially what I was suggesting which is that if there are areas that are a bit more opaque in terms of what we're going to find like the high frequency testing, as a practical matter, I'm suggesting, and I'm not asking for a response, that it may be that we would want to look in the out years at the application of people and resources to those area where we feel we have significant learnings yet to find and to not lock in now to what had been some previous and, in my view, adequately addressed areas that we've already been looking at.

Mr. McCann, I wanted to turn to your advice or recommendation that the approach that has been used for seismic would be beneficially applicable to other hazards. You had kind of closed by talking about that.

But you did acknowledge that in these areas data is and will be limited. So, I'm trying to understand what specific elements of the approach are beneficial. Is it something akin to the SSHAC process where you have a very structured method for coming to terms with inputs and methodologies early on, again, by their nature, the hazards -- the class of hazards that we would be looking at are low probability?

And I think that's why you've acknowledged the data will than of necessity be limited for those particular types of events. So, could you talk a little bit more about what elements of what we've done for seismic would be the beneficial approaches and techniques for the other hazards?

DR. MCCANN: Yes. I think you can divide it into two parts kind of the envelope of things which is, I'll generally summarize as NRC engagement in dealing with the problem.

Take, for example, external flood. The NRC has been engaged at the very outset in its early funding of research studies and probabilistic seismic hazard with Lawrence Livermore Lab back in the '80s and '90s.

They then got involved in the development of -- recognizing the need for the SSHAC process as it came to be and supporting that and being involved in it.

So, at a very high level, having the NRC with industry, academia and so on working to come to a satisfactory framework, I think, is a positive.

But now that we've done that in the seismic area, it seems to me that's a good template to use at the envelope level, if you will, meaning being engaged.

But at the core of dealing with problems like external flood hazards that the SSHAC process would be the core call it technical tool for dealing with areas where there's limited data, where there's currently different interpretations of that data, different ways of modeling the problem and the SSHAC process is suited to deal with those issues whether it's seismic, whether it's volcano, et cetera.

However, it's not a cookie cutter which is to say everything that's being done in the seismic hazard area is not directly applicable to say the flood hazard area. It's a different problem. It's different data, there's different aspects of the problem that have to be treated differently.

We've done some thinking about it, we've talked to the staff about it and had workshops on it. But the core fundamentals of the SSHAC process are suited to dealing with those technical issues that are complex, maybe controversial.

COMMISSIONER SVINICKI: Okay, thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Okay, Commissioner Ostendorff?

COMMISSIONER OSTENDORFF: Thank you,

Chairman, thank you all for your presentations, they were very informative.

I am struck by, as my other Commissioner colleagues have noted, some recurring common themes across almost all your presentations and I wanted to kind of hit on one of these and it deals with our job as regulators.

One of our principles of good regulation deals with reliability. And there's a tension in that given principle between using the best available knowledge and at the same time not having our regulations unnecessarily in a state of transition.

And so the stability nature of regulations and not every year changing some requirement or specification is a key concern, at least for me I think, but also for the colleagues.

And many of you touched on that theme and in various aspects of your presentation, Dr. Applegate talked about the six year cycle for USGS to review your national seismic hazard map.

I think Dr. McCann talked about the SSHAC model and you thought there was technical validity for perhaps a ten to 15 year period for some of the findings of your committee work.

And then Mr. Hardy has this great slide that Commissioner Svinicki referred to that really kind of puts it all together here. And I've not seen this slide before preparing for this session but this is very helpful to see how it all fits together because, at the end of the day, this Commission has provided direction to our staff to kind of fit all these pieces together in way that makes sense. We can't have a --

Though we want to maintain appropriate research programs, at the end of the day, we can't have a continuous research project going on to every year change our regulatory approach for these issues. It just doesn't -- that does not pass a pragmatic reality check.

So, I appreciate the fact that many of you raise these challenges and I think I'm going to kind of go to Mr. Hardy's slide because I think you mentioned the remaining challenges, technical methods still under discussion, acceptable risk versus modifications versus development of more accurate seismic risk methods. I resonated with those two bullets in your Slide 12.

I believe Dr. McCann in your Slide 6, excuse me, Slide 10 I think you made a comment, if I had this -- if I captured this incorrectly, please correct me, I think you commented the NRC strategy in the seismic area was positive and forward thinking. I believe I captured that from your slide.

So, with that predicate laid down, I wanted to kind of get this opportunity, and I'm going to ask Mr. Hardy first because his slide was a catalyst for me to ask this question.

But you know, recognizing at the end day, we have to come up and make all this stuff fit together and we have requirements for Fukushima actions and the Near Term Task Force 2.1 work and so forth.

I'll start with Mr. Hardy, do you think the approach NRC is using is overall is it solid or do you have any criticisms of that approach?

MR. HARDY: No, I think it's a pragmatic approach but the purpose of this slide was just to kind of inform people of the degree of parallel efforts going on, any one of which could kind of bring up questions on changes that are occurring.

The key is to understand the effect of those and do they really drive the situation of the seismic risk to the point where you need to change course and do something different?

So, we've heard talks about seismic hazard. There's ongoing research, there will be changes. But the hazard itself is not sufficient to understand what you ought to do next. You need to take it the next step.

The same thing goes with high frequency capacity testing, anchor bolt testing, there's many things that we're using to try to improve our understanding of the safety of the plants. Overall, you've got to be a little more pragmatic long term on how you implement those and when you make kind of step functions.

Fukushima was the source of obviously tremendous worldwide interest and deservedly so. I think there was a program in place to try to address it. I think it's looking like the programs that are being implemented should be sufficient and will identify areas that need improvement.

COMMISSIONER OSTENDORFF: Thank you. Would others like to comment? Anybody?

MR. HEACOCK: I'll make one comment. What's interesting to me is Martin McCann's comment about, yes, there's been some changes in the seismic short term and in the attenuation model and so forth.

But it really doesn't move the needle very far. And I think that was evident when I looked back at the 2010 Generic Issue 199 summary and then looking for the next hazard. They weren't very far apart, the 2008 hazard versus the 2012 hazard essentially. So it's a four year difference and the attenuation model changed in between.

But the overall industry has a curve and really didn't move the needle. If you look at the entire population of all 61 plants east of the Rocky Mountains, there really was essentially no change to the overall hazard there.

So, kind of a big picture, I know that's on a very high level but that kind of gives me some comfort that there's significant margin in these plants and even the hazard moving around and, as the Chairman pointed out, it might move around further in the future, we need to understand what that is but I think we can do that at a high level before we trip into individual seismic PRAs for every plant in the country again.

Do a sensitivity and see what the industry curve looks like for the fleet and we can make decisions whether we need to do any further results beyond that.

COMMISSIONER OSTENDORFF: I want to come back with a separate question of margin. Let me give others a chance to respond if anybody else would like to weigh in on this.

MR. ANDERSON: What I have in mind when I mentioned, in particular, having a pathway for new information to get into place is in Fukushima, the geological community had identified evidence of a large tsunami in the year 893 and that -- and I read more than one editorial in technical journals saying that even though that was known for at least a decade prior to Fukushima, that some of the decisions makers in Japan were not aware of that research.

Now, I don't know if that's really completely true that they weren't aware, but in any case, it was written that it was. And if that's the case, and one of these editorials was very specific, I don't remember the author right now, but I could get it for you. But it was very specific --

COMMISSIONER OSTENDORFF: No, I think --

DR. ANDERSON: -- I think it was evidence of a breakdown --

COMMISSIONER OSTENDORFF: We've heard the same news before.

DR. ANDERSON: -- in communication.

COMMISSIONER OSTENDORFF: Thanks for raising that.

DR. APPLEGATE: Yes, I would just add to that just along those lines. I mean I think one of the things that's so important is that, you know, the U.S. NRC does have its Office of Research, does have them actively engaged with this broader community and that's true not just in the seismic arena, I also chair the NST, National Science and Technology Council Subcommittee on Disaster Reduction.

We really value having the U.S. NRC's active engagement so that there is that, you know, again, that process whether it's through the very formal process like a SSHAC process but simply that level of engagement I think is so important.

COMMISSIONER OSTENDORFF: Thank you.

Let me get back to my question on margin that I alluded to.

Dave Heacock, I appreciate your leadership in the industry area. I know we sat here maybe three years ago, not quite three years ago, and in the wake of the North Anna earthquake and we were having discussion about cumulative absolute velocity and the application of the NRC's NUREG from the late 1980s that had not been applied yet until it was for your plant at North Anna from the August 2011 event.

You raised the question or the topic of margin and now that three years have passed since the restart of North Anna and there's been other work done across industry and with EPRI and other institutional approaches.

Is there a consensus now on how we at the Commission ought to look at margin in existing nuclear power plants in the event we have an earthquake?

MR. HEACOCK: Yes, I think so. I think in my opening remarks, I talked about I think there are tremendous margin. We look at some of the events worldwide and put those into terms relative to what we have more experience with, I have more experience with here at North Anna.

But even the new Ground Motion Response Spectrum for North Anna which is higher than the August 23rd, 2001 Mineral earthquake values. We have done the expedited seismic evaluation process already for North Anna. There's no modifications required, at least for the train of safety equipment we evaluated. IPEEE validated that for two shutdown safety trains.

So, it looks to me like there's significant margin.

The other comment I'll make is many plants have gone a long way through their expedited seismic evaluation process, a vast majority are near completion, they're doing reviews and so forth. And we're finding very little, if any, modifications required. So that shows me on the important safety equipment there is significant margin even when evaluated using existing standards in the requirements.

COMMISSIONER OSTENDORFF: On the consensus piece, that's where I want to really understand like would Exelon or Entergy with their fleet of nuclear power plants look at margin the same way Dominion does?

MR. HEACOCK: Yes, I think so on the seismic side, it's all being done the same way. The ESEP and then if it requires a seismic PRA, it'll be done the same way.

COMMISSIONER OSTENDORFF: Okay, thank you. Thank you all, thank you, Chairman.

CHAIRMAN MACFARLANE: Okay, any further questions? No, okay. All right, thank you. And we'll take a short five minute break and then we'll have the next panel.

(Whereupon, the above-entitled matter went off the record at 10:22 a.m.)

CHAIRMAN MACFARLANE: Okay. I think we're going to get started. All right, I'm going to turn this over to our Executive Director for Operations, Mark Satorius.

MR. SATORIUS: Hi. Good morning, Chairman.

Good morning Commissioners. We're here today to discuss the activities associated with Recommendation 2 of the Near-Term Task Force, Insights of the Fukushima Events.

Recommendation 2 requires licensees to reevaluate and upgrade as necessary the seismic and flooding protection of each plant.

We take today's opportunity to discuss how the staff has addressed the seismic portion of the Near-Term Task Force Recommendation 2.

Considerable progress has been made regarding Recommendation 2 and the staff's discussion will focus on what activities have already been completed and what still remains to be done.

How nuclear power plants are protected from earthquakes has received increased attention since the Fukushima event as well as other seismic events affecting nuclear power plants here in the United States such as the earthquake at the North Anna power station.

Seismic safety is and continues to be an area of focus for many programs within the NRC and the nuclear industry. As you've heard from the previous panel, this is not a stagnant area but a continuously evolving and expanding area.

The knowledge gained from both national as well as international operating experience along with the advancement of the state of technology is crucial in supporting these activities.

The NRC and industry have performed physical plant walk downs, and the review of the seismic hazard reevaluations are in progress.

Many of the identified issues have been resolved. The NRC has determined that plants continue to pose no undue risk to public health and safety.

Even while we work to further enhance the safety of these plants by progressing through the lessons learned activities, the staff has and continues to engage stakeholders to inform our decisions on these activities associated with Recommendation 2.

Today's staff is a joint effort by the Office of Nuclear Reactor Regulation and the Office of New Reactors. However, the work has primarily been a full wide agency effort.

Jennifer will provide an overview of focused activities in the seismic area over the last several decades and how we continue to focus in moving forward.

Scott will then update you on the progress of the Near-Term Task Force Recommendation 2 activities and share some insights that we've gained. Cliff will provide some details on the review of the reevaluated seismic hazards and next steps.

And since the Japan Lessons Learned Division is overseeing the technical and project management functions associated with the Near-Term Task Force activity, Jack is here at the table as well to help answer any of your questions.

If I could have the next slide please. And now, let me turn it over to Jennifer who will start today's presentation of the staff. Jennifer.

MS. UHLE: Thanks, Mark. My name is Jennifer Uhle. I'm the Deputy Director for the Office of Nuclear Reactor Regulation.

As Mark indicated, I'll be presenting a brief or high level overview of our seismic efforts. So could I have the next slide please.

So to support the NRC's mission, it's important to protect plants from external events that can impact public health and safety, such as seismic events.

Since the time period when the current operating fleet was first licensed, significant advancements have been made in the seismic area. And NRC has applied this information in its decision making.

This is important because, in fact, for some plants, seismic events can be a major contributor to plant risk in large part because large earthquakes can cause common cause failures with an extended loss of power.

Although the NRC is determined that plants can continue to operate and they pose no undue risk to public health and safety, seismic issues have been and will continue to be a focus area for the agency.

Can I have the next slide, please? Okay. Depicted on this slide are some of the relevant programs that the NRC has engaged in over the years.

The first program, the Systematic Evaluation Program, was initiated in 1977. It dealt with plants whose seismic design was not consistent with the seismic design criteria at the time.

Some voluntary plant modifications were made to address identified issues while others were incorporated into the individual plant examination for external events, which I'll talk about in a little bit.

In 1980, the NRC opened Unresolved Safety Issue A46. The purpose of this program was to verify the seismic adequacy of equipment when compared to newly established qualification criteria.

A46 equipment walk downs and evaluations continued through the '80s. In 1991, NRC issued a request to licensees to conduct the Individual Plant Examinations for External Events.

And the acronym I'll be using is IPEEE in case I slip into that. This included identification of potential vulnerabilities to the beyond-design-basis earthquakes.

As a result of the Individual Plant Examination for External Events and the efforts on unresolved safety issue A46, about 70 percent of the plants reported or proposed improvements.

Examples of these improvements included strengthening anchorages, replacement of low ruggedness relays, reinforcing block walls and other equipment upgrades.

In 2005, depicted on the slide, NRC issued, opened Generic Issue 199, which is entitled, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants."

This work was started when the staff reviewing the applications for early site permits recognized that the new seismic hazards for plants had increased.

As a result, prior to Fukushima, the NRC had already begun a systematic assessment of seismic risk under GI 199 for the operating fleet.

An illustrative GI 199 safety enhancement involved a 50 percent height reduction in Indian Point Unit 1 exhaust stack.

The stack was a high seismic risk contributor to Unit 2. After Fukushima, GI 199 work was subsumed into the Near-Term Task Force Recommendation 2.1, which you'll be hearing more detail about throughout the presentation today.

So in March 2012, to implement the Near-Term Task Force Recommendation 2, the NRC issued a request for information related to seismic walk downs and hazard reevaluations.

And as I said, you'll be hearing more detail. But before I leave this slide, I'd like to highlight two conclusions or observations.

And the first is that because of NRC's continuous focus on seismic safety over the years, seismic enhancements were made to the plants, which have enhanced plant safety.

And then the second observation is the advancement in the analytical tools used in these efforts over the years has provided us with the technical framework to support Recommendation 2 activities today.

So could I have the next slide? So to support our seismic efforts, NRC uses multiple sources of information. These include operating experience, knowledge gained through research programs, the use of the analytical tools developed in the Office of

Research and through collaborative efforts with others.

Recent operating experience from Japan and the United States with plants experiencing ground motions that were close to or exceeded the plant's design basis have demonstrated the ruggedness of plant designs and provided other insights into the validity of our previous decision making.

Such experience was gained from the July 2007 earthquake that affected seven units at the Kashiwazaki-Kariwa site in Japan, the March 2011 earthquake that affected 13 units on the eastern coast of Japan and the August 2011 earthquake here in the United States that affected two units at the North Anna station in Virginia.

Over the years, the Office of Research has supported and also supported advancements in the seismic area through collaboration with others, in particular, Research led the development of tools for application to the nuclear industry for probabilistic seismic hazard assessment, seismic probabilistic risk assessment and seismic margins analysis and have been used in the past and will also be used in response to the Fukushima efforts under Recommendation 2.

So in partnership with the business line owners, the Office of Research also ensures the agency is ready to review new technologies and analytical techniques.

For example, research is developing a technical basis to support the licensing of new reactor designs.

Two examples include seismic isolation testing of structures in collaboration with the University of Nevada, Reno and the development of engineering methods for deeply embedded reactors, such as small modular reactor designs.

An important area of interagency coordination is the NRC's work with the U.S. Geological Survey and the Department of Energy.

As Dr. Applegate indicated in the last panel, this work includes the development of the Next Generation Attenuation Model-East, which is a successor to today's central and eastern U.S. ground motion model.

The agency actively seeks out opportunities to learn from our international colleagues as well through its engagement with the International Atomic Energy Agency's International Seismic Safety Center and through seismic working groups of the Nuclear Energy Agency.

So I think that provides you with a good overview of our many sources of information that help ensure that we maintain a robust infrastructure for our decision making.

I'll turn the presentation over to Scott Flanders, and he'll provide a status update on Recommendation 2 and the application of this infrastructure.

MR. FLANDERS: Good morning, Chairman, Commissioners. Today I'll briefly provide you with a summary of the progress in implementing the Near-Term Task Force Recommendation 2, share some insights from the walk downs and inform you of upcoming activities related to the recommendation.

The last time the staff met with the full Commission to discuss Near-Term Task Force Recommendation 2 in detail was in

April of 2013.

Since that time, the staff has continued to make progress on Recommendation 2 seismic activities. Some of the significant accomplishments since that time include the completion of the staff's review and inspection activities of the licensees' seismic walk downs, the licensees' submittal of the seismic hazard reports for the central and eastern United States plants and the staff's screening and prioritization of the central and eastern United States plants.

This slide provides a quick snapshot of the Near-Term Task Force Recommendation 2 seismic activities and their statuses.

It illustrates the significant progress the staff has made, that has been made on Seismic Recommendations 2.1 and 2.3.

Lastly, I will note that as more insights are gained from Recommendation 2.1 activities, staff intends to evaluate the regulatory value of augmenting the current regulatory process with a periodic review of external hazards as proposed by Recommendation 2.2.

Next slide, please. All licensees have met the intent of the Seismic Recommendation 2. The focus of this recommendation was to confirm that plants are in compliance with their current design basis by reviewing a smart sample of safety related equipment to identify non-conforming or degraded conditions.

Licensees completed the walk downs for all the units, with the exception of a few components that were identified as inaccessible until the plant is in an outage.

Licensees committed to completing walk downs of these few items during their next outage, and we expect that most will be completed by December of 2014.

The staff will verify the licensees' results for the limited number of remaining components once the walk downs are complete.

Although these limited number of components need to be checked, the staff reviewed the submitted walk down reports, completed several onsite audits and inspections and issued the staff assessment for all plants.

The staff concluded that all plants have completed their walk downs and met the intent of the walk down guidance.

This was a coordinated agency effort that involved staff from the Office of Nuclear Reactor Regulation, the Office of Nuclear Reactor Research, the Office of New Reactors, and of course the Regional offices.

During the walk downs, some degraded and non-conforming conditions were identified. Such conditions were dispositioned and entered into the licensees' corrective action program.

Some of the identified issues include minor anchorage issues, spatial seismic interactions and problems associated with housekeeping.

Although degraded and non-conforming issues were identified, none represented any significant safety concern.

Picture 1 on this slide illustrates a degraded condition identified during the walk downs. This is a bent and corroded and not fully tightened anchor bolt that was supporting an emergency diesel generator fuel tank.

Picture 2 is an example of a non-conforming condition.

Here's a support bracket that has only one U-bolt installed, contrary to the vendor configuration mounting, which requires two U-bolts.

The staff intends to prepare a lessons learned document summarizing key issues found during the seismic and plant walk downs at some point in the near future.

Next slide, please. This slide illustrates the process that is being followed to address Recommendation 2.1 for seismic.

The process is divided into two phases. Phase 1 focused on information gathering from the licensees, and Phase 2 focused on the decision making process.

The first stage of Phase 1 included an extensive interaction with the industry to develop the guidance to perform the hazard and risk evaluations to ensure alignment on the methods of evaluations in the content of the submittals.

Licensees in the central and eastern United States completed and submitted their hazard evaluations in March of 2014.

They also submitted, along with their hazard evaluations, interim evaluations as needed. Within 30 days of receiving the hazard reevaluations for the central and eastern United States plants, staff screened the plants to identify those who needed to perform risk evaluations.

The staff also binned the plants into priority groups for the risk evaluations. Concurrent with the staff's screening and prioritization efforts, the staff also reviewed the interim evaluations.

The interim evaluations were necessary to demonstrate that the plants can cope with a higher seismic hazard while the longer term risk assessments are ongoing.

Dr. Munson will provide more detail about the process used to prioritize the plants as well as the review process of the interim evaluations.

The next steps for the plants going forward, for all central and eastern United States plants, that screened into perform risk evaluations, licensees are expected to submit an expedited seismic plant evaluation by December of 2014 and implement any necessary modifications by 2016 that resulted from the expedited evaluation.

All central and eastern United States plants in the highest priority group are to submit their seismic probabilistic risk assessment by 2017.

For plants located in the western United States, they are nearing completion of Stage 1 and plan to submit their reevaluated hazards by March of 2015.

This effort of information gathering, the results of that effort is intended to inform the Phase 2 decision making process such that any necessary regulatory actions would be based on the good understanding of the risk posed by the reevaluated hazard and the most effective actions to meaningfully reduce the risk.

Now I'll turn it over to Dr. Munson.

MR. MUNSON: Good morning, Chairman, Commissioners. Slide 11 please. Okay. Seismic designs for operating nuclear power plants in the U.S. were developed using a deterministic approach.

Each licensee evaluated the geology in the region surrounding their sites, including a catalog of nearby earthquakes.

Taking into account the earthquakes in the region as well as the potential activity of seismic faults, licensees selected the earthquake that would cause the largest ground shaking at their sites.

The results of the licensees' deterministic evaluation was the establishment of a safe shutdown earthquake or SSE for the nuclear power plant.

The safe shutdown earthquake is defined in our regulations as the vibratory ground motion for which certain structure, systems and components must be designed to remain functional.

Next slide please. In 1997, the NRC published new geologic and seismic citing criteria in 10 CFR Part 100.23, which called for the analysis of uncertainties inherent in the determination of the safe shutdown earthquake and specified probabilistic seismic hazard analysis as an appropriate approach.

Various regulatory guides, such as Reg Guide 1.208 were also developed to provide the various details on acceptable approaches for performing a probabilistic seismic hazard analysis.

Recommendation 2.1 calls for seismic hazard reevaluations at each nuclear power plant using current NRC regulations and guidance.

The outcome of the probabilistic seismic hazard analysis is a set of seismic hazard curves, which you saw earlier this morning, which are used to develop a Ground Motion Response Spectrum or GMRS.

With each step in the probabilistic seismic progress, uncertainty in each of the parameters is evaluated and incorporated into the hazard calculations through the use of multiple models, a range of values for each parameter as well as the recognition of the uncertainty associated with the randomness of the phenomenon.

And of course this is the SSHAC process that was covered earlier this morning. Slide 13, please.

For Recommendation 2.1, each of the licensees has performed or will perform a probabilistic seismic hazard analysis to develop a GMRS for their sites.

Licensees whose plants are located in the central and eastern U.S. developed a GMRS for their sites using what has been referred to this morning as the CEUS-SSC, which stands for the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities.

This model was jointly developed over a five year period beginning in 2007 by the Electric Power Research Institute, the Department of Energy and the NRC, so it was a cooperative process.

This regional source model was published in six volumes, so it's quite big, as NUREG 2115 in 2012. The figure on the right shows the geographic area covered by the CEUS-SSC model and some of the larger source zones, such as New Madrid and Charleston.

The CEUS licensees also used a set of regional ground motion models published by EPRI in 2013 and then performed a site response analysis to develop a GMRS for their sites.

This work was submitted to the NRC in March of this year. Licensees whose plants are located in the western U.S. do not have the advantage of using previously developed seismic source and ground motion models.

As such, these three licensees were given more time by the NRC and have been developing their own regional source and ground motion models using the same NRC endorsed process.

The NRC staff has attended the workshops held by the western U.S. licensees to observe the process used to develop these models.

And the Western U.S. hazard reevaluations are due to the NRC next year. Next slide, please. The first step in Recommendation 2.1 is a comparison of the probabilistic GMRS with the plant SSE.

Based on this comparison of the GMRS with the SSE, there are three potential outcomes. The first possible outcome shown above in the upper left plot is that the SSE is greater than the GMRS for the entire frequency range.

For this case, the licensee does not need to do any further analysis and has completed the Recommendation 2.1 process.

The second possible outcome shown in the lower left corner is that the GMRS exceeds the SSE but only for frequencies above 10 hertz.

For this case, the licensee will need to evaluate the high frequency sensitive components in the plant, such as electrical relays, to determine if they have sufficient capacity to handle the GMRS accelerations.

To support this evaluation, EPRI is performing a testing program for high frequency sensitive components.

The third possible outcome, shown on the top right plot, is that the GMRS exceeds the SSE and in the important frequency range of 1 to 10 hertz.

The 1 to 10 hertz frequency range covers the natural frequencies for a majority of the systems, structures and components in nuclear power plants.

For exceedances in the 1 to 10 hertz range, licensees screen in for further plant evaluations, which I will describe in more detail next. Next slide.

The staff's process for reviewing new seismic hazards is multilayered and robust. In general, plants where the GMRS exceeds the SSE in the 1 to 10 hertz range screen in for further risk evaluations.

The interim evaluation, which has been completed for the central and eastern U.S. plants was a preliminary look at the seismic risk of the plants based on combining the new hazard curves with the plant's seismic capacity information, determined from the IPEEE program in the 1990s.

The interim evaluation, which I will describe next in more detail, was submitted to the NRC in March of this year.

Plants that screened in will also perform the expedited seismic evaluation program, which is a near-term evaluation of critical plant equipment needed for coping with loss of AC power.

Finally, plants that screened in for further evaluation may also need to perform detailed seismic risk evaluations using the seismic probabilistic risk assessment methodology.

I will describe the expedited evaluation program and seismic risk evaluations in more detail later in my presentation.

To implement the 50.54(f) request for information, industry developed a guidance document commonly referred to as the SPID, which stands for Screening, Prioritization and Implementation Details.

The SPID provides guidance on performing the hazard reevaluations to determine the GMRS, the screening approach, seismic PRAs and additional limited scope evaluations for high frequency sensitive equipment and spent fuel pools.

Staff and industry held several public meetings during the development of the SPID, and these meetings ensured that the industry and NRC were aligned on expectations for the submittals.

Next slide. On March of this year, industry submitted an interim evaluation, which combined the new seismic hazard curves with the plant seismic capacities determined from the IPEEE results to calculate an estimate of the distribution of seismic core damage frequencies for the central and eastern U.S. plants.

These results are shown above as a cumulative distribution plot with the industry's calculated values as the red curve and the staff's confirmatory calculations as the blue curve.

Also shown as the green dashed curve are the results from GI 199 report from 2008. What these plots show are that the distribution of seismic core damage frequencies for central and eastern U.S. plants are all below 10 to the -4 confirming that the plants can continue to operate safely while the longer term plant risk assessments are being completed.

Comparing the 2014 results to the earlier GI 199 results shows that there has not been an overall increase in seismic risk for the fleet of U.S. plants.

The results of industry's interim evaluation study, which was confirmed by the staff, provides an important measure of the overall safety of the nuclear power plants in the central and eastern U.S.

However, the study was performed to determine the overall distribution of seismic risk for the central and eastern U.S. plants and not to determine a specific risk value for any given plant.

This is due to the use of the IPEEE seismic capacity information. The NRC gained valuable insights from the IPEEE program. However, the primary purpose of the program was to identify plant-specific vulnerabilities to severe accidents caused by seismic events and gain a qualitative understanding of the overall likelihood of core damage.

Next slide. Each of the central and eastern U.S. plants submitted a hazard and screening evaluation report in March of this year.

In the 50.54(f) letter the staff outlined a 30 day screening and prioritization process to evaluate which plants screened in for further review and to prioritize the screened in plants.

In order to perform this rapid, 30 day review, the hazard submittals from the 60 central and eastern U.S, plants, the NRC staff formed, prior to the March submittals, a team of geoscientists and engineers from the offices of New Reactors Research, NRR, NMSS and the Regions to develop independent GMRS curves for each site.

As soon as the central and eastern U.S. hazard evaluations arrived, the staff was able to go through each of the reports to evaluate the licensees' screening determination and then to group the screened in plants into three priority groups.

Next slide. The NRC grouped the screened in plants into three groups based on certain key parameters, such as the maximum ratio of the GMRS to the SSE in the 1 to 10 hertz range, the highest value of the GMRS in the 1 to 10 hertz range and insights from previous seismic risk evaluations.

The two figures shown on the slide are an example of a plant GMRS and SSE for Priority Groups 1 and 2. Shown on both plots are the plant SSE as the black line, the GMRS calculated by the licensee in red, and the NRC GMRS is the dashed green curve. The plants screened into Group 1 have the largest difference between the GMRS and SSE response spectra over the 1 to 10 hertz range.

Although the GMRS relative to the SSE is higher for Group 1 plants, it is important to remember that nuclear power plants are very rugged structures that have been designed and built to withstand ground shaking beyond their SSE ground motion levels.

The risk evaluations for Group 1 plants are due in 2017. Group 2 plants have GMRS to SSE ratios that are greater than one, but the amount of exceedance in the 1 to 10 hertz range is moderate and less than Group 1 plants. The risk evaluations for

Group 2 plants are due in 2019.

Next slide. The two figures shown on this slide are an example of a plant that falls into Priority Group 3 and an example of a conditionally screened in plant.

Group 3 plants have GMRS to SSE ratios that are greater than one but the amount of exceedance in the 1 to 10 hertz range is relatively small.

Given the limited level of exceedance of Group 3 plants, the staff is evaluating the need for these licensees to conduct a seismic risk evaluation in order for the staff to complete its regulatory decision making.

After review of the expedited approach submittals, the staff will decide which Group 3 plants need to complete a risk evaluation.

The figure on the right shows that for some plants the NRC staff and licensee reach different screening conclusions based on the GMRS to SSE comparison in the 1 to 10 hertz range.

The NRC staff conditionally screened in these plants while it performed additional evaluations which I will describe next. Next slide.

These two graphs show the screening and prioritization results after completion of our 30 day review in May of this year compared with where we are now.

The number of plants assigned to each priority group reflects the relative priority for conducting a seismic risk evaluation and accounts for the appropriate allocation of limited staff and available expertise for reviewing and conducting seismic risk evaluations.

During the prioritization review, the staff considered each licensee's reevaluated hazard submittals, seismic risk insights from GI 199 and the staff's confirmatory analysis.

The graph also shows the plants that screened out of performing additional seismic risk evaluations. The lower graph shows where we are as of September.

As you can see, we have made considerable progress in that we've resolved the majority of the conditionally screened in plants.

In order to resolve the status of the conditionally screened in plants, the staff conducted several public meetings to clarify the approach used by licensees to develop their GMRS as well as their screening conclusions.

Plants were conditionally screened in either due to differences between the GMRS or the staff needing extra time to verify the licensees' use of the SPID screening criteria.

Both the staff and licensees found the public meetings to be very beneficial in identifying the key issues. And as a result, the staff was able to resolve the status of most of the conditionally screened in plants.

For the remaining conditionally screened in plants, the staff has made significant progress towards a final resolution and will provide its determination in a letter to each of the licensees.

Next slide. Central and eastern U.S. plants that screened in are currently performing an expedited seismic plant evaluation.

The purpose of the expedited evaluation is to focus on short term evaluations of critical plant equipment to determine if prompt modifications are necessary to improve plant seismic safety while the more detailed seismic plant risk evaluations are being conducted.

The expedited evaluation begins with the development of a list of equipment identified in the plant-specific FLEX implementation strategy for scenarios involving loss of AC power, which is an important contributor to seismic risk.

Specifically the scope of the expedited evaluation is focused on installed plant equipment identified as FLEX Phase 1 equipment.

The expedited evaluation evaluates the seismic capacity of the equipment up to twice the plant SSE depending on the ratio of the GMRS to SSE between 1 to 10 hertz.

If the equipment capacity does not exceed this review level ground motion, then the equipment will be modified within two years of completion of the expedited evaluation program unless a plant outage is required to implement the modification.

The longer term seismic risk evaluations provide the most comprehensive information to make regulatory decisions, such as whether to amend the design or licensing basis or to make additional safety enhancements.

The key elements of the seismic probabilistic risk assessment are the modeling of various combinations of structural and equipment failures that could initiate and propagate a seismic core damage sequence, a fragility analysis of the key plant equipment and structures, and finally, a seismic risk quantification for the plant.

The staff will use the information from the risk evaluations in conjunction with the existing regulatory tools to decide on further regulatory actions. Last slide.

To summarize the key parts of Recommendation 2.1 of the seismic hazard reevaluations followed by the expedited evaluations and risk evaluations for the plants that screen in. Central and U.S. plants completed their hazard reevaluations in March of this year while western U.S. plants will submit their hazard reports next year.

CEUS plants that screened in for further plant evaluations are currently working on their expedited evaluations, which are due at the end of this year.

Priority Group 1 plants are also performing risk evaluations, which are due in June of 2017. Risk evaluations for Group 2 plants are due at the end of 2019.

And Group 3 evaluations, if needed, are due at the end of 2020. In conclusion, we've made a lot of progress on Seismic Recommendation 2.1.

The process and approach ensures continued plant safety while more detailed reviews that use state of the art methods are completed. That ends my presentation. I will now turn the presentation over to Mark for closing remarks.

MR. SATORIUS: Thanks Cliff and thank you for your presentation. I'd also like to thank the others for their presentations. We're a little ahead of schedule, but we're ready for your questions now.

CHAIRMAN MACFARLANE: Great. Excellent. It's always good to be ahead of schedule. All right, so I'm going to start off.

Thank you all for your presentations, and let me just say at the outset, I really want to commend the staff for their work.

I've been particularly impressed by Scott's team of Cliff and John and Dohan and a number of others. They've really been ahead of the game.

I was really impressed with the fact that you guys did your own GMRS analyses. You were ready when the licensees came in with their analyses, and you were ready to evaluate them.

You did it amazingly quickly, in a month, so kudos to the staff. You guys have done a great job. But of course now you've set our expectations very high.

So I'm going to go to this question of margin that was brought up at the last panel. I have a derogatory term for these things. I call them magic margins because I don't really know what they are.

I've been wondering what they are for years before I came to the NRC, and I remember asking George Apostolakis when he was a Commissioner and I wasn't even thinking about being here what these margins were.

And he gave me some kind of unsatisfactory answer. Sorry, George. But anyway, in our analyses, in our seismic analyses, do we give credit for margin. And if so, how?

How does one quantify this? There's been a lot of discussion at the Commission lately about quantification, quantitative versus qualitative.

And it seems to me that you could only really give credit for margin if you could quantify it, but seeing how it seems to me that the margin at plants, it was like well, we put an extra thick bolt in or we put a few extra inches of concrete or whatever.

But they were never quantified when the plants were built, so how do you actually account for this?

MR. MUNSON: That's a key, your question is a key part of both the expedited evaluation program and the seismic PRAs.

For both those processes, those risk evaluations, we looked at the actual equipment in the plant and determine its capacity either through analytical methods or experience.

And you evaluate that, the capacity of that equipment to a certain G level, acceleration level. And so we actually have specific quantification of the capacity of the plants based on the equipment in the plant.

Then we fold that all together and come up with a plant level capacity. And so that work was done, initiated in the 1990s.

Some of the methods were a little not quite as mature at that time, but through the expedited evaluation program and the seismic PRA that's a major part of those processes.

CHAIRMAN MACFARLANE: But that doesn't get to the margin question.

MR. MUNSON: It does because the --

CHAIRMAN MACFARLANE: Or you just don't account, give any credit for margin.

MR. MUNSON: Well the margin, also the capacity of the plant is in a sense the margin. Okay. So we look at that term that Greg Hardy used this morning, high confidence, low probability of failure.

That's a metric that in a sense quantifies the margin that we have in nuclear power plants.

MR. CHOKSHI: This is Nilesh Chokshi, Division of Site Safety and Environmental Analysis. The simple definition of margin is the capacity over demand.

It's a ratio, but demand is defined by the design basis load, SSE loads. So if I take a pump I have designed for a certain seismic design value, the capacity you can define now capacity various ways.

The capacity in the context we talk about margin, this concept of high confidence, low probability of failure, all it says is the ground motion level where we have a 95 percent confidence that the probability of that component is only 5 percent, no greater than 5 percent.

So it's already low probability of failure. That capacity was determined by well developed methods. You can use PRA versus there are specific seismic measuring matters.

And you do that for each necessary component in a safe shutdown plant. And then you evaluate from the plant perspective what's that margin.

That's the margin we're talking about, this 5 percent probability, no greater than 5 percent probability of failure with 95 percent confidence divided by the design basis demand.

MR. FLANDERS: I would just add to Nilesh's answer. Part of the reason why you see this is the plants are designed for many different types of transients and loads.

And so in consideration of design, the plant can take on the various transients that we would expect them to. In a design basis standpoint they may have loads or demands that exceed maybe just solely what we consider for seismic, which is often why we will see margin as well.

CHAIRMAN MACFARLANE: Okay. I'm not completely convinced because I'm not sure that what you're describing as margin is what Dave Heacock was describing as margin.

But anyway, some plants have had problems under seismic conditions. The Kashiwazaki-Kariwa plant was shut down for many years because maybe the margins on the safety equipment weren't exceeded.

But on other equipment they were definitely exceeded, which was why the plant was shut down for I don't know, three years or something like that.

So anyway, I have a question about the reevaluated GMRS curves. A lot of them seemed to exceed the safe shutdown earthquake in the higher frequencies. Why is that?

MR. MUNSON: That's a characteristic of the type of ground motions we see for rock sites, harder rock sites.

CHAIRMAN MACFARLANE: Right, okay. These are the hard rock sites.

MR. MUNSON: The --

CHAIRMAN MACFARLANE: So we didn't understand this before when the first GMRS --

MR. MUNSON: Right. Well, the earliest SSEs were developed using western U.S. ground motions where we don't see, generally don't see that type of high frequency shaking, although it does happen.

But it's predominant in the east on hard rock sites.

CHAIRMAN MACFARLANE: And do you guys feel like you have a good handle on the effects of the high frequency on plants, high frequency shaking on plant equipment or are we doing any research on this, or are we just relying on industry?

MR. FLANDERS: I'll start, and then I'll let Cliff add to that. The study that Greg Hardy was talking about in terms of the EPRI work to actually go off and test components, actually put them on a shake table to understand the capacity for components that may be sensitive in a high frequency area.

The construct for that study, similar to the public interactions we've had with industry, we participated in the development of the scope of that study. And we are looking at that work that they're doing in terms of evaluating the high frequency.

So we are focused on and rely on that in the near term. I don't know if you guys want to add to that.

MR. MUNSON: Yes, I would say that actually that was initiated through a cooperative agreement between industry and our Office of Research to look at the high frequencies.

So we've been intimately involved in looking at that in a cooperative fashion.

CHAIRMAN MACFARLANE: So let me ask about timing. Do you feel that the industry's going to, the Priority Group 1 plants are going to meet their 2017 time line?

MR. MUNSON: As far as I know they're on schedule. In fact, we've heard that some of the early starters are actually finishing up SPRAs. So we're optimistic --

CHAIRMAN MACFARLANE: Good.

MR. MUNSON: -- that the 2017 --

CHAIRMAN MACFARLANE: Do we have the resources we need to evaluate them once they come in?

MR. FLANDERS: Right now as we look at it, based on the agreements we are continuing to examine the resources we need to be able to review them.

We do think we do have the resources, but as Greg alluded to, the training and development is also an important aspect to continue to groom our staff.

In addition to external training, we've done a number of internal training activities. We've done activities such as we rehired annuitants we bring in to help develop staff as well in this area.

So we're very focused on assuring that by 2017 we do have the appropriate set of staff to be able to review these, but it's a continuing process. We have to start now to make sure that we're ready.

MS. UHLE: Although, I would like to add though as part of the seismic PRA submittals, part of the requirement that, or the guidelines that we established is that there is a very thorough peer review process associated with it.

And so our review will, of course, be informed by that external peer review that gets done for each of the plant submittals.

CHAIRMAN MACFARLANE: Okay. And what about the western U.S. plants? Are they, there are just two of them, no three of them. Are they going to be on time?

Has Palo Verde and Columbia Generating Station been doing a SSHAC process?

MR. MUNSON: Yes.

CHAIRMAN MACFARLANE: Okay.

MR. MUNSON: Yes.

CHAIRMAN MACFARLANE: And do we think they're going to be on time?

MR. MUNSON: We haven't heard it any otherwise so --

CHAIRMAN MACFARLANE: Okay. On to Commissioner Svinicki.

COMMISSIONER SVINICKI: I also want to thank the staff for their presentations. Risk communication as a subset of the field of communications is acknowledged for public agencies, such as ours, to be a very, very challenging task.

And I would observe that it's my view that the staff has done a really high quality job in attempting, and I say attempting because as all the presentations this morning demonstrate, there's a lot of terminology.

There's a lot of things probably only deeply understood by practitioners when we're talking about this particular area of risk communication.

But I reflect that over the years that I've been at NRC. I think we've done a good job in making this as understandable as possible.

It began with the North Anna event where I think we suddenly found ourselves tripping over some of this terminology.

But I think over the course of time, Scott, you and your group and generally all the NRC staff that have contributed in this area have, I think, been striving to make this understandable to those who are demonstrating the commitment to follow along with NRC's actions here.

And I think as a Commissioner I want to thank all the NRC staff who've worked on this for being very proactive in keeping members of the Commission informed about this work.

And I'm not saying that NRC staff doesn't strive to do that generally, but I think that the outreach that you've made when you're going to have a significant public engagement or release a document, you have reached out to Commissioner's offices and said do you want us to come by.

Do you want us to bring a team up to talk about it? That's been very, very helpful. So I thank all of you for that.

The other observation I would make about our work in this area, it's come up in a number of your presentations how various parts of NRC contributed to this work.

And so I want to observe that this is a positive example of where NRC was able, for whatever reason, to have the agility to put critical skill sets on a body of work very quickly.

There have been other, I would think of maybe some ongoing licensing work in NRR, other areas where there seem to have been maybe some administrative burdens and impediments to moving skill sets as quickly.

So I know as we proceed with Project Aim, the EDO and CFO and Mr. Webber will be looking closely at why it is, what are the agency processes for getting the allocation of critical skill sets on important work and not creating additional administrative barriers to ourselves in doing that.

So I think this is an area where we did get the skill sets on it, so I commend all of those who moved with fleetness of foot to apply ourselves to looking at these seismic challenges.

There's been discussion on the previous panel and certainly it manifested in the Near-Term Task Force work about periodic review of either seismic or other hazards.

We've had now two, since Fukushima, two NRC Chairmen and any number of Commissioners who have testified and explained to the Congress and others about the regulatory framework for responding to new knowledge.

And so I want to direct a question. I think I'll direct it at Jennifer. Don't look for hidden meaning in this question. It is frankly as simple as it sounds.

But under the Atomic Energy Act and our regulatory framework as it's existed and exists now, if we have knowledge as the safety regulator, of risk significant new information that affects our conclusion about the continued operation, in this case, of a nuclear power plant, would it be permissible for us to wait six years or ten years or 15 years to take regulatory action on that knowledge?

MS. UHLE: The simple answer is no. And I would say no way.

COMMISSIONER SVINICKI: Okay. Thank you for not parsing it and looking for a lot of other, again, I've watched now Chairman Jaczko, Chairman Macfarlane, members of this Commission attempt to communicate this.

And maybe we need to get some lessons learned about risk communication that I was complimenting you all on.

We seem to have had a lot of difficulty in having certain very important and key stakeholders understand that the reason that we do not have a framework for periodic safety review is that we have an enduring, day to day, continuous, Jennifer, you used the, your exact words were NRC's continuous focus on seismic safety. We have a continuing obligation to act on knowledge as it becomes available.

And so whether or not USGS is updating every six years, ten years, whatever it is there is not a disconnect there because of the fact that our obligation is to evaluate the risk significance.

And if we determine that regulatory action is needed, there is no permissibility to waiting for some to say oh, we do that every ten years. So we'll get around to that later.

That simply isn't the way that we regulate on these topics, and I, Jennifer I viewed your Slide 4 or the staff's Slide 4 which you spoke to, to be nothing other than a representation of this continuous reaction.

It's kind of a gathering, or as USGS said, we're actually a bit more proactive than just receiving information. But we're a part of this continuous process when it comes to seismic of making sure that updated models are there for our regulatory purposes, taking in the state of the art, feeding them into those models and then taking off and having a regulatory response.

And whether you want to call it Safety Issue 49 or whatever it was, Generic Issue 199, IPEEE, this is the chronology over, I think you might have just cut it off at whatever decade you cut it off.

But I don't, Jennifer, would you like to, I've characterized your slide. Would you like to say anything about that?

MS. UHLE: I would just like to reiterate the points that you made. We do have a continuous questioning attitude that we apply.

So we do seek out information to verify that the plants are safe to continue to operate. We have a very robust research program.

We have a number of partners that we work with, so it's not only sitting back and being reactive to information that others find. It is also, I think, a very strong effort to be proactive.

We can point to the generic issue program where we have people from, external stakeholders that can raise safety questions as well as internal to the agency, people that raise questions.

And we address, we look at it from a generic perspective and determine if there is some risk significance to the issue. And if so, then we go forward with appropriate action.

And so the generic issue program does that. We also have other means of public interaction through the 2.206 program and also, of course, with our resident inspectors on site, maintain awareness of allegations that could be raised.

So our entire framework is, I would say, very focused on day to day ensuring plant operation is safe.

COMMISSIONER SVINICKI: So taking that description then of how NRC has approached taking in new information and acting on it in a regulatory sense, a phrase was used in the first panel of how or there was a discussion of how significantly knowledge advances.

Is it an overturning of previous knowledge, or I think the phrase someone used was if the needle moves only a little bit every time you update your state of the knowledge, you're really just adding further granularity to knowledge you had?

And that's often what happens. If we take the framework that we've applied in the past to responding to new knowledge, would the staff assess that if the needle only moves a little bit, it is appropriate in the future perhaps if that's what occurs, to have some sort of approach that would scale the regulatory response to the significance of how far the needle moved.

I think the first panel talked about do you need to do a new seismic PRA if the needle only moves a little bit. Can you do a high level screening, or can you do some sort of sensitivity analysis? Jennifer, could you react to that?

MS. UHLE: Yes, I would say that the generic issue program as well as our backfit criteria is based on what you just indicated where new information comes in and we assess its safety significance through the tools that are available, if possible, the use of probabilistic risk assessment with other factors considered.

And so our decisions are very systematic based on the set criteria that have been established. And we follow that not only in the generic issue but also in backfit.

And that's, as you indicated, the regulatory attention increases as the safety change or the safety significance of the change increases. And I think that we've done a good job at establishing that criteria and sticking to it over the years.

COMMISSIONER SVINICKI: I appreciate you commenting on that structure because I agree with Commissioner Ostendorff's concern that he expressed after the first panel when he said there's so much discussion of areas of additional analysis and research.

I think it could create an impression perhaps that we lack a structure, Jennifer, that you just described. There is always new knowledge, and there is always change.

And that isn't anything new to NRC. Fukushima didn't create a new circumstance for us, so we have long had to deal with that. And within that structure we do need to have some reliability and predictability.

And what you've just described is how we have addressed that up until now, and I think in looking at seismic, what I've heard today is that same structure is what you use to do the work that you briefed on and that it has served us well.

So with that, Chairman, thank you very much.

CHAIRMAN MACFARLANE: Okay. Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Chairman. Thank you all for your presentations, and I add my thanks to that of Chairman Macfarlane and Commissioner Svinicki for all of your work and that of your terms throughout the agency.

I do think this has been a very commendable effort to deal with a dynamic area and to put you guys in a position but also to inform the Commission of here's some hard regulatory decisions that have to be made on a plant-specific basis.

And I am very proud of your work and that of your teams. I have a couple questions, but I want to first, does anybody here at this table have any comments you'd like to offer anything said at the first panel?

Sometimes that's helpful to see if there's anything, reaction or maybe a different position or stance anybody would have.

MS. UHLE: I would just like to take the opportunity to thank the representatives at the table and also to note that there were several partners that we work with on a daily basis at that table.

Just another example of how the agency not only uses its in-house capabilities but also learns from others.

COMMISSIONER OSTENDORFF: That's good. I appreciate you raising that, Jennifer. I think the Commission heard a very positive theme about the interaction between the NRC and the various organizations represented by the first panel participants.

I wanted to just for a minute follow up on a question the Chairman had asked Cliff on margin in reference to Dave Heacock's presentation.

I know when I was on the submarine force, I knew exactly what the crush depth was for a submarine and how far below operating depth I could go.

I knew what the design margin was for fracture toughness, analysis of a flaw in the reactor vessel wall, and I appreciated the tech assist from the back bench there from the Chairman's question.

But I think the Chairman has raised an important point, and I want to make sure I understand it. Is there a difference in how industry is looking at margin and how the NRC staff is looking at margin in the context of seismic issues?

MR. MUNSON: No, there's no difference. We're using established methods that we've been using since basically the '80s and '90s to look at and evaluate the capacity of equipment in the plants and to come with an overall capacity.

And so the capacity relative to the demand or the hazard is the margin that the plant has. So we're not, we're doing it the same way as industry is doing it.

COMMISSIONER OSTENDORFF: Scott, anything you want to add?

MR. FLANDERS: I would add, I agree with everything that Cliff said. I would add that I do think that sometimes we have to be careful in terms of how we describe the margin in the comparisons that we make in a generic sense about margin in plants as opposed to more specific situations because in some cases the way we characterize margins and we say it in a very general sense may not be as applicable.

Or it may not be as robust for all plants, so we always have to be thoughtful in terms of how we use it. But as Cliff said, what we call margin is the same thing. How we calculate it is the same thing.

(Simultaneous speaking)

COMMISSIONER OSTENDORFF: And I understand the margin will vary from one plant to the other, but the methodology used --

MR. FLANDERS: That's a valid point.

COMMISSIONER OSTENDORFF: -- it's important for that to be consistent. Is it consistent from your perspective?

MR. FLANDERS: Yes. As Cliff said, the methodology is the same.

(Simultaneous speaking)

MS. UHLE: If I could, sorry.

COMMISSIONER OSTENDORFF: No, please.

MR. FLANDERS: I can't tell if Scott's still talking because we had somebody coughing next to me, but I think what gets confusing is, and I think Scott alluded to this is that the term margin gets thrown around in a number of different contexts.

Early when the plants were first licensed, there were certain code requirements, and they met those code requirements based on their knowledge of what was necessary for safety.

I don't think at that time necessarily that people would have said there is a lot of margin. It's over time as operating experience has been gained that we now recognize that and can quantify in a calculational way that yes there is this large margin, and in fact, the IPEEE programs in the development of the high confidence low probability of failure actually calculates what the acceleration is and can compare it to if we were to ever get information from shake tables that would then say yes, in fact, this component does have this margin up to this ground shaking.

COMMISSIONER OSTENDORFF: Okay. So a follow-on question then, Jennifer, on that topic is, is there anything in NRC regulatory guides or other documentation that officially describes an approved methodology or that describes techniques that we've considered acceptable for licensees to use in this area.

MS. UHLE: Well, I would point to, well there's the term seismic margin analysis that was done under the IPEEEs as well as in some case may be used for some plants in the reevaluation efforts.

And that has been documented in a regulatory guide on how to do that, and Nilesh Chokshi can provide more detail.

MR. CHOKSHI: There are industry standards on the

PRN margin methods. Also in the 2.1 we have an ISG on that particular margin method, which can be used.

COMMISSIONER OSTENDORFF: Okay.

MR. CHOKSHI: So, yes, I'd say it's been practiced since IPEEE and before that.

COMMISSIONER OSTENDORFF: Thanks for that clarification, appreciate that. Jack, I don't want you to sit there and not have a question.

MR. DAVIS: Figured as much.

COMMISSIONER OSTENDORFF: From where you sit with the Japanese, Japan Lessons Learned Directorate and so forth, are there any big picture lessons learned you're seeing from how we've dealt with the seismic analysis or how this has impacted your group's work?

MR. DAVIS: With respect to how other countries are doing it or --

COMMISSIONER OSTENDORFF: No, no with respect to how you're looking at U.S. nuclear power plant, our work.

MR. DAVIS: Yes, I think as we go along knowledge evolves and we, as we started to look at some of these things, some of the original thoughts that we might have had on them has evolved since that time.

I think that's healthy, and there's healthy debate that's going on on those types of things. Similar to what you see here on whether we would do a seismic PRA for a Group 3 plant is one example, right.

MS. UHLE: And if I can I can add my thoughts. And we've discussed, Jack and I have discussed this earlier as well as others.

And that is, I think, in the seismic area because of all the infrastructure that had been developed over the years and the use and the evolution of the seismic probabilistic hazard assessment and the use of seismic PRAs in the past, that has, it fits in very well, as Commissioner Svinicki pointed out, our decision making approach here at the agency.

And I think that has allowed the seismic work to at least the decision making to be much clearer up-front, whereas at this stage now we are doing, we're focusing a lot of attention on that decision making for flooding because we don't have access to that probabilistic insight that we have for the seismic area.

MR. FLANDERS: I would just add to Jennifer's comments as well as focusing on the decision making, as we structure both seismic and flooding, we've structured it from an information gathering and decision making standpoint.

And I think what helps facilitate the decision making process is as Jennifer says, experience with seismic.

But that also is a tremendous asset in the information gathering part in terms of the standard practices and understanding how you go about doing that where in the flooding, even you heard Dr. McCann refer to some of the continual uncertainty and debate about the level of hazard that should be considered.

And I think that creates additional challenges in flooding that we don't necessarily have in seismic.

COMMISSIONER OSTENDORFF: Thank you all. Thank you, Chairman.

CHAIRMAN MACFARLANE: I have a couple additional questions. It dawned on me in listening to Commissioner Svinicki's discussion.

In your Slide 4 you have the different things that you've done, the agency's done over time in response to seismic. So I guess Jennifer talked about that.

MS. UHLE: Yes.

CHAIRMAN MACFARLANE: So in each of these unresolved safety issue A46 IPEEE thing, did you require the plants to do a new seismic PRA?

MS. UHLE: I would say the techniques for seismic, the answer is no. The seismic techniques back in the '70s, the PRA techniques I don't believe were developed at that point.

I'm going to look to Nilesh there. I think he's shaking his head that they weren't. So we asked for this information from a performance-based approach.

Provide insights into the ability of your plant to either meet the ground shaking, or also in light of the changes to the design criteria, can your plant withstand this new design criteria.

And we didn't specify necessarily how that was to be developed, although there I guess back in the '70s, '80s that there was obviously guidance that was developed.

CHAIRMAN MACFARLANE: Each time you asked the plants to do a robust seismic hazard --

MS. UHLE: After the state of the, for the state of the art at the time, and the PRA information --

(Simultaneous speaking)

CHAIRMAN MACFARLANE: I don’t know if I'm in full agreement on that.

MR. CHOKSHI: May I? If you're going back to the first the systematic evaluation program, that was at that point in time there were specific new ground motions were developed for those plants.

It was generic spectrum, so there was a new hazard --

CHAIRMAN MACFARLANE: So basically then what you're saying is you've been doing it every ten years.

MR. CHOKSHI: No. I can come back to that.

CHAIRMAN MACFARLANE: That's what your chart suggests.

MR. CHOKSHI: So on the IPEEE this is where, just looking at a beyond design-basis, and they were allowed, most of them used what is called seismic margin methods.

CHAIRMAN MACFARLANE: Right, and do you think that the methods they used are really valid and comparable to what we have today?

MR. CHOKSHI: Yes, the basic method is the same, but the hazard that was used was not based on a new hazard analysis.

CHAIRMAN MACFARLANE: Right.

MR. CHOKSHI: It was a predetermined level of earthquake, which was greater than the plant, the design basis. So, but they also had an option for doing a seismic PRA.

And about 30 percent of them did that. In that case, they did, they used the hazard analysis which was existed from the Lawrence Livermore and --

CHAIRMAN MACFARLANE: So they all didn't do a seismic PRA --

(Simultaneous speaking)

MR. CHOKSHI: -- right. So part of them did the margin. Part of them did the seismic. It's a sort of complicated answer, but --

CHAIRMAN MACFARLANE: Right. It makes it difficult to compare then and to generalize.

CHAIRMAN MACFARLANE: It just seems to me that this question of well, when there's new knowledge do you act on it is an important one.

And I don't see the evidence for that completely. So, for example, the Generic Issue 199, that was prompted because, not because there was new knowledge out there.

Yes, the new knowledge existed. We only acted on it because when we did analysis for the new plant siting, we realized oh wait a minute.

We can't have a plant with, a facility that has existing plants and have a different seismic spectrum for the new plants. So we better get up to speed here.

That's the reason that you made the change, not because the new knowledge existed. So I think there is an argument for a periodic revisitation to make sure that we know what we're doing. We know what's out there.

MS. UHLE: Chairman, if I, can I respond to that question?

CHAIRMAN MACFARLANE: Yes.

MS. UHLE: And I think that was a lesson learned from us after the IPEEEs. We had confidence that the plants, I'm going to use the term margin.

And I don't know if I should or not. I think it's like a lightning bolt term, but I'll say that the plants did have margin.

And we did. For whatever reason I think it may also be because of our focus on internal events, was always where we would typically focus our time.

We did lose some attention, or we lacked attention on the external events over time. And that was a lesson learned from us that.

And when we started siting again for new reactors in the early site permits and we were ramping back up in our external events at the siting area, we recognized that there were these differences.

And so we did learn a valuable lesson. And --

CHAIRMAN MACFARLANE: And the lesson is?

MS. UHLE: And the lesson is that we need to constantly be looking at external event risk as much as we look at internal event risk.

In fact, we are doing a lot now to get that effort underway. And it will continue because we know now that the dominant risk contributor is typically external events.

MR. FLANDERS: I would say in this whole discussion for the need for periodic review is that that's something that staff has. It's on their charter to do.

And I think one of the things, in my presentation I mentioned the need to collect the information from the 2.1 reevaluations because I think that's important input to balancing how we might augment because perceivably we always have a continuing process.

If we identify something, then we would react to it. It wouldn't wait. But the question is, is there value in having a set time where we may look or consider some new information. And --

CHAIRMAN MACFARLANE: Somehow you have to get that new information in there and not have it be a surprise later.

MR. FLANDERS: But the balance, I think, the key balance in I think the 2.1 information is so important to us, is to understand if you were to do or develop a process to do that, what's the threshold?

What's the necessary information that would, as you say, have a meaningful difference such that we would want to consider some kind of action moving forward?

And I think it's certainly an understanding of how the natural sciences and our knowledge of them involved as well as our understanding of the plants and their capabilities and being in a position to be able to set up a process that takes the appropriate look in an efficient way before making decisions to act.

And I think it's that additional information we need to gather from the 2.1 process that would help inform any recommendation we may make around a periodic review.

MR. DAVIS: Yes, Chairman, that's a Tier 3 item, for periodic review to determine if we're going to do that and what frequency we would do it on.

CHAIRMAN MACFARLANE: Okay. Any other comments?

COMMISSIONER SVINICKI: Yes. My point on Slide 4 is to elevate this beyond just seismic. I think that there are many countries, we're familiar with the regulators of those countries, we work closely with them, that have established at whatever frequency, ten years seems to be popular, resubmittal of fundamental safety cases for various operating facilities.

That is not how NRC has approached these questions, and Scott, I would ask you, and I'm sure you will, you and your thoughtful team will struggle with how to have, what is meaningful in terms of a structure for some predetermined frequency.

You've said you would complement that with a continuous look. I question whether there is an authentic commitment to continuously look at something when you, I think it's human nature to say if we look at it every six years, then we're going to look at it every six years.

And I don't know that you can safeguard against the fact that looking at it continuously doesn't slip further and further down the priority list.

And I also, I don't understand how to make an artificial frequency meaningful unless, again, if your commitment to continuous seeking and acting on knowledge is not sincere and authentic, then, and I would posit if that's the case we have a much, much bigger problem because our entire safety program is predicated on our commitment, which again, in my experience is authentic and sincere, to take in the state of the art and act on it.

And so if a frequency of review is needed for seismic, I would argue that if you can make the case that that's needed, it's needed for other hazards.

It's needed for other safety questions, and slowly but surely you are at a very different regulatory framework, which again, I don't criticize or fault, but is adopted by other countries where, on some frequency, there is an intensive relook at everything.

And in between those relooks they're either looking at other facilities, or if it's facility by facility, or they're engaging perhaps in oversight of other activities.

And so, Scott, I know that as you look at this as a Tier 3 item, those are all, yes it is somewhat regulatory philosophy, but you do need to look at how to make both meaningful if they're side by side.

MR. FLANDERS: Absolutely. That's the challenge that we have in terms of making that recommendation.

All the factors you just brought up we have to take into consideration as we make a recommendation on whether or not we need to do a periodic review, all external hazard and then how does that fit in the context of our overall regulatory process.

Those are the types of things that we're thinking about in terms of moving forward on the Tier 2, or the Tier 3 2.2 recommendation.

COMMISSIONER SVINICKI: See, I knew you would. I said you and your thoughtful team will do that. Thank you, Chairman.

CHAIRMAN MACFARLANE: All right, well, with that I thank everybody, the first panel, the second panel for all your presentations and the discussion. And with that, we are adjourned.

(Whereupon, the above-entitled matter went off the record at 11:44 a.m.)