UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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BRIEFING ON FLOODING AND OTHER

EXTREME WEATHER EVENTS

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MONDAY

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ROCKVILLE, MARYLAND

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The Commission briefing convened in the Commission Hearing Room, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, at 1:30 p.m., Allison Macfarlane, Chairman, presiding.

NRC COMMISSIONERS:

ALLISON M. MACFARLANE, Chairman

KRISTINE L. SVINICKI, Commissioner

GEORGE APOSTOLAKIS, Commissioner

WILLIAM D. MAGWOOD, IV, Commissioner

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PRESENTERS:

GEOFF BONNIN, Chief, Hydrologic Science and Modeling Branch, Office of Hydrologic Development, National Oceanic Atmospheric Administration (NOAA) National Weather Service

ROBERT DENIGHT, Operations Director, Salem Nuclear Generating Station

STUART LEWIS, Program Manager, Risk and Safety Management, Electric Power Research Institute (EPRI)

DAVID LOCHBAUM, Director, Nuclear Safety Project, Union of Concerned Scientists

CHANDRA S. PATHAK, Senior Hydraulic Engineer, Engineering and Construction Branch, U.S. Army Corps of Engineers

LANCE VAIL, Senior Research Engineer, Pacific Northwest National Laboratory

NRC STAFF:

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P R O C E E D I N G S

1:31 p.m.

CHAIRMAN MACFARLANE: Good afternoon. I'd like to welcome you all here for this afternoon's session, our briefing on flooding and other weather events.

Over the past few years, the nuclear industry has experienced multiple flooding and extreme weather events and not just in the U.S., I'm talking globally, the nuclear industry, which has caused the NRC to take a harder look at our oversight of natural phenomenon.

For instance, on March 11th in 2011 the Fukushima Daiichi Nuclear Power Plant in Japan was inundated by a tsunami after a very large earthquake occurred nearby and the height of the tsunami exceeded the sea walls by about 27 feet. It caused extensive damage to the facility, most of which was the loss, complete loss of electrical power to five of six reactors and the subsequent meltdown of three of those reactors.

In the summer -- it was an eventful year. In the summer of 2011, the Missouri River reached record flood levels and flooded the site of the Fort Calhoun Nuclear Power Plant for many months. And then in October 2012, Super Storm Sandy, one of the largest recorded hurricanes tracked up the eastern seaboard and

created meteorological conditions that in the end were not too much of a challenge to the nuclear power plants, but in particular in New Jersey did cause some levels of flooding.

The NRC has been paying attention to this, industry has been paying attention to this. In fact, right now nuclear power plants throughout the country are working to reevaluate their flood hazard analyses as mandated by us at the NRC using the most up to date methodologies available.

Some of those licensees have already completed those evaluations, some are still in the process of doing those evaluations. For those that have completed their evaluations and where it was determined that the flood hazards were not bounded by their current design basis, they have instituted interim actions, and we have inspected those interim actions to make sure that they are adequate.

So, today the Commission is going to be briefed by two panels, an external panel and an internal panel, our own staff. Let me remind all of you as I did this morning at our sessions this morning that I would like you to keep your talks to 10 minutes. Is that the time? Thank you. And please refrain to the best of your ability from using acronyms because not only are the people in the room interested in what you're saying, but this is being webcast, as well, I hope, and people outside are interested, as well. So, I look forward to the presentations.

Before we begin, let me ask if any of my fellow Commissioners have any comments to start off with. No?

All right, then I'm going to turn to the external panel, and first we're going to hear from Mr. Robert DeNight from the Salem Nuclear Generating Station.

MR. DeNIGHT: Thank you. Good afternoon. My name is Robert DeNight. I am from the Salem Nuclear Generating Station, and I am the Operations Director there.

I'd like to thank everyone for the opportunity to present the practical view of some of the severe weather preparations on the days leading up to and including the east coast most recent severe storm, Super Storm Sandy.

Salem Generating Station is located in Southern New Jersey on the Delaware River. Our site also includes the Hope Creek Generating Station.

The forecast that we had for Sandy called for light rainfall and wind gusts up to 65 miles per hour with a storm surge of three to six foot. The storm surge was projected to occur at high tide concurrent with a full moon. Up to the slide with the forecasted versus actual.

Going on to actual, we saw local wind gusts of between 60 to 70 miles per hour. North of the station the gusts did reach 90 miles per hour with a storm surge of approximately 11 to 13 feet. Next slide.

So, status of the units prior to the arrival of Sandy was Hope Creek and Salem Unit 1 were both operating at 100 percent reactor power. Salem Unit 2 was defueled with the core fully offloaded. Our additional equipment that we had out of service on Salem Unit 2 two days prior to the storm's arrival, where we were in a single source of offsite power alignment with a single service water header available, and one emergency diesel generator and battery train were out of service. Next slide.

I did provide a diagram presented on this slide just showing our normal tide levels. Our normal tide level is approximately 89-foot elevation. Our site grade is at 100-foot elevation, and our design-basis flood level is at 120-foot elevation. The intakes for both the service water and emergency diesel generators are much higher at 127-foot and 126-foot elevation respectively. Next slide.

Our shutdown criteria are if river levels are greater than 98.5 feet elevation, or if hurricane force winds are imminent. Neither of these criteria were reached during Super Storm Sandy. On to the next slide.

Our emergency action levels are at 99.5 feet, or an average wind speed of approximately 95 or greater than 95 miles per hour. And any time that we have those action levels then an unusual event would be declared. These conditions also cause visible damage to any of our safety-related structures, then an alert would be declared. Next slide.

Our preparations for a storm like Sandy are laid out in a severe weather operating procedure. I've included some of the major actions that we take, but there are specific checklists for each department. They're typically three pages long, and implemented in a phased approach. During Phase I, or approximately three days prior to a storm arrival Operations inspects all of our station blackout equipment. We verify our remote shutdown panel, communications, and any of the blockhouse sump pumps. Next slide.

For Maintenance, they insure that the spare equipment is available and protected for any station recovery efforts. We inspect outside areas for potential missiles. We pre-stage sump pumps and sandbags, and insure supplies such as flashlights and potable water are available for the staff to use. Next slide.

In Phase II or two days prior to a storm arrival we again conduct walkdowns, verify our water-tight doors, we insure our emergency diesel generator availability, and we return any major plant equipment to available status. We also insure that our water intakes are prepared and we address any potential staffing requirements. Next slide.

Staffing is such that only essential personnel are required to report. We do staff full, or two full emergency response organization teams, and two operating shifts on site such that the Operation Support Center, the Technical Support Center, and the Emergency Operations facility have a full complement of emergency

responders. Next slide.

In Phase III, or just prior to the storm arrival, we close watertight doors, relocate personnel, implement preplanned sandbagging, relocate vehicles to shelter, establish our fire protection command post. And then one additional action that we did for Sandy is verify the repairs were completed to all penetration deficiencies identified during our Fukushima walkdowns. Next slide.

The impact associated with Sandy is that Hope Creek remained at 100 percent capacity throughout the storm with its output actually greater than the demand on the PJM and New Jersey grid following the storm's passage. Salem Unit 1 was manually removed from service at 1:09 a.m. due to debris loading into our circ water intake structure. That's our non-safety related cooling supply to the condensers.

We had no consequential impact seen at our safety-related service water intake structure. In addition, however, we did lose a non-safety related switching station due to water intrusion that caused loss of power to several of our buildings on site and lost the intranet non-emergency site phones, and the meteorological tower data into the Salem control rooms.

Our safety-related equipment and features were not challenged, and our flood levels remained well within our design limits. Next slide.

We did suspend all Salem Unit 2 refueling outage

activities for two days prior to the storm's arrival. We returned all equipment except our redundant service water header to service. We flooded up the reactor cavity to the refueling level for defense-in-depth, and all contractors supporting that outage left site. Next slide.

Our Lessons Learned are specifically commercial-related and non-safety related, and that dealt with the switching stations are susceptible to water intrusion. We also lacked an outage contingency plan for loss of building capabilities. There was also a lack of a formal plan associated with our sleeping arrangements for essential personnel on site. You could imagine with two different shifts on site, this is a power plant, not a Holiday Inn Express, and there was a lack of good sleeping arrangement for some individuals.

We also need to pre-stage extra fill for any access road or shoring repairs, and all issues were entered into our Corrective Action system for resolution. Next slide.

Our abnormal procedure guidance we found was not adequate to predict the impact of the debris on the circ water intake structure. Our decision-making on the unit power did not account for the wave action effects into the circ water traveling screens, and there was no single designated information source listed in our procedures for decision-making to track the storm and its wind speed.

In other words, the decision-making that we had on the prediction and projection of the storm for three hours prior to the arrival, we were using reference materials such as the Weather

Channel and other government weather stations. Next slide.

During Sandy, our shutdown criteria was 98.5 feet. Our maximum tide level seen on the site was 97.2 feet. We also went back and calculated the effects that the Sandy storm surge would have done if it hit Salem directly. As you all know, north of Salem saw the highest impact. And what we went back and calculated is the maximum tide would have been approximately 100.1 foot, or essentially ground level for us.

Our shutdown criteria for the wind speed was if hurricane force winds were imminent, and the maximum wind speed that we saw was approximately 59 miles per hour. It did shift, however, 180 degrees over four hours which caused the challenge out in the circ water intake. Last slide.

Our new criteria assumes a combination of grassing, tide, wind speed, and wind direction as a composite indicator in lieu of one parameter to manage the risk on the intake structure. In addition, we added criteria to shut down to Mode 3 if a hurricane was predicted to pass within 50 miles of site.

That concludes all the prepared remarks that I have on the slides.

CHAIRMAN MACFARLANE: Excellent. Thank you very much. We'll move on to the next speaker. We have Mr. Stuart Lewis who's the Program Manager in Risk and Safety Management at the Electric Power Research Institute.

MR. LEWIS: Thank you, Chairman. My remarks today really represent a summary of where we are with our research program related to external hazards.

This is an area that EPRI had intended to engage in for quite some time, but other resource needs to address fire risk, seismic risk, and a number of other areas continued to seem to take priority over external hazards. And it was only in January of 2011 that we were able to make the assessment of external hazards other than the seismic events a really high-priority item. And, in fact, we made it a strategic initiative within our program, and found a little bit of funding to get started.

Of course, as the Chairman pointed out, that was kind of just before there were a number of events that made research and analysis of external hazards much more relevant than they might have been considered to be before that. So, while we attempted to be somewhat proactive, it turns out we weren't very far ahead of the curve with this work.

So, I'll summarize where we are. Much of this work is in progress right now, so I don't have a lot of details to report, but I will describe some of the programs we have underway. But if we turn to Slide 2, the -- we do have one product that we completed in 2011.

The first thing we did with the budget we had available was to develop a more comprehensive, more systematic approach to identifying which external hazards needed to be

evaluated in a site or plant-specific PRA, Probabilistic Risk Assessment.

We performed that work because if you look back to the last time there was really kind of a comprehensive risk assessment for external events in the mid-1990s, the individual plant examination of external events, a set of screening criteria were used at that time that really were not as effective as they could have been, and we thought it was important to try to provide more substance to that approach. So, we developed a process that includes both qualitative and quantitative screening criteria in an attempt to focus resources on those events that are most likely to be important for our particular plant. So, that's a report that's been out in use by our members for about two years now. We, over the weekend made it a public report, something that will be available more broadly than just to EPRI members. But we have had quite a bit of feedback from those utility members who had it available over the last two years. If we can turn to Slide 3.

This little map at the top shows essentially where we have members around the world who are using this report to one extent or another. It has been used by every utility in the United States to some extent. All the utilities have the report, and we've gotten a lot of feedback within the United States, but also from several other countries that have had experiences with it. And we're continuing to collect feedback from those countries so that we can improve the

process going forward.

We have gotten some initial insights into the value of the process that we developed. They include the fact that as with almost any process, more detail on how you actually implement the approach is useful and would be valuable going forward. And, in particular, some of our members primarily from outside the United States have expressed a lot of interest in how we might provide guidance on addressing correlated hazards, or combined hazards.

There's been a lot of work done in this area in the United States and elsewhere. And, for example, we work closely with EDF, the utility in France. They've done a lot of statistical analysis of multiple hazards occurring at the same time. We've looked more from the standpoint of where there are reasons for hazards to be correlated, where you have high temperature and high winds, for example, where that might be the case. So, we're trying to integrate that knowledge and provide additional detail to make the screening process more effective going forward. If we can move on to the next slide.

The next big area we undertook was to look at the methods available for analyzing the risk of external flooding. Obviously, this is one of extreme interest around the world. We aren't spending so much time trying to develop brand new methods, but rather to assess the existing methods and to determine which are the most effective and most useful for our members. And where we see

the need to expand or structure the methods that exist now, we'll do that, but we have been tying into the research within the NRC and other U.S. agencies and from around the world to try to inform that process. We think there's a lot of really good information out there. There are some methods that are used beyond their reasonable bounds, I think, and we're trying to provide guidance to make sure that when an analysis is done, it's done in a reasonable way. We're really trying to integrate, again, the understanding that we can get from the various sources on external flooding.

We have been through a series of tabletop applications of some of the methods. We've worked with a couple of utilities late last year to try to see which methods were most effective on a river site, and we're continuing that process.

I should mention we also went through an exercise, going back to the report on screening, we went through an exercise just in December with a U.S. utility that had used our approach at several different sites that are geographically varied. In other words, there are ocean sites, there are lake sites, there are river sites to try to understand where, again, we might be able to improve our methods or see where they were most effective. So, we do a lot of work collaboratively with our members to try to make our research most relevant and most useful to the members.

I'm not going to go over the next slide in any real detail partly for time, and also because I'm not directly involved in

these analyses, so I'm not in a position to speak very much to the specific approaches. I think you may hear a little bit more about some of these, or some analogous approaches to analyzing flooding from some of the gentlemen to my left, but we are looking at a broad range of methods from both the U.S., and from outside the U.S. to try to capture the hazard most effectively. Moving on to the next slide.

The next hazard that we've begun to do some work in relates to high winds. EPRI was heavily involved in doing research into high winds back in the 1970s and '80s. In fact, in the 1980s EPRI produced a computer tool called TORMIS that was used for analyzing the risk of tornado missile strikes. And although that piece of software hasn't been maintained over the years, it has been used by a number of different plants to analyze the risk of damage to the plant if tornadoes are generated -- if missiles are generated by a tornado.

There have been a number of studies conducted in the last few years on high winds, but not so much in the United States. That's something that, again, I think external flooding has taken precedence, but we are seeing more and more work done in this area, as well. It is an important part of our roadmap to provide a strategic focus on external hazards.

With regard to our high winds research we're continuing to look at the work that has been done in the nuclear and other industries trying to pull together the most effective pieces of the technology that we can. We have not at this point concluded whether

we should update our old TORMIS code and make it a useful current tool for utilities to use. We would prefer to see if there are barometric approaches that could provide the same benefit maybe in a somewhat simpler format, more user-friendly approach, so we're still open to considering upgrading our software, but we haven't concluded that's going to be necessary yet.

We are looking at a graded approach to analyzing the fragility of structures and systems to high winds; that is, what's the conditional likelihood of damage that might be caused by different levels of wind loading. And, ultimately, we'll make some decisions this year about exactly where we're going with our high winds developments.

Just to capture what I think applies to all of these areas, the screening, external flooding, high winds, really other hazards that we have on the table to investigate down the road. There really is a high degree of plant and site-specific nature to these hazards. There isn't a one-size-fits-all approach, I think, to analyzing external hazards.

We think that the notion of a progressive screening approach makes a lot of sense to focus resources rather than attempting to perform detailed analyses on a broad range of hazards. We are trying to understand what the state-of-the-art looks like for each of the hazards that we've looked at to pull important insights from the different approaches and compile them into an approach that

makes sense overall. And ultimately, of course, our focus is on the ability to generate reasonable and appropriate risk insights from the tools that we apply. And that's the conclusion of my remarks.

CHAIRMAN MACFARLANE: Okay, thank you very much. Next we're going to hear from Dr. Chandra Pathak, who's a Senior Hydraulic Engineer in the Engineering and Construction Branch at the U.S. Army Corps of Engineers.

MR. PATHAK: Thank you. Good afternoon. Thank you for the invite.

So, we're going to talk about if you go to the first slide and then subsequently, we're going to basically talk about the coordinated studies and the databases specifically about the extreme storm events. So, we're going to talk a little bit about Corps of Engineers background, interagency collaboration on flood and extreme storm-related activities, cataloging of those storm events, research and development on flood flows and rainfall frequency analysis and with the summary. Next slide, please.

So, in the mission area you will see on the right, this civil work, so that is one of our major area of work. And below that is research and development. We call it ERDC, Engineering Research and Development Center, and we do some work in that area. We have a coastal and hydraulics lab. Next slide, please.

So, in the country we have about eight divisions. They are colored represented here, and about 41 districts, and each of the

districts where all the work is being done. And out of those 41 districts, we have 38 districts where we have some work goes on. Next slide, please.

In terms of infrastructure, we have 708 that we have just got reclassified. We have 708 dams, and we have about 2,500 levy systems that combines to about 15,000 miles of levees. The next slide, please.

So, we are doing some interagency collaboration specifically with National Weather Service NOAA and U.S. Geological Survey, USGS. Next slide. In here specifically, National Weather Service gives us two bullets there. They provide forecasting data, short term and long term forecasting, and in the second bullet they talk about -- we talk about doing some river flood forecasting which is a collaborated work effort. And the third bullet, which is the rainfall data analysis which our publications come out of there where we use this data to do the design of the infrastructure. Next slide, please.

And in terms of USGS, we have a gauging program where the measurements of the flow through the systems are -- in the river systems is being measured. And there are close to about 8,000 locations out of which Army Corps of Engineers gives them about $19 million a year to manage and maintain. The next slide, please.

Specifically, the events, and during the storm events we have rapid deployment gauges, and those are the ones are done onset of the event. For example, for Sandy we had collaborated with

them to have specific locations where we need to put those RDGs, and do the measurements for that specific location. In addition to that we were what we call flow rating curves. These are normally done, flow to the structures specifically, its flow ways and such. Next slide, please.

And then we have a collaboration which is formally what is called IWRSS, stand for Integrated Water Resources Science and Services among these three agencies. Next slide, please.

This is a Memorandum of Understanding put together on May 11th, 2011 under which we are doing some work currently. Next slide, please. Under that, we are doing two charters. The first one is national flood inundation mapping which is currently ongoing. And the second one is system interoperability and data synchronization. Next slide.

In the national flood inundation mapping, we are putting together the framework where all the maps of the flood inundation would have similar feel and formats of such where we're going to be working -- we are working with them putting together the technical requirements. Next slide, please.

In terms of system interoperability and data synchronization where we have data exchanges on 24/7 basis, 24 hour and 7 days a week basis, we are putting together so there's a seamless data transfer taking place. And under that, we are putting together the systems requirements. Next slide, please.

So, continuing in terms of extreme storm, we had part of the Subcommittee on Hydrology which is being managed under ACWI. This stands for Advisory Committee on Water Information System under USGS. We had formed a group, and that is called Extreme Storm Group under which Army Corps of Engineers established an Extreme Storm Team, and that has 12 members, and we are collaborating closely with US Bureau of Reclamation. Next slide, please.

In terms of the data needs, we are looking for extreme storm events historical, and regional and site-specific analysis with respect to probable maximum precipitation known as PMPs, and also we are looking to see in future to do some hydro meteorological reports updates which has these PMP for that country available. Next slide, please.

So here in terms of projects, we are collecting the data. This is tied in the historical storms isohyetal maps converting the data imagery to the rainfall and developing a database, combining the database with U.S. Bureau of Reclamation, doing some more work in terms of other specific basins, river basins, channel basin, as well as Wyoming's wide PMP studies. That's our efforts ongoing. Next slide, please.

So, in terms of research and development under our research group in Vicksburg which I mentioned earlier, we are doing, and we started in 2013 a project which is for a duration of five years.

Specifically, the object is to develop some tools which districts could use in terms of using the extreme precipitation and flow frequency methods. And here we are looking to develop some software for precipitation extreme events and the flow generated from these extreme events. Next slide, please.

So, in summary, we are looking -- we have interagency collaboration on flood and extreme storm-related activities with NOAA, USGS. We are cataloging the historical storm events of national significance, and doing research and development on flood flow, rainfall frequency analysis specifically generated from extreme storm events. That closes my prepared remarks. Thank you.

CHAIRMAN MACFARLANE: Thank you very much. Now we're going to move on to Mr. Geoff Bonnin from the National Weather Service. He's the Chief of the Hydrological Science and Modeling Branch.

MR. BONNIN: Thank you. Thank you for the opportunity to speak today.

I'm going to talk a little bit about semantics, primarily, today. And you'll notice on the title that I talk about rare precipitation and I'm trying not to use the word "extreme" or anything like that any more, and I'll explain why. And this is a fairly new thing, and Chandra and I haven't had the opportunity to talk about that yet.

But there's a couple of topics I want to cover. The first one has to do with two different approaches to hydrologic design and

where we get to some of the things that Chandra mentioned. A concern that the National Research Council has, the semantic problem itself, and then that gets us to trends in the historical record with respect to exceedances. And that'll be from an engineering point of view.

So, there's really two approaches to hydrologic design. The first one says that it's generally too costly to avoid any sort of failure, so let's accept a probabilistic approach, and let's accept a certain amount of flooding. So, you might think of a storm water drain on the street, we're prepared to let that flood every now and again. And that comes from flood frequency estimates and precipitation frequency estimates for specific durations that are associated with that particular design, so there's a variety of different durations that we deal with.

The second approach is one that says we cannot have a failure. We just cannot. We have to avoid it at almost all costs. And that's the approach that we use for designing, "we" I mean all of us, designing very large dams in the U.S. We try and anticipate what the worst case flood might be, which is often driven by the worst case rainfall which is the probable maximum precipitation or PMP. And that's worst case just for a generic reference. I'll say that that's the perfect storm, and maybe Sandy was a perfect storm, as well.

So, the National Research Council took a look at what has been happening with respect to climate change in the community.

They did this back in 2010 and ‘11 and issued a report. And I want to quote two items that are in that report, because I think that they’re important.

The first one is that, “Management and mission-oriented agencies with public sector responsibilities have been provided with marginally useful scientific information about the likely manifestations of future climate change.” That’s a little bit of a concerning type of statement. This Board is the Water Science and Technology Board. It’s generally representing the civil engineering community rather than the climate community.

The second quote is that, “There are insufficient interactions and knowledge exchange between climate scientists, water scientists, and engineers and practitioners to solve these challenges.” So, we’re not talking to each other enough, and that creates a problem.

So, I’m going to address where I think this problem really lies, and I think it lies in a question of semantics. And let me take a couple of quotes from a variety of different documents. First one is from the IPCC, Intergovernment Panel on Climate Change, their 2007 Synthesis Report.

“It’s likely that the frequency of heavy precipitation events has increased over most areas,” most area of the world they’re referring to, and I’ve underlined and am focusing on the term “heavy” here. Second quote is from one of the papers, Pavel Groisman, who’s

a colleague of mine in NOAA. Pavel found “significant increases in the frequency of heavy and very heavy precipitation events,” so there’s a variety of that sort of terminology in the literature, primarily the climate literature that uses terms such as heavy, very heavy, and extreme. And most of that literature, particularly the literature that’s being used by folk like the IPCC and the U.S. Climate Assessments are using definitions that are the same and were developed by folk in NOAA as part of the climate research activities.

Sometimes, however, there will be papers that have different definitions of those terms. There’s an example I want to quote again from Pavel Groisman. I keep thinking Pasha because that’s how we talk to each other. We define daily precipitation -- define a daily precipitation event as heavy when it falls into the upper 10 percent and/or 5 percent of all precip events as very heavy when it falls into the upper 1 percent and .3 percent. These actual numbers are important. And extreme when it falls into the upper .1 percent of all precip events. Return period for such events varies, for example, from three to five years for very heavy precipitation events. And most of those studies are generally only concerned with a single duration and that’s a daily duration. They’re not concerned with a six-hour, a one-hour, or a three-day duration.

But civil engineers aren’t using those types of terms. That terminology that the climate community has assigned definitions to in my belief is that in the civil engineering community and likely the

general public at large those are very subjective terms. And if I were to go to the person in the street and say what do you mean by -- what is heavy rainfall? And then ask them what very heavy rainfall is, then ask them what extreme, they'd probably start getting a little bit annoyed because I'm using tricky terms that are contrasting with each other.

Now, in the civil engineering community, and again Chandra referred to this, we use annual exceedance probabilities, or often average recurrence intervals, just a similar sort of reference to the same information. And those come out of existing documents, for example, NOAA Atlas 14 which isn't completed for the entire U.S. at the moment. That provides information on these intensities in terms of their probabilities and durations from five minutes up through 60 days, and up to 1,000-year return period. So, they are very objective statements of what we mean when referring to rare rainfall.

Now, as a result of a number of issues we looked at trends in the exceedances of those thresholds, and the climate community has done a similar looking at these trends. And when we looked at those, I'm going to go very fast through these, we found very, very small trends, and in most cases statistically insignificant trends in the historical data which goes back for about a century.

We found in some cases that the trends were positive, in some cases they were negative, and in many cases the trends for one duration was different from another duration. So, I'm going to focus a little bit on this chart here which shows each point on

that is a combination of duration and the probability of exceedance. And then the average change is on the Y axis, and the exceedance value or the return period is on the X axis. And what this shows, and this is for a large part of the country, the semi-arid southwest, is that rare rainfall up around 25, 50, 100 year return period, those trends tend towards zero, but as you look at the more common rainfalls as you're moving to the left on this chart that can range all over the place with high values in the trends both positive and negative. And the three to five years that Groisman referred to from a climate community point of view is this yellow bar here. And if you look at his results, you see that they're relatively consistent with this curve, but that yellow bar doesn't cover the full range which is the X axis here of what the civil engineering community really needs.

So, we're really referring to two different definitions of rare rainfall here, and that's causing a problem because most of the literature and what we see in the press says ah hah, very heavy or extreme rainfall, and it's changing a lot but from an engineering perspective and historical record it doesn't seem to be changing a lot.

So, I'm going to skip now to my conclusions. And they are that, first of all, the climate community statements on trends in rainfall exceedances don't address the frequencies and the durations required for civil infrastructure. That's, I think, a big problem. But I don't think the climate community is really to blame here. I think the blame is shared with my community, the civil engineering community,

because my community is misinterpreting the statements that the climate community are making, and misinterpreting what they're saying in their conclusions. And if we did a better job of that, we'd have a better understanding.

Third point there is that the historical trends and exceedances in rare rainfall are actually quite small compared with the uncertainty in those probabilistic thresholds themselves, very small with respect, so much so that one could potentially argue that we ought to just ignore it and worry about the error in the design standards themselves.

And, finally, that we need better guidance on the potential impact of climate change on these curves in the ranges, in the full range that is relevant to civil infrastructure. That's it. Thank you very much.

CHAIRMAN MACFARLANE: Okay, thank you. Moving on Mr. Lance Vail, who's a Senior Research Engineer at the Pacific Northwest National Lab.

MR. VAIL: Thank you. My talk is going to be, again, on flooding, and it's going to be focused on what I would consider the extreme flood side as opposed to the sort of extreme precipitation. And I haven't been able to sort of revise my vocabulary, but I appreciate why you made those changes, because clearly this communication between climatologists and hydrologist, civil engineering community and stuff has been -- certainly has been weak.

The joke used to be when I was in graduate school hydro climatology is climatology done bad by hydrologists, and hydrology done bad by climatologists. And they were in different buildings and had a different perspective on science entirely. But I'm actually today going to be sort of talking about my background, my career, and actually looking back over 30 years and stuff when I sort of started doing some of the very early climatology work with linking hydrology and climatology. And I think what you'll see is that there has just been this rapid acceleration in my community and at our laboratory and stuff. We do a lot of that work, but we're still not to where we're talking about extreme events in the sense that an agency like the Corps or NRC would consider extreme flood events and stuff.

So, to a certain extent, you know, the hydrology community has been a back on its heels and stuff, while I think the climate community and stuff has been sprinting ahead and stuff. And it's part just because of what we were sort of focused on at the time and stuff. But originally, you know, historically let's say when I was in graduate school, which was a few years ago, you know, we knew the climate wasn't stationary. There was already an appreciation that there was climate variability. We weren't talking about climate change, but we were talking about climate variability, and how climate variability, some persistent patterns would buy our estimates in extreme events. And we had statistics that we were using that were all based on sort of standard type, you know, Bell Curve type mentality

and stuff, and we knew that that didn't do very well when you get out onto the extreme end of the tails and stuff.

So, basically, that assumption of a stationary climate and stuff doesn't entirely pass the laugh test right now and stuff. And, you know, we need to make some -- you know, I think as a community and stuff, I'm not talking specifically about NRC, but I think as society and stuff this is something we need to make investments in and stuff just because of the overall risk to the public that's involved. Could I have the next slide? Okay, that's quite a ways down. Yes, if you could go back. Okay, Slide 2, sorry. Okay.

Like I said, I'm from Pacific Northwest National Laboratory, a DOE lab. My research over my career has been focused on water energy and access questions and stuff. I have done work in the past for NRC but interesting enough, or ironically enough today I'm just going to be talking about work I've done for people or agencies like Department of Energy and EPA, NOAA, NASA, and actually some of the Corps over time. So, the next slide.

To bring this home, that's -- the little gray structure over on the left side of the -- the right side of the slide is actually my house. And if you look over on the left side you actually see the Yakima River. You can sort of see where the ice has sort of come up. That's my front lawn and stuff. That was where we got -- and that sort of represents, you know, my catalog. That was about a five-year event and stuff to sort of keep it in perspective. A 100-year event, the water

will start coming at my front door, so that's about 16 feet above there and stuff. From my perspective, and certainly my wife's perspective, that's an extreme event, you know, just because of where I chose to build my house and stuff. But if we talk about it in terms of a probable maximum flood, my house would be devastated and stuff well beyond that stuff. Keep it in context, bigger paleo floods the water depth would have probably been about two or three hundred feet there and stuff, so we sort of need to keep it in mind. But for the focus of the discussion, I really want to focus on those probable maximum flood levels and stuff. So, if we move to the next slide, and you can go on to the next slide.

Just to sort of -- when I talk about tails, I am -- you know, we sort of talk loosely in terms of the terminology, at least in my world, about operating at a one sigma level, so you're sort of at the end of the right side of the blue zone. You're sort of at a five-year exceedance and stuff when these are annual precipitation, or annual flood extremes. If you go to sort of the end of the red off there you're probably about 50, and then you get out to about three sigma and stuff, and we're starting to get closer to what you nominally think is a probable maximum flood, which I should say doesn't have a probability with it so it's a probable maximum flood that probably needs a better name and stuff. But that's where we're talking about.

So, when we think about it in terms of the research, there's a lot of activity in terms of client science like what Geoff was

talking about that operates and makes some conclusions about really what's happening in the one sigma zone and stuff like that. So, if we go to the next slide, this is a study I did in the early 1980s.

We looked at -- the American River Basin, it actually turns out there's an American River in -- that's a tributary of the Yakima River. It's a sort of unique area. We did this assessment using some of the -- it was one of the original linked hydrology-climate models where we took results out of the climate model to help drive our assessment and stuff, and when we were getting done with that we realized that, you know, if we look at this seriously and stuff we're not even able to say anything past the one sigma level and stuff. So, you know, our predictions really weren't going to tell us anything and stuff past about a five-year return cycle and stuff. It told us a lot of interesting stuff about other stuff, but we were still in that sort of one sigma area and stuff.

The next slide was a subsequent study in the 1990s where we started to move with radically, dramatically improved climate models already at that time and stuff compared to what we were looking at just five years earlier and stuff. And we had to move to doing some ensemble simulation looking at some of the uncertainty directly in our assessment and stuff.

At that point I'd say that we were maybe able to get past one sigma level, certainly less than -- definitely couldn't say anything at a sort of two sigma level, so in that sort of five, 50-year

interval we could maybe get some information.

The next project was Accelerated Climate Prediction Initiative. This was using regional downscale models, sort of state-of-the-art high-end. This was in about 2000, and at that point we maybe could have said -- inferred something possibly and stuff -- at best and stuff out, you know, closer to two sigma but not all the way to two sigma and stuff.

So, we've gone through all this, you know, these processes and sort of evolution in the modeling and stuff, and we're still not at a place where we're going to get out past three sigma and stuff. And it's not going to happen, you know. I mean, there's a lot of other questions that we have that are fundamental to this, and one of them is the difficulty in estimating extreme events to start with, and also how you deal with non-stationary climate and stuff at the same time. And we have to be dealing with those simultaneously.

I'm running out of time so I'll -- actually, if we move to -- you can just go to the last slide. I stole two phrases here from politicians since I was coming back to D.C. Nancy Pelosi had to embrace something recently, and I said, you know, "Systematically we need to sort of embrace the uncertainty in our analyses." And some of that's already happening and stuff but like I said, I think we're back on our heels a little bit and stuff from the hydrology side.

And then I think we also need to trust and verify the climate models and we need to understand much better and stuff what

we're getting out of the climate models because there has been this lack of communication. Sorry to overrun.

CHAIRMAN MACFARLANE: Okay, thank you. On to David Lochbaum, the Director of the Nuclear Safety Project at the Union of Concerned Scientists, well represented today.

MR. LOCHBAUM: Thank you, and good afternoon. We appreciate this opportunity to share our views on this topic. Next slide, please, Slide 2.

I'll focus today on three issues. The first issue involves the need to integrate the flooding hazard with other known safety hazards when making regulatory decisions. Next slide, please.

But before I turn to our concerns, I want to repeat our appreciation for the great job the NRC did identifying and correcting flood protection problems at Fort Calhoun before it became an island in the Missouri River in June of 2011. The NRC's inspectors, risk analysts, and managers performed commendably. Next slide, please.

Regarding flooding hazards, nearly three dozen reactors were identified by the NRC staff in Generic Issue 204 with potentially inadequate protection against flooding. Slide 5, please.

In Generic Issue 199, the NRC staff identified nearly two dozen reactors with potentially inadequate protection against earthquakes. Next slide, please.

And there are typically between one and two dozen reactors not in Column One of the NRC's Action Matrix and, thus,

having identified risk-significant performance shortfalls. Slide 7, please.

The unresolved hazards known to potentially exist can double, triple, and even quadruple up. For example, 10 reactors currently have unresolved flooding and seismic hazards. Slide 8, please.

Our concern is that the NRC's decision-making processes consider these hazards in isolation without accounting for other hazards known to be unresolved. Slide 9, please.

If a doctor's diagnosis only considered a patient's weight, or pulse, or temperature without considering other medical parameters it would be time to look for another doctor, and perhaps a coffin. Next slide, please.

Reactors are not always afflicted by only one hazard. All known risk factors must be considered by the NRC when making decisions about schedules or enforcement discretion, and other operational risk issues. You cannot connect the dots to see the full picture by focusing on only a single dot. Slide 11, please.

Our second concern involves the NRC mandating walkdowns and assessments of flooding hazards before defining its expectations and standards. Slide 12, please.

This is an abridged time line relative to the external flooding walkdowns conducted by NRC inspectors and plant workers. Slide 13, please.

For the walkdowns to be effective in providing input for flooding hazard assessments, the NRC's expectations for these assessments should have been issued before the walkdowns were performed. The August 2011 earthquake near the North Anna Nuclear Plant illustrated the NRC's putting the horse before the cart. After an earthquake shut down its two reactors, the NRC applied the criteria in Regulatory Guide 1.167 before permitting the reactors to restart. This Regulatory Guide had been issued in March of 1997 and directed the plant's owner and the NRC through the proper steps to safely restarting the reactors. It was done then, it should be done now. Slide 14, please.

In late January of 2013, nearly a year after the walkdowns were mandated, the NRC and its federal partners conducted a three-day workshop on flood hazard assessments. Slide 15, please.

Recurring themes throughout the workshop were illustrated in these slides. Again and again presenters indicated that the existing standards are woefully outdated and inadequate. So, what did the walkdowns using outdated and inadequate standards accomplish other than some exercise? Slide 16, please.

For example, TVA reevaluated flood hazards at Sequoyah and Watts Bar caused by dam failures assuming sunny day conditions when the reservoir behind the broken dam holds far less water than if the dam failed following heavy rainfall, or very heavy

rainfall, or whatever term best estimate or most convenient. There's been much talk about cliff edge events since Fukushima, but pretending cliffs don't exist won't prevent future falls. Next slide, please.

Industry panelists at a flood hazard session during the June 2013 American Nuclear Society Annual Conference reported that walkdowns looked at whether flooding above design-basis levels with over top barriers or reach unprotected pathways into vital structures, but they did not consider whether that much water weight might fail a barrier, or cause other damage such as submerging and disabling electrical cables. Next slide, please.

In 2012 representatives from Oconee told the NRC how they'd use the equipment inside the safe shutdown facility if flooding damaged the auxiliary feedwater system and other emergency equipment. The safe shutdown facility is protected by a flood wall five feet high. Representatives stated that workers periodically simulate performing the actions necessary to be taken in considerably less than 30 minutes. The workers simulate this response on nice sunny days when they can stroll across the site, climb up the stairs over the wall into the facility, but could flooding impede their movements and prevent them from completing the necessary actions in time? No one ever checks. Slide 19, please.

Workers at Fukushima had actions they could have taken to prevent three reactor meltdowns. Extreme conditions at the

site prevented them from doing so. It's not clear that our flooding assessments are properly accounting for the difficult conditions that flooding forces workers to perform under. Slide 20, please.

So, the question is would the NRC mandated walkdowns and assessments have prevented the Fukushima disaster had they been completed in Japan prior to March 11th, 2011? I'd have to say no. Next slide, please.

Perhaps a better answer would be not yet. If Recommendation 2.2 ever gets enacted, and if the federal government ever updates federal flood hazard standards and guidance, and if identified shortcomings ever get remedied, the answer could then be an honest yes. Slide 22, please.

More than 25 percent of the plants in Category One missed deadlines for submitting their flooding reevaluations. The reasons for some of these delays involve the horse cart issues previously mentioned. There's little evidence to believe that further delays will not transform flooding hazard upgrades into the next fire protection or GSI-191 regulatory fiasco. Next slide, please.

Even more troubling, nine out of ten plants found longstanding violations of existing regulatory requirements. How is this even possible? Many, many walkdowns have been conducted by plant workers and NRC inspectors over the past four decades allegedly looking for stuff like degraded missing seals, so why did so many attempts over so many years fail to find these numerous violations?

This must not remain a rhetorical question, for its answer provides the best assurance that the efforts being taken now will actually remain effective. Absent the fixes this answer will trigger there's no protection against upgrades becoming degraded and missing in the future, and lots of workers and NRC inspectors wandering around cluelessly. Next slide, please.

Our third concern involves the agency's inconsistent oversight of flooding issues. The secret handling of flood protection problems at Oconee, and a very public handling of similar problems at Fort Calhoun, Point Beach, and Monticello is just wrong. People living around Oconee had a right to know about its problems, yet the NRC improperly withheld that information. And why did the NRC protect Duke while throwing other owners under the bus? Next slide, please.

We urge the NRC to formally account for all known unresolved safety issues when making regulatory decisions. We urge the NRC and its federal partners to update flood hazard standards before owners conduct the 10-year reassessments. And we urge the NRC to implement a better means of classifying documents to achieve more consistency and less bizarreness. Thank you.

CHAIRMAN MACFARLANE: Thank you very much, David, excellent.

Okay, so appreciate all your presentations, and we will now move to questions from the Commission. We will start off with Commissioner Apostolakis.

COMMISSIONER APOSTOLAKIS: David, if we go to your Slide 8, I don't understand what you're saying there. Can you explain, "largely made without formally considering other known risks."

MR. LOCHBAUM: Yes. When Regulatory Guide 1.174 or other NRC regulatory tools are made they're made based on that specific issue, and what change it makes in the core damage frequency. It doesn't look at what other problems may be known to exist at that facility so, therefore, a determination -- if two plants had the same delta core damage frequency but one plant was -- had a bunch of other problems, in the other facility that was the only problem it had, that should also be factored in the decision about whether to tolerate or not to tolerate that condition, or either to authorize that change or not. But right now, the NRC tunnel visions in on that specific issue in its delta risk without looking at other risk factors that are known to exist at the facility. In our view that's just wrong.

The NRC doesn't allow plant owners to do that when they look at 50.59 changes and Corrective Actions. The NRC requires plant owners to look holistically at those, and yet the NRC takes a different do as I say, not as I do thing.

COMMISSIONER APOSTOLAKIS: Well, that's – in some cases that may be true, but in a lot of the applications it was really a unique issue like extending the diesel generator outage time. I mean, what else are you going to look at?

MR. LOCHBAUM: In that case, what we've

recommended is if you're going to extend the diesel generator outage time, you might want to provide additional security so the insider threat or the outsider threat doesn't take advantage of the plant already being down one diesel generator.

COMMISSIONER APOSTOLAKIS: So, you want security. Okay.

MR. LOCHBAUM: But, again, focusing in on only one, you can make the right decision for that question, but there are other unanswered questions on the table.

COMMISSIONER APOSTOLAKIS: Okay, that's a good point. Mr. Vail, you -- following this former Speaker of the House, you want us to embrace uncertainty. Because uncertainty is not a physical quantity, I have difficulty understanding how I'm going to embrace it. Can you elaborate a little?

MR. VAIL: Yes. What I'm trying to say with embracing uncertainty is knowing that the climate -- you know, we need to have, you know, more probabilistic type estimates probably associated with -- you know, moving away from a deterministic PMP approach. We need to have that more climate-informed, and we also need to know that climate science is going to evolve over the period of time, and that may change our estimates. So, we don't know exactly where this going to be leading but we need to accept that.

COMMISSIONER APOSTOLAKIS: Has anyone quantified those uncertainties due to climate changes or so on?

MR. BONNIN: Yes, let me answer that question with NOAA Atlas 14. With NOAA Atlas 14 the precipitation frequency estimates for the country for the first time we've had error estimates associated with the estimates themselves, so we provide the upper and lower bounds of the 90 percent confidence limits. So, that allows an engineer when they're designing a culvert to say well, I'm going to design this for 3.4 inches, that was what the 50-year, one-hour, whatever, 3.4 inches, but those errors really do range from about plus or minus 10 to plus or minus 30 percent depending on where you are in the country and the conditions.

So, what happens in the past is use 3.4 inches, but what happens if it's really 4-1/2 inches? Off the top of my head I don't know whether that's within the bounds, so it seems to me that when people start considering the uncertainty in these things, that should push them to look at different values, and different ranges of values. And that was a very simple case I gave you, so a lot of that sort of thing starts to combine.

COMMISSIONER APOSTOLAKIS: That's very useful, but I'm sure it will be. I mean, we are -- another thing that you may not know is that whenever we have an estimate like 3.5, for example, we always add margin to cover the unknowns, so the 4-1/2 wouldn't do much to us. Please.

MR. PATHAK: Yes, but if you look at the education system, if I were to go civil engineering department and teaching the

classes and designing the hydrologic structures, typically they just look at the one value which is cast in stone. Either you design for X number or you don't do this, so this is a new paradigm shift in the teaching the younger generation to think in probabilistic sense. So, uncertainty when he said embrace, if you talk to the traditional engineers, what uncertainty are you talking about? They seem to look at as if something new terminology has been put in place, so I think there is a -- at least in civil infrastructure side I could say that needs to happen from the younger generation, and to look into this a little bit more. However, having said that, it's not to say it's too late to start looking into it, and that's one of the things I think we need to pay attention to.

COMMISSIONER APOSTOLAKIS: I'm very glad you're saying that, but what I would like to point out, this is great to educate a new generation, but this agency has been dealing with uncertainty for decades. The last 15, 20 years we've actually quantified it. And we have complained ourselves here about the -- you mentioned civil engineering departments, mechanical engineering departments, do they know what uncertainty is? That has been a separate problem. So, you are not really asking us to embrace. We have embraced it, and kissed it for a long time. Okay?

(Laughter.)

MR. VAIL: Yes. I was trying to say as a community.

COMMISSIONER APOSTOLAKIS: If you are talking

about the civil engineering departments, that's fine, that's great, that's very noble.

And one last comment, Mr. Stuart Lewis. In two of your slides you talk about plant-specific and site-specific impacts, PRAs and so on, so you do believe then that we should do site-specific analysis? Be careful.

(Laughter.)

MR. LEWIS: Well, again, we -- I think that, again, we started with a process to try to identify which hazards need to be evaluated on a site-specific basis. So, I don't think that every site necessarily has to address every hazard in detail. But I think it is worthwhile for those sites that have a potential vulnerability to perform –

COMMISSIONER APOSTOLAKIS: But it is a site-specific investigation.

MR. LEWIS: It is.

COMMISSIONER APOSTOLAKIS: I mean, you have to understand the site-specific nature of risk.

MR. LEWIS: That's right.

COMMISSIONER APOSTOLAKIS: Very good, thank you. No, don't say anything else.

And, Mr. Lochbaum, I'm still trying to understand how the cart goes in front of the horse. I must say I read your report. It's still not very clear to me.

MR. LOCHBAUM: When this issue came up, I put myself in the shoes of somebody doing one of the walkdowns. And without knowing the mechanics, or the details, or more information about the flooding hazard assessments, I'm not sure what I'm walking down. I know I'm supposed to be walking down the intake structure, or this building, but without knowing how that data, the results from my inspection will feed into the next step, I may miss things, not intentionally, but I don't know.

COMMISSIONER APOSTOLAKIS: I thought the staff developed guidance.

MR. LOCHBAUM: Yes, and they issued it after the walkdowns were done.

COMMISSIONER APOSTOLAKIS: I'm sorry?

MR. LOCHBAUM: They issued it after. That was the cart-horse thing. It should have been issued up front before the walkdowns.

COMMISSIONER APOSTOLAKIS: I'm done.

CHAIRMAN MACFARLANE: Okay. Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you, Chairman. Thank all of you for coming and sharing your thoughts with us today.

Let me pick up where Commissioner Apostolakis kind of left off. I suspect he's looking at the slides in somewhat the same

way I was when he saw your slides about the site-specific nature of this. And I wanted to ask you, you heard what Mr. Lochbaum had to say about connecting the dots. Do you have a reaction to that? Do you agree with that? Do you think we sometimes don't connect the dots, we don't connect the site-specific interfaces between seismic and flooding, and storms, and those sort -- do you feel like we -- do you think we need to do more in that direction?

MR. LEWIS: Well, I think he may have been talking about something somewhat different from what I deal with. I'm a probabilistic risk assessment person, and one of the real –

COMMISSIONER MAGWOOD: That's why I asked.

MR. LEWIS: One of the real strengths of probabilistic risk assessment is the ability to integrate all the different challenges to the plant and understand the relevant importance of different aspects of the plant. So we don't intentionally exclude -- I should be careful how I say that because there have been certainly limited scope risk assessments done in the past, but we don't try to exclude something on a -- anything other than a technical basis from the assessments that we perform.

I think Mr. Lochbaum was talking more in regulatory space, and he can correct me if I'm wrong there, but he was talking about sort of siloing different considerations from a regulatory perspective that we wouldn't intentionally do in a risk assessment.

COMMISSIONER MAGWOOD: But from a regulatory

standpoint, if we're to apply risk disciplines shouldn't we be integrating in that fashion? I mean, doesn't that make sense?

MR. LEWIS: It does very much make sense to me that I don't think you can make good decisions focusing on one aspect of the plant at a time. I think that could well lead you to make inappropriate decisions from a risk perspective.

COMMISSIONER MAGWOOD: Thank you. I appreciate that.

Let me sort of switch to another part of your presentation, David, because you highlighted some things where you -- at the end of your presentation where you felt that we were not implementing our responsibilities quite correctly, missing of the pieces particularly when it came to the flooding and other areas.

And it occurs to me, particularly as you talk about things like the fact we don't look at the practicalities of manual actions during a flood event. As I've gone around to different plants, I think we do that. And I question whether we don't. I think maybe what we don't do is maybe we don't do it as consistently and at the same level of detail at every site. Maybe there's criticism there, but I do think that -- as I talk to resident inspectors and others at different sites, they clearly ask those questions, and we clearly do review those manual actions in that light.

MR. LOCHBAUM: That's not been my experience. For example, at the Susquehanna Plant there was a response plan to

a question you asked this morning about the nexus between reactor accidents and spent fuel pool accidents where there were some actions that needed to be taken in the reactor building to protect the spent fuel pool. They had radiation dose maps of what the dose would be in various buildings after a design-basis accident, design-basis core damage, and they ran through those buildings without checking the radiation levels because they had a map. Well, in real life you're going to check periodically to make sure you're not being fried. You're not going to run, but the NRC inspector checked it and said yes, he can run that fast. And that was totally bogus. Yes, it proved a point that's not really relevant. And I've seen that done at many other plants. I've not seen where anybody accounts for the fact that you can't walk on water and get across five feet of flood waters to the safe shutdown facility. I've not seen that. You may have different experience. I've just not seen that.

COMMISSIONER MAGWOOD: Yes. Well, that's why I say, I think, and maybe the staff will want to react, I know Eric is going to be at the table, so I'll queue that up for Eric, wherever he is in the room, to be prepared to respond to that. But I have -- because I've had the conversations and we've gone through those, so maybe it's a matter of consistency as opposed to not taking the actions.

But also, as you pointed out, with some of these implementation Recommendations 2.1 and 2.2, which you kind of highlighted as the right thing to do once it's fully implemented, I just

wanted to highlight that that is -- that does answer a lot of the questions you pose. You know, once those things are actually fully implemented those problems are largely solved. So, I just wanted to highlight that because you were –

MR. LOCHBAUM: Yes, I appreciate you picking it up because we deliberately put that in because it's a work in progress. If we get to that point we'll be happy, and you'll hear us whining about something else, not that. So, I think everybody wants to get to that destination, so I'll stop there.

COMMISSIONER MAGWOOD: Great, fair enough. Thank you.

Let me shift back to Mr. Lewis for a moment, because the work that you're doing I thought was very much in synergism with some other work we've seen coming out of the industry lately. NEI sent us a letter back in October highlighting a draft probabilistic screening process for assessing nuclear plant issues and risk prioritization. Is that something you're engaged in? Is that part of -- are you part of that activity?

MR. LEWIS: We haven't directly participated in that activity. I'm aware of it, and I followed it to some extent but that's been done largely outside EPRI.

COMMISSIONER MAGWOOD: Oh, okay, I wasn't aware of that. So, is it -- as far as you know, does that -- is that activity going to include the external events?

MR. LEWIS: I don't think it's meant to be limited to any particular aspect, so I would expect that it would include external events.

COMMISSIONER MAGWOOD: One would think your work would be relevant to that. One would think. All right, I'll leave that there.

Let's see. One other question, I think I want to ask -- actually, let me shift to something else because Mr. Bonnin and Mr. Vail, since we have you here and you're working in the climatology area a little bit, we can get your view on this.

You both have talked about the uncertainties associated with how the scientists are approaching this, and whether the engineers are engaging in the conversation. Can you give us some guidance? I mean, are there things that are actionable today? Are there things that agencies like NRC should be doing now that we're not already doing in terms of preparing for climate change and incorporating climate change uncertainties into our regulatory decisions for the longer term future?

MR. VAIL: Well, you know, I think one thing that I actually had noticed recently within NRO, they actually have the meteorologists and hydrologists in the same branch, you know, which actually sort of enhances that sort of communication with the hydrologists and the climatologists, so I think that that sort of helps inform the process and stuff. You know, I don't know if that was done

for this reason or not and stuff but, clearly, you know, it was a good move and stuff otherwise and stuff. But yes, I think that there's -- I think the most valuable thing that could happen right now are the activities like with Dr. Bonnin and stuff to start moving down the road and sort of updating, revisiting and revising some of the documentations that are sort of key to a lot of those activities and stuff because, ultimately, we're going to go back -- you know, whoever is doing this assessment is going to rely on those. I don't think NRC really has the responsibility to do climate research. I think you are a consumer of that climate research. And, unfortunately, because climate research is popular and there's a lot of spending on it and stuff, there's not much spending on the sort of practical stuff that I need to do my assessments with. So, they're looking out at longer terms.

I know if I talk to some of the people on the research side they'll say oh, yes, you know, we talk about extreme events, but if that's a 5 percent precipitation exceedance and stuff that's not what I'm talking about and stuff in terms of analysis. But I -- you know, I think the most valuable resource right now is to try to get some of these -- the HMRs and other documentation climate-informed and brought up to date, because we're sitting right now on a lot of them that are from the '70s.

MR. BONNIN: Yes, and that's actually one of -- I wrote down three points just here. The first one is updating the

standards that we've got. Some of the standards, the PMP standards don't include any storms beyond I think it's 72, so that hasn't gone into any sort of assessment at the moment. The older -- I mentioned the TP40 doesn't cover the whole country yet. The latest that we had produced was NOAA Atlas 2. That is still in the northwest, a 1972 document, and Texas which we haven't covered in our Atlas 14. They're still using Technical Paper 40 which dates from the early '60s. So, I think someone made this allusion before that we can do things like modernize flood inundation maps but then when we say modernize flood inundation maps and we use standards from 1960, I kind of wonder what that means. So, that's the issue that I think you highlighted well.

The second point I wanted to make was it's all very well to update the standards, but that's still based on this assumption that we all know that's incorrect, but we buy it, that climate is stationary, that there's a stationary climate. And we have to start dealing with what are the potential impacts of climate change, and we have to start pushing the research to do research in the range that is relevant to civil engineering. And that's very difficult to do, and there's not enough of it happening, and there's not enough people who really realize that semantic problem, that it really isn't happening.

And then, finally, the issue of embracing uncertainty. Again, I keep coming back to I'm designing a culvert. I'll do 3.4 inches because that was the 50-year, three-hour value, 3.4 inches, but what if

it was really five, what if it was really two? Would I change my design approach if I started thinking that there wasn't this single threshold and I can ignore anything that happens once that's over top because I'm designing to that. And when you start to consider uncertainty you start to think -- I think people should be starting to think about well, what are the failure modes here? Are the failure modes catastrophic? Are the failure modes manageable?

The idea Commissioner Apostolakis mentioned of adding a free board, a kind of a fixed free board, the core is in there probabilistic approaches is starting to abandon those fixed-type thresholds. Chandra can say this better than I can, but looking more at evaluating probabilities for handling those types of safety factors.

COMMISSIONER MAGWOOD: Thank you very much. That was just a very long response, not an extremely long response. Chairman, it's all yours.

CHAIRMAN MACFARLANE: Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Chairman. Thank you all for your presentations, I found it very interesting.

Let me start off with Mr. DeNight. So, Salem-Hope Creek you had some Lessons Learned from the Hurricane Sandy experience. Are there any of those Lessons Learned that you would not -- let's assume Sandy did not happen, but you knew those

Lessons – are there some of those lessons you would have not have learned from the flooding actions that we're requiring you to do as part of post-Fukushima actions?

MR. DeNIGHT: I think the Fukushima actions and taking a look at those where almost everything that I've seen so far with the Fukushima project, Fukushima team, and then the walkdowns that we've been supporting and associated with those are really to add defense-in-depth more so beyond just what our current capability and design capacities are for the unit. And really that's what I'm getting from the Fukushima team right now, is that defense-in-depth beyond where we're at.

There was I'll say little Lessons Learned coming out of that particular team that we could have applied to the Lessons Learned that we had coming out of Super Storm Sandy when it came through which were more on the commercial side affecting the turbine and condenser more so than affecting any of our safety-related systems.

COMMISSIONER OSTENDORFF: Okay, thank you. My next question is for the Army Corps and for EPRI. And this question gets into areas outside the electrical generating industry, outside of the nuclear industry. So, let's just take the State of Louisiana, and we have a lot of experience with Katrina, a lot of experience with the hurricanes. Are you -- either of you aware -- again, I know you've got different perspectives, one government, one

industry. Different approaches taken by the oil and gas industry as far as offshore oil rigs, lots of refineries along the Mississippi River between Baton Rouge and New Orleans. Are there any different approaches that other industries take to flooding that you don't see being taken by the electrical generating industry? Or perhaps, in the Army Corps case, you know, you've got a lot of levies down there in Louisiana, maybe it applies strictly to levies.

MR. PATHAK: Right.

COMMISSIONER OSTENDORFF: But I'm just trying to see where are we learning from a broad-based perspective elsewhere?

MR. PATHAK: Right. In terms of Katrina and Lessons Learned from the Army Corps of Engineers for levies and other infrastructures, one thing we have done is significant work in the area of estimating the surge using the models which are developed by our Engineering Research and Development Center called Arctic Model, and which used -- had developed about close to about 150 scenario storms, and using those storm conditions they're predominantly meteorological and specifically on wind-driven system. And the storm estimates were made, and now currently we are doing the same work in the northeastern corridor. So, that did not happen before Sandy, so now we are engaged in doing what we did for Katrina, aftermath of Katrina, so using those estimates we are now using that updated information based on those sophisticated model, so we have much

better estimate of the storm surges that we had before Katrina. So, that is new information, and that is where the heights of the levy were used in determine -- using that information from the models.

COMMISSIONER OSTENDORFF: Does the Army Corps envision this information resulting in going back and increasing the height of existing levies?

MR. PATHAK: Yes.

COMMISSIONER OSTENDORFF: Has that happened so far?

MR. PATHAK: Right. And the other thing -- yes, that is true. In addition to doing that, what we have done is we have looked at the multi-aspects of risk taking or risk aversion by not only relying simply on the infrastructure, but other means which maybe not necessarily -- non-structural measures. So, insurance is one of them, and also the other parameters where, for example, setbacks from the levies, so things of those nature are also being integrated in the systems part of it.

In addition to that, what we have done typically is most of the levies we are not resilient. What that really means is when the levy overtops it would fail, but now we have made sure in those cases where we have resiliency in the levy system being built so even if it overtops it will not fail.

COMMISSIONER OSTENDORFF: Okay. Just for clarification, a question on that.

MR. PATHAK: Right.

COMMISSIONER OSTENDORFF: Are you requiring, or is anybody requiring modifications to existing levy systems to incorporate new notions of enhanced resilience for overtopping?

MR. PATHAK: Let me be very specific to New Orleans area. We have done that, and we are looking at -- the questions we are asked whether we are using the same standards. We have the standards are used in New Orleans are being applied elsewhere. Yes, we are in the process of using those. We have different scenarios in inland conditions, as opposed to the coastal conditions.

COMMISSIONER OSTENDORFF: Okay.

MR. PATHAK: So, there is distinction there to be made.

COMMISSIONER OSTENDORFF: Okay. Mr. Lewis?

MR. LEWIS: I can speak a little bit to experience in the oil and gas industry more from before I joined EPRI where I've done some work, and I'm fairly familiar with most of the methods used there. But I don't know of anything different, or that's better, or goes beyond what's done in the nuclear industry specific to external flooding.

Most of the work in the oil and gas industry has tended to be more qualitative in nature. There is some quantitative risk assessment, but there's a lot more qualitative work that's done there. I

don't know anything specifically.

But if I could answer a slightly different question, you might be interested to know that in the aftermath of Super Storm Sandy, we were working with EPRI's power delivery and utilization sector separate from the nuclear section to assist the utilities in New York, Long Island, and making good decisions about how to improve their infrastructure, what kinds of things they ought to protect. They didn't have the same kind of systematic approaches to understanding where their hazards are, and what they can do to protect against those hazards that we use fairly routinely in the nuclear industry. So, we do have that kind of cross sector work going on. And I realize that's kind of the reverse of your question.

COMMISSIONER OSTENDORFF: That's fine. That's helpful.

MR. LEWIS: It turned out to be an interesting project.

COMMISSIONER OSTENDORFF: Thanks for sharing that.

Dr. Bonnin, let me ask you a question from the NOAA National Weather Service perspective. In the area of let's say flood prediction, because I know you do a lot of things in your agency, but in that area is there any big difference between what you do and what the United States does via your agency, and what's done let's say in the Netherlands who faces significant flooding issues from the North Sea, dealing with floods for centuries.

I'm trying to understand is there any big delta between our practices in this country on flood prediction or how we address these issues than what you might see internationally?

MR. BONNIN: Yes, I think there is, and I think that Chandra might be able to better answer part of that question. I do know that there have been a lot of interactions between various folk in the U.S. and various folk in Holland in the recent couple of years. But, for example, there's a lot of planning, of land use planning that goes on in Holland that I don't think that we really do here. It's really quite extensive and it allows for progressive failures, failure in depth.

COMMISSIONER OSTENDORFF: It's that the context of where you allow people to build homes and vacation properties, that kind of -- is that kind of the subset? I'm not trying to make a political question, I'm just trying to get a context.

MR. BONNIN: Well, I think that the cases where we have -- Chandra mentioned, what happens when the levy fails? We want it to be resilient, and fail gradually if not at all, as a structure. But all of a sudden when these levies fail such as in New Orleans, it's a disaster, and it's a disaster because we haven't anticipated what's going to happen beyond the protection level we're providing. That's get down to a community understanding that you build a dam, it's going to protect people to this level here. It protected them to this level before, so they start sorry, the other way around. And what happens, they'll build houses down to what the original -- down to that 100-year

risk line, whatever -- accept the same risk. So, those sorts of land planning issues are really what the Dutch have been very good at. Chandra, do you want to –

MR. PATHAK: Yes, I think I would agree with that. In addition to that, I think one of the things I noticed in the visits to the country that they have a lot more understanding and self-realization in the community of what the flood is all about. Unlike in the areas in other parts of the country where you go, people say we have flood insurance, we don't need to worry about it. And when you look at that, when you think about that, I don't think people tend to -- and even if you look at the building encroachment to the top of the levies, a very classic case, we have about 15,000 miles of levees listed in our database, there are at least another 50,000 miles of levees which are non-federal, and they are no different than -- the scenarios are no different. So, the question is does the general population gets it? And have we done an adequate job of explaining, and that's why we call this risk reduction as opposed to risk elimination on the floods. I think that's a key point there.

COMMISSIONER OSTENDORFF: That is very helpful, thank you. Thank you, Chairman.

CHAIRMAN MACFARLANE: Yes, it's not limited just to levies, it goes on –

MR. PATHAK: Absolutely.

CHAIRMAN MACFARLANE: -- to coastal issues, and

fire hazard, et cetera. It's the whole shebang. Anyway, my turn.

So, let's go back to flood prediction. So, we sort of talked about it around the edges but let's talk about whether we're any good at it. I take it from you not really. You know, we can sort of get the mainstream stuff, but we keep getting surprised. Right? I mean, we keep hearing about floods, the most recent one somewhere in, I don't know, Tennessee. I don't know, I'm not even remembering the most recent one, but I guess how often do we get it wrong?

MR. VAIL: You know, again it's the magnitude of the flood that you're talking about and stuff. Are you talking about us missing a PMF or are you talking about a flood happening that may have, you know, we thought would be around 100-year flood or something like that? I don't think there's very many instances and stuff from we've missed a PMF calculation based on a PMP.

CHAIRMAN MACFARLANE: A PMF is?

MR. VAIL: I'm sorry, Probable Maximum Flood. And, basically, a Probable Maximum Flood is the flood that you get when you have the Probable Maximum Precipitation. And we don't have a lot of instances where those are occurring. And those are, basically, what the Corps uses, primarily, in a great extent to protect dams from catastrophic failure and stuff. There's a lot of other flood systems, you know, in some case levies and stuff that aren't designed to maintain PMFs. So, I wouldn't say, necessarily, that at the PMF level we're missing it. There are some examples, like the American River and the

Sacramento, they build the Folsom Reservoir as a -- to protect against a 500-year flood. I think now they're saying that was a 70-year flood, you know. So, sometimes we miss on the PMPs.

I think when -- you know, I plead total innocence to all this because I just take the PMP and run it through, and I think what we're doing there is pretty conservative.

CHAIRMAN MACFARLANE: The PMP is the Probable Maximum Precipitation.

MR. VAIL: Precipitation. Yes, sorry.

MR. PATHAK: So, maybe if I can add on to that PMP, Probable Maximum Precipitation. If you go back and look at the concept where it came from.

CHAIRMAN MACFARLANE: Right. That was going to be my next question.

MR. PATHAK: That is basically an assumption made, and the method used in developing that PMP, Atlas back in 1970. And the work was probably in the '60s, and if you look at the data which was used primarily up to 1960s or late '60s. Since then, these have not been updated. The size has gone far ahead. We are way behind in updating it leave alone the sizes.

Now, if you've got to go back –

CHAIRMAN MACFARLANE: Of what?

MR. PATHAK: Sizes of estimating the Probable Maximum Precipitation, which by definition is maximum amount of

rainfall generated based on atmospheric conditions, humidities, temperature, and so on. Those we have learned a lot more about –

CHAIRMAN MACFARLANE: But we haven't updated them.

MR. PATHAK: Exactly.

CHAIRMAN MACFARLANE: Why not?

MR. PATHAK: And it's a lack -- and let me be -- take a very crack -- very first crack at it. It just comes down to resources. And it's not a whole lot of thing, exactly. I mean, if you look at it -- what you have –

MR. BONNIN: Let me –

MR. PATHAK: You can go ahead, you can pick it up from there.

MR. BONNIN: I'm responsible for shutting -- the Weather Service produces those estimates, has for many years. I shut it down. I'm the person that shut it down. I shut it down in the early 2000s because -- we were being paid to do that by other federal agencies with reimbursable funds that came in, nothing out of the –

CHAIRMAN MACFARLANE: Yes.

MR. BONNIN: So, it's in our budget. Those funds dried up. I said I can't maintain a critical mass of expertise without those funds. That didn't happen, and now we have a committee that was referred to. I think it was your slides that's been meeting for a couple of years, whose mandate really is to find out and make

proposals on what it would cost to do that, and how we would do it. But that committee is a little bit stymied by the fact that we know that if we were to make a real estimate what it would take, it's multiple millions over multiple years, and it's hard to find those funds.

CHAIRMAN MACFARLANE: Okay. So, you're telling me that the Probable Maximum Precipitation and the terms that you're using are the 100-year flood, the 70-year flood, the 500-year flood, the whatever. So, you're basing all of this on historical data.

MR. PATHAK: Correct.

CHAIRMAN MACFARLANE: I'm a geologist. Is historical data relevant? It wouldn't be for me because it's -- and you're telling me now that the actual historical data is from 1960s and before, so we're not even talking 100 years of data. Correct?

MR. PATHAK: Correct.

CHAIRMAN MACFARLANE: So, we're missing a lot I would imagine, which takes me to your terminology questions, which I think is right. I would have a slightly different spin on it. I don't like using the word "extreme" weather, you know, the extreme cold that we are going to experience because to me it's just part of normal. We just haven't defined normal properly because we haven't looked back far enough.

MR. BONNIN: When we're designing structures those generally have a lifetime of 30, 50, 100 –

CHAIRMAN MACFARLANE: Yes, that's true.

MR. BONNIN: Yucca Mountain might be a little bit longer than that. So, we're not really dealing on geological time scales. However, in the analysis of flood flow frequencies, they are going back into the geological record and have developed a set of statistical procedures to be able to incorporate that non-continuous record into those estimates. So, yes, they are using those. But, again, it's a question of what sort of point on the geological time scale are you designing for something to be –

CHAIRMAN MACFARLANE: You're right. You're right, we're designing these structures that are going to last for, in the case of nuclear power plants, 60 years, maybe longer. Okay? But certainly, the sites may be around longer. We had an estimate this morning from EPRI of they're looking 100-years for the dry casks. Okay? So, say we're talking about 100-year scale. And we've been talking a lot about climate change, and we haven't included that in our estimates of Probable Maximum Precipitation. I see this as a problem. Yes, do you agree?

MR. BONNIN: Absolutely, and that's what this committee is all about, and the answer is more money.

MR. PATHAK: So, coming back to your PMP question, if I could divide the data into two parts; one where we have precipitation data available for 50, 60, up to even 100 years in some location, but some places, so where we look at the -- develop the Atlas 14 or TP40 where we were using the data to extrapolate portions

of the time series to look at the statistical analysis to come up 100-year rainfall, 500-year rainfall, and now a new one we have a 100-year -- a 1,000-year rainfall. That's one part of it. PMP is completely different. It is deterministic, it is a value, and it is determined based on the possible -- the data set which they looked at it in various conditions.

The point is that we need to do some investment in doing some research, R&D not for 10 years or 20 years, five years reasonably which NSF is willing to do. They need dollars, none of us have it, so the point is we need at least two to five million dollars. Once we have that new methodology, because this is almost 70 years old, the methodology we talk about, the science is there. We need to integrate the extreme storm methods which are used, which are used in numerical predictions, weather predictions. That needs to be integrated. All of that, we have radar data available which is completely new relatively speaking, so all these data sets are available. The work needs to be done –

CHAIRMAN MACFARLANE: You just need the money to do it.

MR. PATHAK: Right. And then we need to develop those -- update those PMP, so you could do two ways. You could take the PMP and update it without –

CHAIRMAN MACFARLANE: So, for us the situation now is that we don't really have, necessarily, the adequate information

that we need.

MR. PATHAK: And we don't have the hundreds of millions of dollars. We're talking about tens of millions of dollars.

CHAIRMAN MACFARLANE: Well, it seems reasonable. I'll talk to my friends.

MR. BONNIN: We're using analyses that existed and understandings before the term mesoscale convective complex was even invented.

CHAIRMAN MACFARLANE: Okay, I have one more question for you that I want to slide in here, and that is, we've been talking about floods for the most part. Are there other weather events that you think we should be concerned about? Today there's an article in the New York Times on the front page about Colorado River, 12 years of drought. You know, should that be of concern? You mentioned missiles from high winds. You know, what else?

MR. VAIL: One point I would just add, and it's actually getting back to floods, but that's that floods are more than just precipitation.

CHAIRMAN MACFARLANE: I know.

MR. VAIL: So, we also have to be considering, if you look at –

CHAIRMAN MACFARLANE: Storm surge.

MR. VAIL: Well, no, the flood at my house, for instance. It was a relatively modest precipitation event that triggered it.

CHAIRMAN MACFARLANE: Right.

MR. VAIL: It was on snow.

CHAIRMAN MACFARLANE: That's right.

MR. VAIL: And we have frozen soils.

CHAIRMAN MACFARLANE: Right.

MR. VAIL: And that, basically, represents it. And if you start doing land use changes, and you get significant possibilities of –

CHAIRMAN MACFARLANE: Which sort of goes to David's point earlier, that we have to consider more than –

MR. VAIL: Yes, so I think we need to look at it broader on the flooding side.

CHAIRMAN MACFARLANE: Good point.

MR. VAIL: And it's not just the precipitation is the end of the story. It's maybe the end of Geoff's issue and stuff, but then I think for Chandra and I on stuff like that, that comes back to being more a hydrology issue.

MR. BONNIN: There's a joke inside the Weather Service about the action statements that we put out with forecasts. So, if there's a tornado, you go down from the top of the hill into the ditch and you lie down in there. But, unfortunately, when there's a tornado there's often rain, so you've got to get out of the ditch back to the top of the hill so you don't get –

CHAIRMAN MACFARLANE: Drowned.

MR. BONNIN: -- flooded. And then when you get to the top of the hill you're going to get hit by the lightning.

(Laughter.)

MR. BONNIN: So, it's this integration that I think several people have been talking about of all of these hazards together. And the new probabilistic approaches that we're talking about are starting to provide us a framework in which we can deal with all of those.

And just if you'll allow me, I don't want to let go by what you said about perceptions of are we doing better with floods or not? We have a set of statistics that we maintain on those sorts of things. What we have not done better is on the accuracy of the main stem river forecast, but our time -- our lead time on those forecasts has expanded dramatically and we're giving -- we're able to give things like three months advance notice of floods on the upper Mississippi, for example.

The inclusion of radar has vastly improved our ability to forecast flash floods, but then if I forecast a flash flood and nobody knows what that means, or pays attention to it, or hears about it, there's a bunch of people in an Arkansas State Park that get flooded. So, we're moving into an era, as well, there's a major program within the National Weather Service of decision support. And this comes back to one of the issues you had in the beginning where we're trying to get with agencies, disaster response agencies, operational

agencies such as yourselves or the Corps to provide points of contact where you can actually get direct to the Weather Service, and we can provide information on the spot to you to help you make those sorts of decisions. We're trying to do that with the broadcast community in partnership with the emergency response community, those sorts of things.

CHAIRMAN MACFARLANE: Great. Well, thank you. Commissioner Svinicki.

COMMISSIONER SVINICKI: Well, I will add my thanks to all of you for coming this afternoon to share your expertise and your presentations.

I just had a few clarifications on topics I wanted to ask about. I'll start with Mr. DeNight. Did you ride out the Super Storm at Salem? Were you there for the peak of the storm?

MR. DeNIGHT: Yes, I was.

COMMISSIONER SVINICKI: I appreciate some of the very kind of human-related Lessons Learned that you shared. I visited years ago, I think I have this right, Turkey Point for Hurricane Andrew, they shared some very interesting -- how extensive and expansive they have to be in their pre-planning. I know you talked about sleeping accommodations and other very practical matters.

One of the things they mentioned to me at Turkey Point was that they actually provisioned so that at least after the peak storm intensity has passed, they would be able to offer some bottled

water and other provisions to family of the operational staff because after riding out the storm, and I'm certain as they went through the storm a lot of the staff of the unit, of course, is very concerned about their family. A lot of them are not able to contact their family, so I think in this case the nuclear plant operation management was trying to take some of that into account to keep people focused on what they needed to be focused on. So, there is a lot of operational experience out there for the nuclear plant operators in the U.S. that have to deal with these types of hurricanes and other events. So, I hope that you will share your Lessons Learned, and I hope that previous hurricane experiences are being shared throughout the U.S. operational community. And I'm confident that they are.

Were there any, though, as you went to execute to your preparations and your plans, were there any like complications with the shutdown of Unit 1 or any other things that when you went to execute a procedure you looked at it and said well, this procedure didn't take into account or accommodate various things. Did you find -- and I'm not asking for minor areas, but in general did you find that what you drilled, and trained to and things, that was a comprehensive preparation?

MR. DeNIGHT: Yes. The procedures that we had, and I started talking about what levels we saw as far as the river goes, what we saw our service water intakes, the safety-related intake structures. We saw some strainer differential alarms, and that was it, a

couple of overheads that we had. The majority of the challenges that we had were on the secondary side with the loss of cooling going to our condensers. We have procedures specifically to go ahead and address that, and then both emergency operating and abnormal operating procedures that we had. Just with any event or any issue that comes through the station, you're always trying to look on how could we have done this better. So, we went back, we did a root cause associated with the storm coming through. We tried gathering those Lessons Learned, we tried optimizing our procedures, and then just making it better so anyone that was coming behind the crews that were on that particular night, because it was a challenging night for them, that they could have those Lessons Learned and we could build it right into the procedure.

We did that, and we also benchmarked up and down the coast, as well, for all the plants associated with the hurricanes just to make sure that we captured it. We've done that in the past, you know, just as each football team is trying to get better going through each season, you know, we're going back just seeing if anybody's had additional Lessons Learned coming through it. So, you know, a challenging night for the crew and, you know, incorporated into our plans.

The substation that failed, non-safety related substation, you know, had water intrusion get inside of it, and the intranet inside of the control room failed, so as we're trying to go on

NOAA or the Weather Channel to try and get some storm data, the internet is down so we're calling over to a different building that still has internet so we can get that information fed into the control room. So, they were the biggest Lessons Learned that we had coming out of it.

COMMISSIONER SVINICKI: Okay, thank you for that. Mr. Lewis, the document, the EPRI document, Identification of External Hazards for Analysis and Probabilistic Risk Assessment, it talks a bit about the treatment of combined hazards. And the treatment has suggested that these combined hazards should be considered only if they're correlated or consequential. Are you -- could you expand on that a little bit?

MR. LEWIS: Well, I'll try. I think the idea there is that you can really spend a lot of time considering different combinations of hazards that where there may not be any particular reason to consider that they might occur concurrently, but if you spend more time thinking about -- Fukushima really was an example that a lot of people cite but, in fact, it was tsunami caused by an earthquake. It's not like they happened to have a tsunami at the same time as an earthquake. You know, obviously, that was 100 percent correlated. There are other things that are correlated that are -- where there's a causal effect that you need to take into account, or where a particular hazard is more likely to be severe if another condition is in place. So, you know, having to look at storm surges at the same time that you already have

high ocean levels, for example, might be something you would look at, if there's a reason to do it. But the point there is you don't necessarily try to think of every combination and permutation of hazards and figure out what they could imply about your plant. You look for reasons to think that there might be some correlation.

We have worked with EDF, as I mentioned earlier, in a complementary fashion. They've looked from a purely statistical standpoint. They didn't look at combinations of different hazards where you might not see any logical connection to try to see if there were statistical connections, and they found very few. They found nothing that you wouldn't have thought of ahead of time. They did find some negative correlations which also make sense in some cases. You know, there are cases where you won't have high temperature at the same time you have another condition just because that's not the way things work. But I think that's one area we need to expand on. We need more practical guidance on what that means. That wasn't a focus of our original report.

We're updating that report with the Lessons Learned, and we expect in the first half of this year to produce a new version of that report. And that's one of the aspects we hope to cover a little more thoroughly.

COMMISSIONER SVINICKI: Okay, thank you for that. I agree that it's an area, hearing more questions posed about it, so I think that a more structured -- at least proposals for a more structured

approach to it I think would be, at least, to begin a helpful dialogue about it, so I appreciate if you're going to have some additional work in that area.

And then, Mr. Vail, I know in the interest of time you had to skip over a number of your slides, but there was one that reading it yesterday in preparation for the meeting was so intriguing I thought I wonder what he's going to say when he gets to this slide, and then you had to skip over it. But it was your Slide 10, and it's the tale of tails, and you weren't able to talk about that.

Now you, I think, were giving us some of the themes of your remarks on some of your earlier slides, but the thing that jumped out at me from this particular slide was you quoted the other NRC, the National Research Council, a report from 1991, and you said you agree that, "It's well established that climate changes irregularly for unknown reasons on all time scales."

So, the question that came to my mind in wondering what you would say about that is, again, the purpose of this meeting, or one of the purposes for the Commission is to have the benefit of your expertise and your long experience on various things. So, one could read that and say it's a bit of a hopeless statement, and that you've recommended that we embrace the uncertainty, so that is certainly a good correlation with that statement from the National Research Council. But I agree with Commissioner Apostolakis that that's somewhat old hat to us at the Nuclear Regulatory Commission.

We've been embracing that, and involved in a very deep relationship for many years with the uncertainty. So beyond that, you know, what does one do, I guess is the question, what advice do you give if you say that we take that as established fact. And I'm not speaking in a strong philosophical vein, I'm thinking much more practically, like the things that come to mind for me not being, again, an agency whose core mission is to do climate science.

We have, you know, not a huge Office of Research, but we do have our own in-house expertise so we follow the science, we participate in the interagency processes, we send people to be a part of that to scientific conferences, stay on top of the issues. What other types of practical things can we be doing as an agency that doesn't exactly move the frontiers of knowledge in this area forward, but certainly as a consumer –

MR. VAIL: Yes. Unfortunately, I mean, back to that statement, the story that goes along with that was, basically, that was 1991. We actually know a lot more now than we did in 1991 about these climate variability questions and stuff, and we're actually able to capture a whole new set of variability in that period and stuff. So, at the same time you have stuff going on, you know, I mean this is another piece that sort of hasn't been incorporated much in our thinking and stuff since 1991 and stuff, so we're vastly better at that now than we were.

We acknowledge the -- you know, I mentioned in

1950 we knew that there were these patterns and stuff. We just didn't have them very well characterized and stuff, and now we know it much better and stuff. We're -- you know, people know, you know, it's common knowledge for people to talk about El Nino now, and most people in the U.S. might be able to tell you what El Nino means for their neighborhood and stuff like that. That's all happened since 1991, I can tell you and stuff, and there's a Pacific Decadel Oscillation, North Atlantic Oscillation, so a lot of that variability.

So, really that gets back to the story, is that things have changed dramatically and stuff. We have a lot of information; we may not, you know, be utilizing it. So, I wasn't trying to cast a bleak picture, it was just how much things have changed and stuff. And that part of the variability I think is a part that sort of potentially enters into questions about uncertainty.

I don't think it's necessarily an issue for the Probable Maximum Precipitation just because of the rarity of that event, but it's certainly, at lower frequencies it's certainly things like in the 5 to 50-year frequencies and stuff like that, change of those and stuff, those are clearly going to show out there.

COMMISSIONER SVINICKI: Okay. Well, I appreciate you had an opportunity to return to get this glimmer of hope that you were able to offer us here. So, thank you, Madam Chairman.

CHAIRMAN MACFARLANE: Okay. Any further questions? George.

COMMISSIONER APOSTOLAKIS: Just one comment. The Probable Maximum Flood is neither probable, not maximum. Thank you.

MR. VAIL: Right. I think we'll all agree with that.

MR. BONNIN: If you look at Probable Maximum Precipitation it may well be the maximum. I can show you that offline.

COMMISSIONER APOSTOLAKIS: With a distribution that you mentioned that you developed?

MR. BONNIN: No, but I can show you what I'm talking about offline.

CHAIRMAN MACFARLANE: Okay. Thank you very much for your participation. Appreciate all your thoughts, and we will take a five-minute break.

(Whereupon, the proceedings went off the record at 3:32 p.m., and went back on the record at 3:38 p.m.)

CHAIRMAN MACFARLANE: Okay, so we don't fall even further behind and we can get out of here at a decent hour, I think we are going to get started. Commissioner Apostolakis will join us in a moment.

So, now we are going to hear from the staff on flooding and I will put it in quotes, "extreme weather events."

But we will start with our Executive Director of Operations, Mark Satorius.

MR. SATORIUS: Good afternoon, Chairman,

Commissioners. It is the tail end of a long day and I know it has been longer for you because the five of you have been listening intently.

I appreciate the opportunity to discuss the staff's -- how the staff has addressed flooding and extreme weather events in its licensing and oversight programs.

How nuclear power plants are protected from natural phenomena has received increased attention since the Fukushima event, as well as other major flooding events affecting nuclear power plants such as Blayais in France and Fort Calhoun in the U.S.

Additionally, some national and international reports on climate change have indicated that more frequent and intense extreme weather events may challenge the operation and safety of nuclear power plants in the future.

What you will hear today is that ensuring plants are adequately protected against natural phenomenon, especially flooding and extreme weather has been and continues to be an integral part of the staff's licensing and oversight program.

You will hear that the guidance and analytical tools the staff uses to assure nuclear power plants are adequately protected continue to evolve as advances in science and technology are made. The staff is staying abreast of the latest advances in climate change science and assessing the need for further enhancing our rules, guidance, and analytical tools.

To date, the staff believes our guidance and tools

appropriately account for extreme weather events. With that said, we are working intently to further refine our ability to estimate the frequency and intensity of extreme weather events. Any new tools or guidance developed from our research activity will continue to account for the state of science in climate change.

Let me turn it over to Eric, who will briefly describe the scope of today's presentation by the staff.

MR. LEEDS: All right, thank you so much, Mark. Good afternoon Chairman, Commissioners.

As Mark indicated, natural phenomena can create significant challenges that plants must be able to cope with to maintain safety. We have a well-established regulatory process that includes a licensing process that determines the appropriate design basis natural phenomena for the site and for the plant design. We have an oversight process that includes inspection activities to assess whether the plant continues to comply with its design and licensing basis. And finally, we have a research program that continues to monitor the state of the science and develop tools and guidance to support licensing and oversight.

Each aspect of this process informs the other. And the process is informed by operational experience, by advancements in technology, by information that we gain from our federal partners, as well as from our international activities.

Plants here in the United States have responded well

to natural phenomenon events. From the seismic event that impacted North Anna that you heard about this morning, Commissioner Svinicki mentioned Hurricane Andrew hitting Turkey Point. Of course Hurricane Katrina impacted three nuclear power plants. The general population probably isn't even aware of this. One of those nuclear power plants, Waterford, is located right on the Gulf Coast within 20 miles of New Orleans. And finally, to the plants in the northeast which effectively handled the storm surge from Super Storm Sandy, which you just heard about from the previous panel.

While United States plants have coped well with these events, certainly Fukushima emphasizes the importance of remaining vigilant in overseeing plants and maintaining our understanding of the state of science for extreme weather and for flooding.

Extreme weather creates conditions such as high winds and floods. To discuss how a regulatory program addresses all aspects of extreme weather would take more time than we have today. So, today's presentation will focus on flooding. Flooding is the one aspect of extreme weather that is included in Tier 1 of the Fukushima activities. So, we thought it was important to discuss flooding in some detail.

Other elements of extreme weather will be addressed in our Tier 2 review of the Fukushima action items.

For our agenda, our speaker will be Mr. George Wilson and he will describe our oversight process and some of the

flooding-related issues identified by our inspectors and the key lessons we have learned from those findings.

Next, Dr. Chris Cook will describe the licensing process used to establish a plant's design basis flood and the evolution of this licensing process.

And finally, we will conclude with Dr. Bill Ott, who will discuss our research program and ongoing research activities in the area of flooding assessment and protection.

At this time, let me turn it over to George.

MR. WILSON: Thanks, Eric. Good afternoon Chairman and Commissioners.

The NRC has long recognized that external flooding can be a significant risk contributor at nuclear power plants. As such, today I am going to discuss the reactor oversight process to provide perspectives on how the program already focuses on these external hazards and describe key examples of NRC findings and plant events associated with flooding and severe storms.

Some examples that I will use include recent findings by our inspectors and staff at the Oconee Nuclear Station, Fort Calhoun, and Watts Bar Nuclear Station. In addition, I will discuss how Oyster Creek responded to Super Storm Sandy, and how the events and the lessons learned from Fukushima highlight the importance of our continued focus on these issues. Next slide, please.

First, I would like to provide some background on how external hazards are inspected in the reactor oversight program. There are specific inspection activities for adverse weather, for flooding contained in adverse weather conditions, flooding protection measures, and external hazard considerations during plant modifications.

The NRC resident inspectors spend approximately 90 hours at each site implementing these procedures and, as a result, they have identified potential flooding and severe weather issues, many before the events occur.

These issues and findings are then fed back into the regulatory process to evaluate if enhancements of the processes are needed.

The revised oversight process consideration of external hazards predates Fukushima. As Eric stated, Fukushima simply highlighted the importance of ensuring that we are vigilant in implementing this process. Next slide, please.

Now I would like to provide a few illustrative examples of how our oversight program has worked to assess external hazard issues at nuclear power plants. One activity that garnered significant external interest is related to the Oconee Nuclear Station. In 2005, the NRC identified an issue at Oconee resulting from an inadequate maintenance procedure to open and control a penetration to a passive flood protection barrier.

Upon the NRC staff investigating further into the design basis flood assumptions at Oconee, a question surfaced regarding how upstream dam failures are considered and evaluated during the original licensing of the plant. This led to the identification of a generic concern with operating nuclear plants, along with insights from the Oconee and additional staff analysis performed by the Office of Nuclear Regulatory Research led to the development and issuing of Generic Issue 204, "Upstream Dam Failures," which has later been subsumed into the Near-Term Task Force Recommendation 2.1.

During our efforts to understand the issue and ensure the licensee was taking appropriate corrective actions, the NRC staff informed and maintained a close partnership with the Federal Energy Regulatory Commission, who is the regulator of those dams.

In a few moments, Dr. Cook will discuss further how we have historically considered external hazards in our licensing process and what actions we are taking now to update our understanding of those hazards. Next slide, please.

I would like to discuss how the inspection finding resulted in the licensee being better prepared to cope with subsequent events at Fort Calhoun and provided valuable insights to support the staff development of Recommendation 2.3, "Walkdown Guidance."

During the execution of a component design inspection in 2009, the NRC staff identified an issue regarding the licensee's flood mitigation strategy at Fort Calhoun. The issue

identified protection of the plant's key systems were lacking. The licensee, since, has taken appropriate corrective actions and a year later when the Missouri River flood happened, although the impacts were severe, plant safety was always maintained.

The insights from this event also highlighted the importance of having adequate sandbagging procedures, which was then fed back into the Flooding Walkdown Guidance for Recommendation 2.3. Next slide, please.

I would also like to discuss an issue identified at Watts Bar. This example is illustrative of how issues identified at other nuclear power plants are fed back into the inspection process to determine if similar issues exist elsewhere.

Based on lessons learned from previous flooding inspections at plants, the NRC staff placed a greater emphasis on observing reasonable simulation of the licensee's implementation of its flooding mitigation procedures.

Upon the NRC staff evaluating the licensee conducting a reasonable simulation of its flood mitigation procedures in 2012, it became apparent that key aspects of the strategy at Watts Bar could not be implemented in the time frame that it was assumed. The licensee has since taken appropriate corrective actions on this issue.

There are several challenges involved in assessing the risk associated with flooding. So, significant benefit can be

derived from continuing development of risk tools NRC PRA, Probabilistic Risk Assessment models. Later on in this presentation, Dr. Ott will discuss further how the Agency is moving forward in the development of the Probabilistic Flood Hazard Assessment. Next slide, please.

As Eric mentioned during his remarks, operating experience at nuclear power plants has demonstrated their ability to withstand extreme natural hazards. Just last year we had another example of this.

In the days leading up to Super Storm Sandy, weather forecasts significantly under-predicted the size and velocity of the storm. By the time the storm made landfall, it was the largest of its type spanning over 1100 miles.

Despite its size and the devastation that it would ultimately cause to the Atlantic Seaboard, safety was never challenged at any of the 34 nuclear power plants in Sandy's path, primarily due to the licensee's advanced preparation and the overall defense-in-depth of the plants.

One of the key lessons learned from Sandy occurred at Oyster Creek. During the storm, storm surges exceeded those predicted and the resulting water levels had the potential to challenge the operation of the service water pumps. The licensee applied its contingency plans to modify the operating procedures, thereby ensuring the continued safe operation of those key components.

In addition, mitigating strategies equipment was also ready to help, if needed. Next slide, please.

I have spent the last few slides discussing how operating experience and the reactor oversight process are critical components of our overall strategy to ensure nuclear power plants are protected from flooding and extreme weather events. The events of March 11, 2011 at the Fukushima Daiichi Nuclear Plant serve as a stark reminder of the importance we must place on continued vigilance to ensure adequate protective measures are in place and maintained at the U.S. nuclear power plants.

One of the first Fukushima lessons learned implemented at the United States nuclear power plants involved detailed walkdowns to ensure that each plant was capable of implementing its flood protection strategy, in accordance with the facility's design and licensing basis. The NRC endorsed industry guidance on how to perform the walkdowns and follow it up during and after the walkdowns with independent inspections performed by NRC inspectors to ensure the guidance was adhered to.

Our inspectors identified some deficiencies at the site, whose risk significance was evaluated through the significance determination process, resulting in corrective actions at the sites to improve their overall ability against these events.

We plan to now feed the insights from the walkdowns in the evaluation process back into the reactor oversight process to

evaluate whether any enhancements are needed in that process.

In summary, we will continue to focus on flooding issues, their potential impact on reactor safety and feeding back the insights into our reactor oversight process.

As new information is gathered and new technology are developed, the agency performs research and evaluates the impact they have on reactor safety. In addition, lessons learned are evaluated to make necessary changes to the ever-evolving reactor oversight and regulatory process, thereby maintaining reactor safety.

Now, Dr. Cook will discuss how some of the lessons learned from operating events are incorporated into the evolving methods for computing flooding hazards at nuclear power plants.

Dr. Cook?

DR. COOK: Thank you, Mr. Wilson. Good afternoon Chairman, and Commissioners. I truly appreciate the opportunity to be here today and to make this presentation. Let's move forward to slide 12, please.

My presentation builds upon the reactor oversight process that Mr. Wilson just presented, and transitions to the discussion to reactor licensing. Specifically, my talk is composed of five topics on the potentially broad subject area of evolution of flood hazards.

First, I plan to discuss what is the same, versus what has changed, from a technical standpoint when many of the currently

operating nuclear plants were licensed by the Atomic Energy Commission or the Nuclear Regulatory Commission.

Next, I will discuss methods used today by the staff to estimate flooding hazards at nuclear power plants. I will then transition to a summary of the motivation for new staff guidance to assist with the review of Recommendation 2.1, which are the flood hazard reevaluations.

I then plan to conclude with a brief discussion regarding how evaluation of flooding hazards is likely to continue to evolve in the future. Next slide.

As I mentioned, the first topic I wanted to discuss is how the evaluation of flooding hazards has changed from a technical standpoint from when many of the currently operating plants were licensed by the Atomic Energy Commission or the Nuclear Regulatory Commission.

When I am discussing flooding hazards this afternoon, I mean the complete set of hydrologic and oceanographic hazards that could potentially challenge a nuclear power plant site. This includes such mechanisms as storm surge, failures of dams, flooding from rivers, intense rainfall on the site and the associated need for site drainage.

In looking back at some of the older hazard reviews which were performed in conjunction with the construction permits in the 1960s, I found that the hazard mechanisms considered as part of

the new reactor reviews today are really the same suite of hazard mechanisms as were considered by the operating fleet. Truly, NRC has a long history of considering the full range of hydrologic hazards that can potentially challenge a nuclear power plant site. Next slide.

So, if the hazard mechanisms are the same, does that mean our evaluation results would be identical? More than likely, the answer would be no. What has changed are several items, including the increased period of record -- of relevant data sets, such as river discharge, precipitation rate and tide gauge data.

We also learned that we need to focus on certain hazard mechanisms more, such as locally intense rainfall at or near the site, given a longer period of experience. I think we have also gained a better understanding of what can happen, should a nuclear power plant be flooded.

We have also had significant advances in scientific knowledge. For example, in the 1960s, the concept of plate tectonics was a new concept but now it is a concept that is generally accepted. But back then, it was cutting edge new.

I consider our knowledge of climate change today to be somewhat analogous to where we were with plate tectonics in the 1960s. It is cutting edge and new. Our knowledge of this topic is rapidly increasing and I suspect it will continue to dramatically increase in the decades to come.

Finally, we have had significant changes to computer

hardware and software. These tools are a revolutionary step change in the ability to predict flooding effects at nuclear power plant sites from various hazard mechanisms, such as the cascade failure of upstream dams or distant tsunami sources. Next slide.

The NRC has reevaluated the potential for floods to impact nuclear power plants before. The first was the Systematic Evaluation Program. In 1977, the NRC initiated the Systematic Evaluation Program to review the designs of 51 older operating nuclear power plants. Approximately ten plants had detailed evaluations that were performed. This evaluation was a means for the NRC to review and validate the safety of older plants based on new at that time, a comprehensive set of licensing criteria. Conformance with the NRC's general design criteria was established as part of the Systematic Evaluation Program.

In June of 1991, the NRC issued a supplement to Generic Letter 88-20, which is individual plant examination of external events for severe accident vulnerabilities. Flood-related hazards were considered in the IPEEE program as part of the high winds, flood, and other external initiating event hazards. Of the 70 IPEEE submittals, most indicated some type of walkdown was performed for the high wind, floods and other hazards.

Most recently on March 12, 2012, the NRC issued the 50.54(f) letters associated with Near-Term Task Force Recommendation 2. Recommendation 2.1 requested that all

operating reactor licensees and construction permit holders reevaluate the flooding hazards at their sites, using present-day methodologies and regulatory guidance as is done for new reactor reviews, to determine if additional regulatory actions are necessary. Next slide, please.

I would now like to discuss how staff presently perform design basis flooding hazard reviews at new reactor sites. The site's potential for flooding is based on the historical record for the site and the surrounding area. The flood hazard review is specific to the site in question. And as you could imagine, the length of the historical record at each site can vary tremendously.

Changes to the underlying baseline data are considered as part of this review. Changes that come from a variety of factors including the potential for climate change, construction of dams, and other changes to the watershed.

Regarding climate change, we monitor the latest updates and information from national and international organizations. We also factor into the hazard calculation for a limited period of record and uncertainties. Generally, deterministic methods are used to calculate the potential for flooding at a site. This is consistent with the current state of the science for many flooding mechanisms. The hydrologic or oceanographic review is based on numerous modeling parameters and assumptions. Although some inputs, such as rainfall rates are deterministically estimated, some examination of

uncertainties are accounted for by use of parameter sensitivity studies.

We continue to work with our research partners toward developing and using probabilistic methods. We are aware that the use of deterministic methods -- we are aware that with the use of deterministic methods, the risks exposure to the site from flooding hazards is not uniform. Instead, uncertainties are compensated for by use of conservative parameter selection and margin.

For those hazard mechanisms for the current state of the science has advanced probabilistic methods, we allow for their use. For example, we are beginning to employ probabilistic methods for storm surge. As Dr. Ott will later discuss, we continue to pursue probabilistic methods as we realized this would help us to have a uniform hazard level at each site. Next slide, please.

As part of Recommendation 2.1, the staff developed several new interim staff guidance documents. As you know, we requested licensees perform the analysis using present day methodologies and guidance, as is done for the new reactor reviews. And since the agency has issued early site permits and combined licenses in the past few years and have several currently under review, you may be asking why we needed to develop this guidance.

Well, first, for the new guidance associated with dam failure, staff are aware that our guidance needed to be clarified in several technical areas, based on experience from our new reactor

reviews. This guidance document is based on published federal guidelines for dam safety. As much as possible, the new guidance also tries to be aligned with guidance from other federal agencies. However, we did note that federal agencies implement the overarching federal guidelines for dam safety differently.

Given the potentially severe consequences associated with flooding a nuclear power plant, and since nuclear plant sites should never be evacuated of all staff during a flooding event, the NRC continues to make realistically conservative assumptions for predicting maximum flood heights at nuclear power plant sites.

The resulting flood heights we require nuclear power plants to protect against may differ from assumptions made by other federal agencies developing emergency action plans, where evacuation is a useful strategy for preventing loss of life, should an upstream dam fail.

Regarding the motivation for updating the storm surge guidance, there are several new reactor sites whose controlling site characteristics for flooding is storm surge. In addition, Hurricane Katrina in 2005 elevated the public's and the federal government's awareness of the potentially destructive power of storm surge associated with hurricanes, which led to the development of new methodologies to estimate storm surge. However, as Mr. Leeds mentioned, our nuclear power plant sites in the area rode out this

event without issue.

In response to both drivers, the NRC formed a storm surge research program to focus on developing modern risk-informed hazard assessment techniques, in cooperation with the National Oceanographic and Atmospheric Association, also known as NOAA, and the U.S. Army Corps of Engineers. Likewise, other federal agencies, such as the Federal Emergency Management Agency and the Army Corps of Engineers continue to invest in separate programs to develop and apply probabilistic approaches to investigate storm surge.

The motivation for updating the tsunami guidance is somewhat similar. Like storm surge, the 2004 Indian Ocean tsunami raised the global awareness of tsunami hazards. This led the NRC to develop a coordinated tsunami safety study in 2005 with the National Tsunami Safety Initiative that NOAA conducted.

In 2006, the NRC also initiated a long-term tsunami research program. This program includes cooperative work with the U.S. Geological Survey and NOAA. Outcomes from both the storm surge and the tsunami research programs have resulted in significant increases in knowledge and are being used as part of the ongoing new reactor reviews. These updates are reflected in this new guidance document.

The last guidance document I wanted to discuss is the Integrated Assessment for Flooding. In March 2012, the 50.54(f)

states that the NRC staff will develop the implementation details of the Integrated Assessment. This guidance was issued by the staff on November 30, 2012.

The motivation for this guidance was the need to risk inform our regulatory decisions for operating plants should the reevaluated hazard be greater than the plant's current design basis. The guidance lays out a methodological process to evaluate the total plant response and by that, I mean both flood protection and mitigation capabilities to the higher reevaluated flood hazard. Next slide, please.

It is highly likely that our understanding of flooding hazards will continue to evolve. That will happen as we increase our knowledge through increased observed data at the site and the surrounding region. As we increase our scientific knowledge, such as our knowledge of climate change, and improved analytical tools, such as computers and computer software, become available for use.

As probabilistic methods become available and accepted by the technical community, staff will incorporate them into the review of new reactor sites. In addition, staff are studying a plan to implement Near-Term Task Force Recommendation 2.2, which is a Tier 3 activity, and dependent on the ongoing Tier 1 hazard reevaluations. This recommendation proposes that flood hazard reevaluations be performed at a set periodicity for all operating reactors. These periodic reevaluations will allow for the timely

discovery, review, and implementation of flood protection and mitigation measures, should conditions change at a site.

So a significant component of the engine that is driving our evolution forward, especially related to probabilistic evaluation of flooding hazards is described in the next presentation. So without further ado, I would like to turn it over to Dr. Bill Ott.

DR. OTT: Thank you, Chris. Good afternoon.

The Office of Research provides support to licensing offices by developing data models and supporting computational tools that can bring state-of-the-art analytical capabilities to bear on licensing decisions.

In the case of flooding, we have been requested by NRO and NRR to update the technical basis for assessing flood hazards and the regulatory guidance for conducting flood hazard assessments.

As mentioned by Chris, the current approach is predominately deterministic but as we have moved forward, our goal is becoming a more probabilistic assessment of this hazard and a more risk-informed basis for licensing decisions. Next slide.

Today, I would like to describe for you our progress on the initial requests and our plans to address the long-term goal. My presentation is divided among the topics that you see on this slide. First, we will talk about the guidance updates. Next, we will talk about probabilistic flood hazard assessment and how we plan to move

forward. I will make a few remarks about considering climate change in this process, and then summarize the status of our program. For concluding remarks, I will turn it over to Eric Leeds. Next page.

Since 1977, the principal guidance on acceptable methods for addressing flood hazard has been contained in Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants." In the interim, there has been an explosion in the volume of information on storm systems due to improvements in data acquisition and storage, a revolution in the computing power that can be applied to the problem, and significant advances in the complexity and realism of models used to simulate historical storms and explore the effects of variations and key conditions.

In 2008, NRO submitted a user need requesting that we update the technical basis and regulatory guidance for flood assessment, consistent with the current state-of-the-art as being applied to ESP and COL reviews. In response, we initiated three projects. The first at PNLL, because they were the primary contractor to NRO for the ESP and COL reviews, was to document the current state-of-the-art as applied in ESP and COL reviews.

The second project with the Corps of Engineers was developed to evaluate storm surge along the Gulf Coast in South Florida, which was a primary locus for several new plant applications.

The third contract with the Bureau of Reclamation was engaged to update methods for estimating probable maximum

precipitation, a topic discussed during the previous panel.

These projects produced five major technical reports and, along with the interim staff guidance and operating experience, allowed us to develop a major revision to Reg Guide 1.59 that is nearing completion. Next slide.

In addition to the work on Reg Guide 1.59, we have also begun work on Reg Guide 1.102, "Flood Protection for Nuclear Power Plants." The motivation here was lessons learned from a series of challenges to flood protection, both domestic and international, both nuclear and non-nuclear.

Some of those examples include the Blayais Nuclear Power Plant on the Gironde Estuary in France, where watertight doors and seals failed and access to the site was severely restricted; Hurricane Katrina, where levies protecting New Orleans failed from under-seepage, overtopping, and inadequate foundations; Fukushima, where the plant wasn't designed for the magnitude of the tsunami; and Fort Calhoun where the anticipated duration of the inundation was far exceeded.

In this case, we engaged the U.S. Army Corps of Engineers to develop an assessment of what they considered to be the state-of-the-art in flood protection for large civilian facilities. Their final report is under review and we are starting to draft the revision to the regulatory guide. The Corps' principal recommendation is a phased approach to flood protection, which recommends primary

protection to keep water away from safety-related structures, and secondary protection involving doors, seals, drains, and pumps for protection from locally intense precipitation.

They also observed that they found little reliability data on doors and seals in the specific task that we gave them, a significant problem for establishing tools to assess risk. Next slide.

We have completed the first phase of the support work. Mostly deterministic but containing a good start towards more sophisticated and risk-informed analyses. We have initiated four additional projects to continue to move forward to a more risk-informed approach. These projects are looking at probabilistic evaluation of riverine flooding, extension of probable maximum precipitation studies to include transposition and orographic features, use of paleo flood data to inform flooding risks at nuclear power plants, and the implications of recent published research on evaluation of dam-breach scenarios.

As we moved forward, NRO, NRR and RES staff decided that there was a need to determine the extent to which other agencies or groups may be applying probabilistic techniques and a joint user need was prepared requesting a public workshop on the subject. The PFHA workshop was held January 29 to 31, 2013, was attended by more than 250 scientists and engineers, including federal partners, industry, academia, and international experts. The workshop proceedings has been published as NUREG/CP-0302.

Next slide.

The staff is developing a research plan to guide systematic and comprehensive progress toward an approach for probabilistic flood hazard assessment. Insights from completed and ongoing research, new reactors, the reactor oversight program, and the recent workshop are providing the foundation. We refocused our agency TAG, Technical Advisory Group on Flooding, including experts from all program offices to increase its role in this program. A subgroup from that program has developed the draft plan. This draft research plan is currently under internal review.

We have engaged and will continue to engage our federal partners and domestic and international experts. Next slide.

Finally, I would like to observe that we are all very much aware of the evolving information on climate change. We know that when those changes influence the safety of our licensees, we must give them careful consideration. We do this first by following important development, such as the recently issued report of the Intergovernmental Panel on Climate Change and the recent DOE report on energy sector vulnerabilities.

Draft Guide 1290, which is the revision of 1.59, discusses the consideration of climate change and flood assessment. Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Plants," also addresses climate change.

These documents are focused on site-specific

estimates of particular hazards for the life of the plant and considering, when appropriate, the effects of climate change. At this point, only sea level rise data are mature enough for routine incorporation in these analyses.

I should not leave this topic without mentioning concerns that have been raised about long-term trends reflected in lower water levels in the Great Lakes. This concern is shared by the Canadians and is the subject of a planned joint workshop. Next slide.

The research program's supporting analysis of flooding is a multi-office undertaking. Insights from reactor operating experience and new reactor licensing reviews helped identify information gaps and the need for new analytical techniques. The larger community of federal regulators and science organizations helps shape regulatory and technical policy to consistently address a wide-range of interests. Cooperation is essential to continued success.

The status of our program can be summarized with these bullets. Substantial work has been completed to support state-of-the-art regulatory guidance, primarily deterministic at this point. New research is directed at providing critical information for probabilistic analyses. So, we are moving to a more probabilistic approach. A research program plan will guide those future activities and advances in climate change science will be monitored and given appropriate consideration. Next slide, Eric?

MR. LEEDS: Thank you, Bill.

All right. So, in conclusion, do we have the last slide. There we go, thank you.

In conclusion, safety is a continual process. The plants are protected from flooding and other extreme weather events today. And as our understanding of the hazards change, we will ensure the plants remain protected tomorrow.

Our understanding and knowledge continues to evolve. We continue to evaluate flooding and other extreme weather events as new information is gathered from operating experience, from new reactor reviews, new information on climate change, and certainly from new technology.

We also get information from our research projects, our cooperative engagement with federal partners, through experience and initiatives from the international community.

The lessons learned will be incorporated into the reactor oversight process. Our processes are designed to incorporate lessons learned for continual improvement. We make changes to more efficiently and effectively implement our regulatory programs.

And with that, I will conclude, unless, Mark, is there something that you would like to add?

MR. SATORIUS: No, we will proceed directly to questions, Chairman.

CHAIRMAN MACFARLANE: Okay, great. Thank

you. Thanks for saving us five minutes. Excellent job.

We will start off with Commissioner Apostolakis.

COMMISSIONER APOSTOLAKIS: On slide 13, you have six possible ways of creating a flooding problem for the plant. Now in the probabilistic, what word, PFHA, Probabilistic Flood Hazard Assessment, how do you combine those things all in the deterministic? Because some are here. The next slide, 16 says that present day methods for estimating design basis flooding hazards are predominately deterministic. So, how do we take those six contributors and do a deterministic evaluation and then a probabilistic evaluation?

DR. COOK: The circles that I pulled out with the different hazards that are there, there is one that is called other hazards. So, that is sort of a catchall for many different things, including locally intense precipitation that is falling on the site that then you have to worry about site drainage and coming down. So that was sort of a catchall. I left out, of course you know icing. You know Mr. Vail was talking about potential ice dams that can form and will flood his house. So, there are a number of other hazards than these six.

The paradigm is really, and if you look at our standard review plan, you will see that there are various sections as part of Section 2.4 that goes through there, titled generally by those different hazards, where you have hazards from riverine conditions, you have hazards from dam failures, you have tsunamis, storm surge and

seiche.

You look at all these different hazards that are together that could possibly challenge the site. As you look at those hazards that can come out, some you can discredit. Ice flooding in Florida is not an issue. However, in other parts of the U.S. it is.

COMMISSIONER APOSTOLAKIS: No, but you said you look at them together. So, are you assuming there is a dam failure and a storm surge and a tsunami altogether and let's save the plant?

DR. COOK: No. No, sir.

COMMISSIONER APOSTOLAKIS: So, how do you do that? In a deterministic world, how do you do that? Do you look at each one separately?

DR. COOK: Unless they can reasonably be combined together, such as we have some sites that are on the coast that are also near the mouth of a river. So it is potential to assume that you could have a dam that maybe failed hypothetically by a large rainfall event that could also cause from a hurricane a storm surge at a plant.

So, if the combination would make sense, we would combine it together. Usually they are looked at individually, though. Each one then individually comes out with its design basis flood level at the site. And then we are generally looking to see which one is controlling, which ones you really need to be concerned with at this

site. The ones that you need to be concerned with we can look at in greater detail. Some of the initial screening can be done qualitatively.

COMMISSIONER APOSTOLAKIS: Now, a lot of the plants were licensed many years ago --

DR. COOK: Correct.

COMMISSIONER APOSTOLAKIS: -- and the design basis flood or the probable maximum flood was determined at the time. Did they do all of this, what you just described? Back in '74, for example, did they do all this stuff?

DR. COOK: Looking back in '74 and even the '75, standard review plan, if you look at the hazard mechanisms that are there, you will see that the same hazard mechanisms are being looked at today when we do new reactor reviews. I am in the Office of New Reactors and we look at the same hazard mechanisms.

What has changed is the information that we have available. What has changed are the computer models. Those are the significant changes. Back in the day, if you were going to be looking at cascade failures, say that we would have a site that would be many hundreds of miles downstream from a dam, looking at that failure of that dam and the propagation of that wave downstream was a huge challenge back in the '70s. Now, it is something that is very possible that we can do with computer models to look at today to come up with the resulting water level at the site.

COMMISSIONER APOSTOLAKIS: The probabilistic

model, how does it combine with these things?

DR. OTT: We don't have a probabilistic model that combines them yet.

The French -- let me back off from that. Deltares, the European group which does flooding for the lowlands and the areas, they will do a probabilistic analysis which includes looking at snow melt in the mountains, spring rains, the management of downstream dams and all of that to propagate flood waters to the coastal areas. And they will do that in a probabilistic sense.

COMMISSIONER APOSTOLAKIS: So, there must be some correlations or dependencies.

DR. OTT: Exactly. In some cases, yes.

In terms of the guidance that was available back in 1977, the first version of 1.59, there is an appendix that speaks specifically to combined events and how to do that analysis. The biggest problem with that appendix is that a lot of people look at it as a cookbook and it needs to be done on a site-specific basis. You need to look at the site and look at what mechanisms are possible for that site and then combine those. Because your overriding situation such as the one that affected the plant at Le Blayais in Gironde was really a set of combined events. You had a storm coming in off of the coast. They had heavy spring rains. They had high tides with a lunar New Year and they had to combine all of those things. And that combined event was actually what caused the flooding problem at Le Blayais.

So, we are aware of the problem. We don't have all the techniques in place yet, but that is the focus of where we are trying to have it.

COMMISSIONER APOSTOLAKIS: When do you think you are going to have it?

DR. OTT: The time frame that has been placed on the research project plan that we are developing is basically the same as you heard earlier, about five years for a fairly aggressive program of research by us, which is focused on developing techniques that will fit into a probabilistic analysis.

COMMISSIONER APOSTOLAKIS: Five years is a long time.

DR. OTT: It is a big problem.

COMMISSIONER APOSTOLAKIS: Because of lack of resources or --

DR. OTT: We actually don't know what level of resources we have available yet because we haven't got the program plan in place yet. As soon as we do, we are going to be negotiating with NRO with regard to resources.

So, it is an evolving situation in terms of the resources and how long it is going to take us to -- we projected five years based on what we thought it would take and what we thought we could get.

COMMISSIONER APOSTOLAKIS: Now, on slide 15, there are three ways that we looked at the flood problem; Systematic

Evaluation Program, Individual Plant Evaluation and NTTF Recommendation 2.1. These sound to me like ad hoc. And there is a recommendation in Tier 3 that says every ten years go and look.

DR. COOK: Correct.

COMMISSIONER APOSTOLAKIS: Would I put you on the spot if I asked you are you in favor of that?

DR. COOK: Personally, I am very much in favor of that.

COMMISSIONER APOSTOLAKIS: Thank you, very much.

DR. COOK: And if you look at my slides --

COMMISSIONER APOSTOLAKIS: That's fine.

(Laughter.)

DR. COOK: Enough said, yes.

(Laughter.)

COMMISSIONER APOSTOLAKIS: Then we have this cart and the horse. Do you guys have anything to say to that to Mr. Lochbaum? Are we putting the cart ahead of the horse many times, a few times, rarely? He made a big deal out of it. So, I would like to know your response.

DR. COOK: Well, I think part of what Mr. Wilson was talking about, just for the record to clarify, the walkdowns --

COMMISSIONER APOSTOLAKIS: I'm sorry, the what?

DR. COOK: The walkdowns --

COMMISSIONER APOSTOLAKIS: Yes.

DR. COOK: -- as part of Recommendation 2.3 that were there. The 50.54(f) letters were issued March 12, 2012, as we know. There were then a series of public meetings where we worked together with the Nuclear Energy Institute, NEI, and they came up with the guidance that was used for the walkdowns and was significant discussions that were there. That Guidance was issued by NEI on May the 12th, 2012.

COMMISSIONER APOSTOLAKIS: But that is the history, Chris.

DR. COOK: Yes, sure.

COMMISSIONER APOSTOLAKIS: Mr. Lochbaum said the inspectors were walking down the plant and, without guidance, they didn't know what to look for. That is pretty strong. They really didn't know what to look for?

DR. COOK: Personally, I would say that they in fact knew very well. There were certain --

COMMISSIONER APOSTOLAKIS: Without the guidance?

DR. COOK: With the guidance because the walkdowns were done when the guidance was issued.

MR. WILSON: We need to --

COMMISSIONER APOSTOLAKIS: I thought he said

no.

MR. WILSON: No, there was a couple of walkdowns that happened. First, there was initial walkdowns that the licensee did right after Fukushima Daiichi happened. And then we wrote a temporary instruction and went and did a follow-up inspection.

But when we actually did the Near-Term Task Force Recommendation 2.1, there was guidance that was issued that the industry followed. Our resident inspectors or regional inspectors went out and made sure in my presentation that that guidance was adhered to. And then we followed up with an additional inspection from NRC inspectors and found additional problems at the sites that they had to put in a direct action program.

So, the 2.1 walkdowns were performed with guidance prior --

COMMISSIONER APOSTOLAKIS: Accepted guidance.

MR. WILSON: -- accepted guidance that we had accepted in the industry. And we trained our inspectors on how to do that guidance.

MR. SKEEN: Yes, Commissioner, if I could, let me go back in time to what were the Near-Term Task Force thinking and what was the Steering Committee thinking as we went through this? And what the Near-Term Task Force had come up with was they recognized you couldn't go off and do all of this analysis and come up

with an answer right away. So, the thinking was if you could do walkdowns quickly, go out there and look around, if there are things that you, and at that time, they used the term cliff edge, if you could find things that were near, maybe just slightly above your current design basis, fix those, if it is easy to fix, easy to get to.

While we knew we had to go back and do a further evaluation, an evaluation against the latest and greatest information that we had. So, that is what the thinking was of how we did that.

So, I wouldn't say it was the cart before the horse. It was do the walkdowns you can do to get some fixes in place, while you did the longer term fixes that looking at the reanalysis.

COMMISSIONER APOSTOLAKIS: Is there a written statement where you are addressing these concerns by Mr. Lochbaum? No?

MR. SATORIUS: I would say other than the transcript --

COMMISSIONER APOSTOLAKIS: You know, he put those things on the record this morning. I would expect you guys to respond without a Commissioner asking because people are listening to this. You know, the external --

MR. LEEDS: Well, Commissioner, let me try to address that, if you don't mind. The staff is always interested in constructive criticism. And sometimes we receive constructive criticism and sometimes we don't. Sometimes we receive criticism

that we just disagree with. But if we start refuting every time somebody gives us criticism, we are going to end up looking very defensive and people won't continue to bring us things that might be constructive.

So, I really urge, rather than spend the resources fighting every time someone criticizes, we listen to the criticism. We go back and take a look. Do we agree? Can we do this better? And if we can, we do it. And if we disagree, well, we don't.

Now, we just gave you answer on the record that we happen to disagree with Mr. Lochbaum on this.

Now, Mr. Lochbaum also gave us kudos for Fort Calhoun, identifying that long before Fukushima. Well, Oconee was identified long before Fukushima. Watts Bar was identified long before Fukushima. All of these events were done by our inspectors going out following our guidance, looking at these plants. So, we have been doing it for years.

So, defer -- that is one answer, sir.

CHAIRMAN MACFARLANE: Okay, Commissioner Magwood.

COMMISSIONER MAGWOOD: Thank you, Chairman. Thank you for presentations. I'm sorry Eric, I did promise to ask you about the manual actions that would be taken in the event of a flood event. And you know, David highlighted some issues there as well. I want to give you guys a chance to react to that.

MR. WILSON: I will actually answer that. If you would -- during my presentation, I talked about the issue that was identified at Watts Bar Nuclear Power Plant. That was a reasonable simulation. That is actually taking all the actions and doing them -- looking at if you have to take a piece of machinery across a field and pick up a manhole cover to put in a portable sump pump to make sure your cables go dry. Well, this time we made sure that during the procedure, when were you doing it? Well, this is flooded. How are you going to get that piece of machinery over there? If they had to perform them all, if there were four or five actions they had to perform in parallel, we evaluated them and performed them in parallel, instead of looking at them in a sequential fashion with them.

Also, in the integrated assessment, we are specifically looking at the human factors portions of doing all these manual actions. And we focused on it on the walkdowns and that is why a lot of these procedures were then found to be inadequate because they couldn't make the time because we looked at them. You have got to rig this up. You have got to pull the pump up. You have got to rig it. And we were looking at the human factors analysis. We are looking at the regional simulation and that is where a lot of these additional findings had come from.

We specifically focused in on that and added that to the guidance. So that is something we did look at.

COMMISSIONER MAGWOOD: Is it fair to say that

some of the procedures that were in place over the last several years may not have been entirely realistic and that we are catching up to some of those now. Is that a fair statement?

MR. WILSON: Yes. Yes, I don't think that we looked at it. If they said they were going to build a wall, we said oh, they are going to build a wall and here is what the wall was.

Well now when we looked at it, based on reasonable simulation, show me you can really build that wall. And that is when we found out they -- we challenged them back and they couldn't build the wall.

So, that just highlights the importance that we were focusing on that.

COMMISSIONER MAGWOOD: So, one might correctly say that in the process of reviewing safety in the aftermath of Fukushima, we have challenged licensees more aggressively with some of these procedures and we are fixing a lot of these things.

MR. SATORIUS: Yes, absolutely. And there is a whole list if you can look through the inspection reports where the fittings wouldn't be right or that the fittings wouldn't come off the pump correctly enough so that they could make the connections for piping it inside or electric connectors weren't consistent between. So, yes, there is a number of issues.

COMMISSIONER MAGWOOD: Along the same lines, I know that we had I think there were two yellow and six white

findings that came out of these reviews. So obviously, not everything and I suspect those are some of the things you are listing.

MR. SATORIUS: Well and not to mention the fact that with the ROP, even green findings have to be entered into their corrective action program and dealt with.

COMMISSIONER MAGWOOD: So, I guess the bottom line message is there were issues. We have identified them. They are being addressed now. They are being captured as part of the process. They are underway right now.

MR. WILSON: Yes, I want to highlight that it is an ever-evolving. It is a feedback loop that goes into the reactor oversight process. We are always changing it.

The actual reasonable simulation that we focused on was based on some field inspectors' experience that happened way before Fukushima. And when we were working with NEI to get that guidance developed, we said this has to be in there because of the importance in some of the findings we had in the program originally.

COMMISSIONER MAGWOOD: Okay. One last question. When we went through the exercise after the seismic event affecting the North Anna plant, the basic conclusion that we came to was that whatever the exceedance was, the margin in the plant for a variety of reasons was large enough and the inspection verified that the plant was safe, there was no damage. It was able to continue operating.

Does that kind of margin exist with our flooding analysis as well? Is there in some fashion in the defense-in-depth and the methodology we used back in the '70s, for example, is there a margin built into the system that gives us extra protection as we go forward with these analyses?

MR. LEEDS: Commissioner, I remember talking about this with the Chairman when she first came onboard. And I remember telling her that I was very, very concerned about flooding just because of that reason.

I don't believe that that margin exists in the flooding as it does for seismic. In flooding, you get to a certain level and the switch gear gets wet. You get to a certain level and you just take out equipment that you cannot recover. You have to bring in other equipment.

Where with seismic, we know pipe deflects. There is elastic and there is plastic deformation. We know that material science, from material science, you have got an ultimate yield strength and you have deformation that can occur and those pipes can still work. With electricity, it gets wet and it is over.

So for flooding, personally, for flooding it is a large concern to me. And I know that we have been very focused as an agency to make sure that these plants are prepared and can withstand that type of thing.

COMMISSIONER MAGWOOD: That is an interesting

observation. Just sort of think about that retrospectively. What happened back in the early days of the plant designs deciding that seismic ended up with that kind of margin through the standards, the regulations, a lot of other things, and flooding didn't? What was happening back then that flooding didn't get the same kind of --

DR. COOK: Part of the perspective, I think, when you look at it is as engineers, which I am, when you are faced with a design basis flood level, you are given a certain number. And a lot of people have interpreted that number as being a number that needs to be met.

In fact, you will see in some license reports there are numbers given of the design basis flood height to the tenth or hundredth of a foot. And with those kinds of numbers that are there, it is an over, I think, interpretation of the significance of that. And really realizing that in many cases these are estimates and really what need to be in there.

So, I think there has been a paradigm shift that has taken place in flooding. And I think looking at the potential for cliff edge effects and where they can go, it is definitely something that we have put into somewhat in the walkdowns, we have requested licensees look at available physical margin that was there for them to have and then to use that, if needed in the integrated assessment.

You know the integrated assessment is when your reevaluated hazard is higher. It allows you then to go in and look at

some of that margin that you have and talk about it and then talk about how you could use it for your site.

So, it is something that is certainly in there in the program. And I think certainly Fukushima raised the awareness of the cliff edge for flooding, which you probably don't have as much in seismic, which is more gradual, instead of having this edge or this cliff that you could then go off of.

MR. LEEDS: And if I can add -- thank you, Commissioner. You know, the previous panel I guess it was Mr. Vail who brought up the point embrace uncertainty. And I kind of like that. In fact, I like that a lot. And when I take a look at mitigating strategies, I think that is one of the ways that we can embrace uncertainty, to make sure that don't put a number on what the beyond design basis accident is going to be because we don't know what it is going to be. And it could be higher than what we expect.

So, I don't want to have some external regulators would say a hardened core that is designed to a number. I don't want a number. I want us to be able to mitigate any type of event. I like the mitigating strategies. That, combined with Recommendation 2.2, I have lost Commissioner Apostolakis, that we can go back on a regular basis and evaluate what the hazard is based on what we know. I think those are two very important activities that have come out of Fukushima.

COMMISSIONER MAGWOOD: And I would say that

the philosophy behind that is very close to what we have always done with emergency preparedness. You know we haven't tried to design to a specific scenario or level of disaster. We simply provide the capability to respond flexibly to a wide range of things. So, I appreciate it. Thank you very much.

CHAIRMAN MACFARLANE: Thank you. Commissioner Ostendorff.

COMMISSIONER OSTENDORFF: Thank you, Chairman. Thank you all for your presentations.

I want to start off with a comment that Commissioner Apostolakis made. And I had a chance to talk to Mr. Lochbaum at the break very briefly on this guidance being available or not. And I don't think that Mr. Lochbaum's -- I think his comment was it would have been nice to have had this guidance in place before doing the hazards walkdowns.

MR. SATORIUS: We can't disagree with that.

COMMISSIONER OSTENDORFF: Nobody can disagree. I think somebody made the comment that our resident inspectors are capable of doing common sense evaluations in a walkdown inspection of a nuclear facility and that there is a good likelihood that they may find something that sticks out, even in the absence of guidance.

And I just wanted to say I think that is a very important point. I don't think that Mr. Lochbaum was suggesting that our plants

are less safe because they did these initial inspections without any written references to go by.

I'm going to ask a big picture question of Eric and then perhaps Dave, David Skeen here.

It is so easy. You get all this information and all these different studies and reports and so forth and sometimes it is helpful to just kind of sit back and say what is the big takeaway.

And so I have a question for Eric and David and you can answer these however you want to in the order. But perhaps the question I will start out with one for David is, what is the biggest takeaway from Fukushima as far as flooding, as it applies to U.S. nuclear plants?

And the question for Eric will be, let's look strictly at Fort Calhoun. What was the biggest takeaway from a regulatory perspective, from your experience at Fort Calhoun?

You can address those or maybe combine both of those however you see fit.

MR. SKEEN: Well let me start with what do I take way from the flooding in Fukushima. It clearly is whether the Japanese didn't design their plant properly, they got hit with a flood they did not expect. So, it is the unknown. How do you deal with the unknown?

And I think I was in the op center for many hours during that event. And those operators were doing the best they could

with no guidance, basically. They were winging it. But they were doing whatever they could with the equipment available to try to cope with the event.

What I think we have done with the flooding piece and through mitigating strategies here in the U.S. is to say how do you deal with that unknown event? When that bad day comes, when the bad day happens at the plant, what tools do operators have that they can try to deal with the event that they didn't have before.

And yes, after 9/11 we had the extra pump and diesel that we had the industry put in place here in the U.S. but this is way beyond even that. I mean, if you get hit with an extreme flooding event, something that you don't expect, do you have equipment available? Do operators have tools that they can use to deal with an event on that bad day when it can be a flood or a seismic event, whatever it might be, that they didn't have before? So, I think we are addressing it in that way.

The only other thing I would say is by going back and reevaluating what is the right flood that I should be concerned about because, clearly, the Japanese, again, got hit with something they didn't think they were going to get hit with a flood of that height. So, we need to go back as we are doing with the reassessments to say, what have we learned with all of the new information, the new methods we have? Are we protected against the flood that we think we are going to see? And then do I have the extra equipment in place

because of the mitigating strategies that says even if I get hit with a flood that I don't expect, I have some way to deal with the event.

So, that is what I would say is the biggest lesson I have.

COMMISSIONER OSTENDORFF: Thank you. Eric?

MR. LEEDS: Commissioner, you were asking me to really focus on Fort Calhoun.

COMMISSIONER OSTENDORFF: Please feel free to talk about it.

MR. LEEDS: Well, I agree with Dave. I thought Dave's was very well stated and he didn't have a chance to think about it, like I did before I got started. So, good job, Dave.

But Fort Calhoun, what struck me about Fort Calhoun and the flooding at Fort Calhoun is -- going into this, I am an engineer. And I think like an engineer. I was trained like an engineer. And I thought flooding was pretty straightforward. Flooding is easy. It gets up to a certain level and you have got a problem. I had no idea how complex flooding really is and how many players are involved in flooding with regard to the federal family. Because we are the Nuclear Regulatory Agency. We are not the Dam Regulatory Commission. We have to deal -- well, some people might think of us.

COMMISSIONER OSTENDORFF: Is that a three-letter or a four-letter word?

(Laughter.)

MR. LEEDS: That didn't come out right.

(Laughter.)

COMMISSIONER OSTENDORFF: We understood.

MR. LEEDS: You know we work with the federal family. We work with FERC and with the Army Corps and Bureau of Reclamation, and all of the others to get involved. And even with working with all of these folks, how do you get to a number? And not everybody is going to agree to a number and we are not going to get to a number that everybody might agree with. And then the NRC, as I think it was Dr. Cook in his presentation, we want to go beyond what the other agencies do because we can't leave that site. We can't have those operators leave the site. We can't desert that site.

So, we are putting them at an even higher number, more conservatisms. And to try to get all these different disparate entities to agree on a number, let alone all the staff to agree on a number, the complexity, the amount of resources, the amount of time. George headed up an effort to do a LIC 504, that is an evaluation, a safety evaluation of the flood height at Fort Calhoun. They had a document this thick of everybody working that hard on coming up with an answer.

It is very, very challenging. It is very important. I hope to see everything continue to evolve so that it gets easier for us, so that we can get through these evaluations.

But Fort Calhoun was tough. I think we got to a good

number for that plant.

COMMISSIONER OSTENDORFF: Was there a tech assist here?

MR. FLANDERS: Hi, this is Scott Flanders, Director of the Division of Site Safety and Environmental Analysis in the Office of the NRO.

I just wanted to provide a little bit of clarification on the issue of whether or not guidance preceded the walkdowns or not. I think it is important to understand and you look at the time line that Mr. Lochbaum provided, they are talking about two different activities. As it relates to the 2.3 walkdowns, guidance was issued and developed prior to the 2.3 walkdowns associated with the Recommendation 2 activities. And that is where we talked about the guidance or reasonable simulation of other activities.

If you look at the time line, it was a walkdown in March of 2011, which is right after the event at Fukushima, which was focused on temporary instruction that said go and look at your current flood protection features and ensure that you have them in place and that you are paying attention to them as a result of the Fukushima event that happened just earlier in the month in March of 2011.

So, it is important to make sure that we are talking about whether the guidance was before what it was intended for versus a walkdown that preceded it for which the guidance was not intended for.

COMMISSIONER OSTENDORFF: Just I want to make sure -- and I think what Mr. Satorius is going to say or did say was that the earlier walkdown using the TI paperwork provided sufficient tools for the resident inspectors to provide a meaningful --

MR. SATORIUS: I was still in Region 3 at that time. And we were asking questions what do we use for a procedure? Use your adverse weather procedure. Just take a look at this. There are paragraphs that can be interpreted in a manner that will get you out there within a week or two to make sure we don't have something that was going to burn down the house. And so that is what we used. We used a procedure that we already had in place.

DR. COOK: If I can follow up. You know I was definitely involved in the later guidance that was developed. And the question that I kept on being asked was why do you have to do this new walkdown when you already did a walkdown right after the event. So, a lot of people were asking me that.

And that is why that other walkdown guidance that George was talking about has a reasonable simulation. It has a lot more into it. It is very different than what was done immediately after the event, which leads into Temporary Instruction 183 versus then the walkdown that was done as part of Recommendation 2.3. So you had the licensee submittal. You then had our review and then you had TI-187 that came out with that and checked against that walkdown.

So, they are very different. There were two different,

certainly, inspections for the agency as well.

COMMISSIONER OSTENDORFF: Thank you all. And that clarification was very helpful.

Thank you, Chairman.

CHAIRMAN MACFARLANE: Okay, thank you. So, a couple of questions. The first one is for Mr. Ott. I note that in one of your slides you said that sea level rise data are mature enough to include in analyses. And so I am just curious, based on the slide that Mr. Vail showed about sea level rise projections, that slide, if I read it correctly, suggested a potential increase of, and I am I going to put this in feet because we are the NRC, unfortunately, of 0.7 to two feet in 40 years.

So, what do we do with that information?

DR. OTT: Well, basically Chris' people and the people at the licensee will have to take into account for a given site what all of the particular conditions are that may contribute to sea level rise.

Classically, for years we have been worried about things like glacial rebound and how that affects things like sea level.

Sea level rise is not a constant.

CHAIRMAN MACFARLANE: Glacial rebound and sea level goes the other way. Well, I guess for intake water it might be an issue.

DR. OTT: Right. Basically, you have to consider all

of the factors that may be relevant at a particular site. And in particular, the work that we did with the Corps of Engineers on the storm surge has a particular term in it that is an added term at this particular time for sea level rise.

The storm surge calculation itself, then, has to include things like what is the new bathymetry. Because if you have got sea level rise, you have also got the sea shore going back. And the bathymetry changes, you have to worry about central pressures in the hurricane and there are a number of factors that come into the calculation. It is just not a simple --

CHAIRMAN MACFARLANE: But this we account for this and project out, in terms of decades, multiple decades.

DR. OTT: Yes, there will be agencies that are looking at sea level rise and we will keep track of what they are doing in terms of say Cape Cod or New York or down in Florida and we will make certain that the latest information is fed into the licensing process.

DR. COOK: If I may follow up, in the -- as part of the JLD, I mentioned that we had several new guidance documents that were there. And one of them was on tsunami and storm surge. And in that document, we went ahead and we talked about sea level and the process that staff should be using in doing the reviews. And what we emphasized in there is that the staff should not only look at just sea level rise itself, but also the vertical land motion that is going on. Because, in addition to glacial rebound, you also have subsidence that

is going on.

And so what we do, in keeping in line with GDC-2, which is looking at historical data is that there are number of tide gauges out there that our colleagues at NOAA, the National Oceanic and Atmospheric Administration have put together. And you have nearby tide gauge stations that are there that allow you to have generally on the order of 30 years, if not more, of record, we are able to see the record of that tide gauge, understand the vertical land motion that goes on, as well as the sea level rise. And then from there, project out for the life of the plant.

CHAIRMAN MACFARLANE: I guess my point is that the sea level rise projecting out is highly dependent probably on climate change, right, and loss of Greenland ice sheet and potentially Antarctic ice sheet. So, those are sort of major game changers.

But you know, 40 years out, that may be an issue. At least, start to be an issue anyway.

DR. COOK: To be honest, Chairman, I mean that is one of the reasons why I think it is important for us to use the best state of the science that we have now to sort of look at that and prognosticate out. But we also don't want to go so far as you take the worst one and the best one and then you average them. I mean, we can't do something like that either.

So, we have to base it on something. We base it on historical data. It is also a good reason, periodically, to maybe come

back and review this say 50 years from now if we know something more. But right now, that is currently how we do it and that is what the guidance document is showing. And that is what we are standing upon is the best information to use right now.

CHAIRMAN MACFARLANE: Again, I would advocate not using historical data for everything, especially when you get into more geologic issues. You really have to understand beyond our total blip on the earth, --

DR. COOK: True.

CHAIRMAN MACFARLANE: -- which really is irrelevant in many ways.

Okay, back to walkdowns because I know you missed this topic so much. So, the Fukushima-mandated walkdowns actually identified a number of issues. Right? And the number of deficiency use was relatively high.

So, does that mean that we are actually, maybe we should change our current baseline inspection effort?

MR. WILSON: One of the actions that I have actually took upon myself is that I will be taking and gathering all the lessons learned from the seismic and flooding hazard reevaluations and incorporating a key lessons learned working through the Division of Inspection and Regional Support and working with the regions and looking if we would see if we have to change any of the inspection procedures to incorporate those lessons learned.

So, that is something that I am going to be doing with DIRS.

CHAIRMAN MACFARLANE: Good. Good, okay. And interim staff guidance documents, again, but different ones, not on walkdowns, on flooding hazard evaluation.

Okay, so let me see if I got the dates right there.

First of all, we binned the plants for their flooding hazard reevaluation into three categories. Category 1 plants, their flooding hazard reevaluations were due last March, March 2013; Category 2, March 2014; Category 3, March 2015.

The guidance documents went out, guidance for performing a tsunami surge or seiche hazard assessment was issued January 4, 2013.

And the guidance for assessment of flooding hazards due to dam failure was issued July 29, 2013. So, slightly before and then long after the March deadline.

So, does that mean that the reports that we get in from the plants will be variable? And will we really be able to assess them properly if they don't include what they should have done?

DR. COOK: To begin with that, the categorization that was put together, the Category 1, 2, and 3 that you referenced, was there. There was a thought process that went through. There was a letter that Mr. Leeds issued regarding that. Generally, the first year categories were sites that already had an early site permit or a

combined license that was going on.

CHAIRMAN MACFARLANE: Uh-huh.

DR. COOK: The year two ones, if you look at them, are mainly the inland ones. A lot of them have dams that are there. Year three, are mainly the coastal sites.

CHAIRMAN MACFARLANE: Right. Right but even those ones in Category 1, some of them like Salem, Hope Creek, they requested an extension because the guidance wasn't out.

DR. COOK: The guidance allowed them to -- and I think we put together a more methodical process that was there that was describing it but if you look at what was done already for PSEG, which is the early site permit site that is close by Salem and Hope Creek, those methods would have been acceptable.

What is put together in that guidance is more able to describe various components that are there that may prevent requests for additional information or other things that would be in there.

For dams, we needed the additional time to go through to work with our federal partners to make sure that we had a methodology worked out that was in place that everyone could agree to that we could all talk about that would be in there.

CHAIRMAN MACFARLANE: I understand that kind of delay.

DR. COOK: Okay.

CHAIRMAN MACFARLANE: But still, it does get to

this cart before the horse issue a little bit for the licensees.

MR. LEEDS: Certainly, Chairman, it would have been ideal if everything had been out years in advance. And unfortunately, that wasn't the case. You know, I think the staff worked very hard to put out the best guidance we could get out and where half of the licensees -- a number of the licensees were able to get it done in the time period. If you needed relief, we gave them relief and we expect high-quality products from them. And we will go follow up on it. And hopefully the next batch we won't have any that need extensions because we have it out longer now.

CHAIRMAN MACFARLANE: Scott, you want to weigh in?

MR. FLANDERS: Yes, if I could add just a couple of thoughts.

First, if we talk about the guidance, the IT associated with storm surge, that guidance document was really focused on incorporated lessons learned from the new reactor reviews, as well as, as Dr. Ott talked about, work that we had done, we had done through the Corps of Engineers developing joint probabilistic method for calculating the storm surge, which was a report that was issued in 2012 and was actually used by a new reactor licensee as a part of the review process.

And so this was that IFG was a formal endorsement of using that methodology. But in many meetings early on when we

first started to engage in industry, we pointed to that methodology and that approach and said it was an acceptable approach to use.

So, anyone who wanted to use that approach would have known early on in the process that that was an opportunity to use. So, I don't think the fact that the guidance document for surge came out later really would have handicapped anyone in terms of completing the year one plant surge assessments.

CHAIRMAN MACFARLANE: Okay.

MR. FLANDERS: As for dam failure, that was a more complex issue in terms of coordinating with the federal family. But even there, there was guidance in terms of what you fundamentally needed to do. It was really getting access to the information which helped drive that issue.

CHAIRMAN MACFARLANE: Okay, thank you. Commissioner Svinicki?

COMMISSIONER SVINICKI: Well, I want to talk about guidance and walkdowns because there would be great disappointment if I didn't.

I just want to say although a popular wager in this room might be that Mr. Lochbaum and I wouldn't agree on a whole heck of a lot, I was glad that he brought up this specific instance of guidance not being available, not because it is something that is a fatal error to getting things done but it is a barrier to efficiency. And I think Eric and others on the other side of the table, if they were being

honest, would admit I have been somewhat of a broken record. And Eric is raising his hand that he would admit that.

And it has to do somewhat -- you know it is a very fair thing that David mentions. But when we hear it from the regulated community, it is not efficient for them. But my principle interest in it is that when we don't have guidance available, it is the same thing in rulemaking, in a perfect world we have draft guidance ready to go with a proposed rule and final with final.

And I think actually in my many years here, we have actually been improving on that since when I came and I really want to acknowledge that and credit the staff with that. But it is also that we don't have the resources to be doing things over again.

The other point that I wanted to make about the flooding walkdowns specifically, and I don't think anyone has referred to this, but INPO, you know U.S. plants is a self-regulating organization, INPO acted, I think, even before NRC initially acted on walkdowns. So, they self-imposed on all U.S. plants a series of walkdowns.

So, it was actually compounded for the facilities themselves. But in the first instance, it had nothing to do with NRC at all. It was something that they imposed upon themselves and they all reported back to INPO as a performance improvement organization.

So, I wanted to make that point. But again, David is raising it. It is fair. He didn't point it out like it was some fatal thing.

So I think in terms of what Eric said about sometimes we take self-criticism and we go, you know well, that is fair. We are trying. We will do better on that one. But it was, to my mind, he could have gotten a bit of an hallelujah chorus from the side of the table, just because I like to not have to be the person always mentioning that. So, it was nice that it was Mr. Lochbaum in this instance.

So, that is all I will say about that topic.

I will now put Chris a little bit on the spot and I think Eric, although he was more evasive about it, I think you are the two proponents of ten-year periodic safety reviews. Did you not say that you also? Chris was very direct. You were a bit --

MR. LEEDS: I was answering and I would have -- I agree but disagree with -- this is 2.2, Commissioner. He is looking at me.

This is the issue of the ten-year reviews.

COMMISSIONER SVINICKI: Let me ask my question to any proponent of ten-year periodic safety reviews. May I ask? So, I will direct it to Chris, since he is willing to own that he said this?

I would just ask then, under that framework, how would you propose that NRC handle something like let's say USGS updates something that is important to safety evaluations that our licensees do or we heard from our colleagues at NOAA and the Corps that they are on different schedules, depending on funding, they get to update various things that they have, what would you propose?

Would you propose that we wait until the next ten-year to take something into account that may have some sort of important safety significance for us?

DR. COOK: I guess I am going to go out on a limb here. Okay, my personal opinion, that would be someone who has looked at this. And my Ph.D. is in hydrology in this technical area. And I do see this continuing to evolve. And I will firmly admit when I finished my Ph.D., I didn't feel like I had all the answers. And I think it is going to continue to evolve as the state of the science evolves.

And I think if we were to push some of the experts that were here on this other panel for looking at the return periods that we typically talk about, and we talk about the uncertainty that is there, they would have a difficult time answering some of those questions. I hope that isn't the case when I finish my career and I hope we make progress.

So the periodic updates I think is important. The ten-year framework to me is not so much. In fact, in my talking points I even said periodic updates and I didn't mention the ten years.

Personally I think that what we need to do as we go through the rulemaking and we look at what the change would happen, we need to learn from Recommendation 2.1. And I am very much a proponent of what management is doing, which is where they are saying that what we need to do is we need to finish Recommendation 2.1, the current hazard reevaluations and look at it.

Because not all new information is significant. So we have to find some way for that new information, understand that it is significant and that we want to act on it.

COMMISSIONER SVINICKI: Well and so that is what -- and again, I appreciate the boldness with which you took a position on that in the moment.

What I would ask you to think about, though, as we proceed through what you just described, is what does a safety authority regulator do when they need to -- they really cannot say I am just going to put that on the shelf for eight years or three years or whatever it is. They really just can't do that because of the mission they have.

So, if they are going to say and, again, since I have come to NRC I testified before our Congressional Oversight Committees many times to the fact that we keep a constant eye on the state of knowledge and we incorporate things if they have the safety significance, if they go through our regulatory analysis process, and we can get to the point where we need to take regulatory action, we do that and we don't wait for some artificial time frame. So, that has been the way that we have explained this framework that we have.

So, to go to a ten-year relicensing or periodic review or other things, I see that as a very, very foundational difference. It is not some small matter of the frequency, changing the frequency with which we do something. It is a change in philosophy.

And so, I think that is something that we are going to need to think about as the staff prepares its evaluation of that particular recommendation of the Near-Term Task Force.

And on that point, you know, very important in having truth to the statement that we are keeping a weather eye, I guess that is a bad pun in this particular topic, but that we are keeping our experts knowledgeable of the cutting edge of science, a lot of which is not our core mission space. One thing that is very important in that is their participation in writing papers, in being published, and going to scientific conferences. I have to say that over the last 12 months specifically, I am hearing more and more from the officials or executive directors of professional societies and other groups that our budget cutting is becoming very evident in terms of our staff being allowed to develop papers, publish them, go to conferences.

I am hearing this much, you know, the government has always had to be careful with its resources but I am hearing it a lot more in a lot of different places. So, I would ask Eric, is that something you are hearing and is it something as kind of a leader of NRR, you are struggling with that a little bit?

MR. LEEDS: I believe it is true, Commissioner. And I know that when we are looking at our budget, we are looking at travel and attendance at conferences very strongly, overseas work, we are really scrubbing those budgets and taking a look at the lists. I coordinate with the other office directors and Brian Sheron and I talk

on the phone. Okay, how many folks are you going to send to this conference? Can we get away with just one? Do we have to send two? Does it have to be one from each of our offices? Get the most we can out of it and sending the least amount of people because our travel funds have been cut.

You know, can we -- we used to be able to go after some training funds but those have been cut. So, it is a big concern to us.

COMMISSIONER SVINICKI: Well, and I mention it in the context of what we are talking about today because I think it is, unfortunately, often viewed as just something that is career enhancing for the staff person. But to me, it is one of the prongs that gives truth to our statement that we are staying on really the cutting edge of knowledge on these important things that are a part of what we do in nuclear safety but maybe not core to it like they are for some of the federal family that we had here today.

So, I think at some point you could see enough erosion in that that you are going to have to begin to question a little bit whether or not we do get our experts to the right meeting. So, I think it has to be a mission priority, not just a career developmental priority.

So, I appreciate that you and your peers are discussing that. The one other topic I wanted to raise was the development of the Probabilistic Flood Hazard Assessment Research

Program Plan. The plan is under development right now. As we go through that, I think one of the things that we have suffered from a little bit as an agency is when some of our research initiatives don't define either milestones along the way where we could be at a stopping point where we might evaluate what we are going to do with what we have learned in a regulatory response sense.

And then sometimes we don't have kind of where is the ending point and what were we trying -- where were we trying to get when we set out on this, so that sometimes some of our research has become kind of a -- Chairman Klein was Chairman of the NRC when I started here and he used to call them self-licking ice cream cones. But what he meant was that we didn't have a good sense of where we wanted to get to and what were the points along the way where we might stop and say is this still the objective that we set out to achieve.

So, you know, you were nodding your head, Mr. Ott, a little bit. So, I think that you are taking that into account as you develop that plan. But I just wanted to say that I know it is something we struggled with occasionally. If you want to make any comment, please do so.

DR. OTT: It is something we are concerned about. The next stage of Reg Guide 1.59 would be a probabilistic version. And we are looking at planning that for about five years from now, in terms of a first draft. So, we have to make progress on that plan, in

terms of getting products and deliverables out in the three- to five-year time frame because it is going to take us about a year to put it into regulatory guide format and get it out on the street.

So, we are thinking in that direction. Whether it is going to happen or not, I don't know. But that is our goal.

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

CHAIRMAN MACFARLANE: Thank you. Additional questions?

COMMISSIONER APOSTOLAKIS: A comment. Eric said that they didn't want to respond to every little criticism because the staff would be perceived as defensive. I think it is a good idea also how the staff will be perceived when it is silent.

You have to use your judgment. You don't have to respond to every little thing. But when Mr. Lochbaum uses three or four slides with the heading cart in front of the horse, you have to say something. And I think after I asked you, many good things were said. Because remember now, there are people who are watching us. There is a record. You know, if you are silent, that means that you have nothing to say and that he is right.

So, it is a matter of balancing, a balancing act. I agree, you don't want to respond to every little criticism but some things deserve a response. Thank you.

CHAIRMAN MACFARLANE: Okay, anybody else?

No? All right.

Well, with that, we are concluding the discussion this afternoon. I thank the staff for their presentations and for their vigorous discussion. And I thank the external panel for their presentations and their vigorous discussion.

And because this was about weather, please stay warm tomorrow. It is going to be a little cold; not extreme, but cold.

Adjourned.

(Whereupon, at 5:06 p.m., the foregoing meeting was adjourned.)