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

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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630TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THURSDAY,

DECEMBER 3, 2015

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., John W. Stetkar, Chairman, presiding.

COMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

DENNIS C. BLEY, Vice Chairman

RONALD G. BALLINGER, Member

SANJOY BANERJEE, Member

CHARLES H. BROWN, JR., Member

MICHAEL L. CORRADINI, Member

DANA A. POWERS, Member

HAROLD B. RAY, Member

JOY REMPE, Member
PETER RICCARDELLA, Member
STEPHEN P. SCHULTZ, Member
GORDON R. SKILLMAN, Member

DESIGNATED FEDERAL OFFICIAL:
CHRISTOPHER BROWN

ALSO PRESENT:
MICHELLE BALES, NRR
DANIEL BARSS, NSIR
JANA BERGMAN, CURTISS-WRIGHT
ALYSIA BONE, NRR
LARRY BURKHART, NRO
QUINTANA LUISS CANDELARIO, NRO
JASON CASTRO, TVA
GORDON CLEFTON, NEI
PAUL CLIFFORD, NRR
MANNY COMAR, NRO
THOMAS EICHENBERG, TVA
KEN ERWIN, NRO
CHRIS FALLON, Duke Energy
KURT FLAIG, Dominion Virginia Power
ROBERT FLORIAN, Southern Nuclear
C.J. FONG, NRR

THOMAS GALLETTA, NRO
STEPHEN GEIER, NEI
LISA GERKEN, AREVA
JOSEPH GIACINTO, NRO
DONNA GILMORE, Public Participant*
MICHAEL GRAY, Lettis Consultants International
PHILLIP GRISSOM, SNC
DONALD HABIB, NRO
EDWIN M. HACKETT, Executive Director, ACRS
PETER HEARN, NRO
RAUL HERNANDEZ, NRO
JERALD HOLM, AREVA
BRIAN HUGHES, NRO
TARA INVERSO, NRR
BECKY KARAS, NRO
ROBERT KITCHEN, Duke Energy
ANDREA KOCK, NRO
STEVEN LAUR, NRR
MARVIN LEWIS, Public Participant*
BILL MAHER, FPL
JOHN McCONAGHY, Duke Energy
TIMOTHY McGINTY, NRR
JOHN McKIRGAN, NRO
SEUNG MIN, ACRS
DAVID MITCHELL, Westinghouse

GEARY MIZUNO, OGC
MITCH NISSLEY, Westinghouse
PRAVIN PATEL, NRO
KEVIN QUINLAN, NRO
DEVENDER REDDY, NRO
ALISON RIVERA, NSIR
ROBERT ROCHE-RIVERA, NRO
MARCOS ROLON, NRC
LISA SCHLEICHER, NRO
JOHN SEGALA, NRO
CRAIG SELLERS, Exelon
ANTHONY SICARI, Westinghouse
STEVEN SMITH, NRR
GERRY STIREWALT, NRO
ANGELO STUBBS, NRO
LARRY TAYLOR, Duke Energy
VAUGHN THOMAS, NRO
KENNETH THOMAS, NSIR
JIM THORNTON, Duke Energy
JOHN THRASHER, Duke Energy
LEE TUNON-SANJUR, Westinghouse
MARIELIZ VERA, NRO
JASON WHITE, NRO
WEIJUN WONG, NRO

*Present via telephone

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

(8:32 a.m.)

CHAIRMAN STETKAR: The meeting will now come to order.

This is the first day of the 630th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following: 10 CFR 50.46c rulemaking activities, discussion of potential Commission meeting topics, LEE combined license application review, and preparation of ACRS reports.

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

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

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

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

And I'll remind everyone to check and please silence all of your little communication devices.

I also want to make folks aware that this meeting is being webcast, and the ability -- with the ability to view our presentation slides on the web. Those of you out there on the bridge line who may want to do that can connect through the NRC's public meeting website at http://video, that's V-I-D-E-O, dot nrc.gov, G-O-V, and click on the link for today's meeting.

I have also been told that the audio out there is better than that over the phone, so you may want to try that. If for some reason it doesn't work, because this indeed is a government operation, please call our office and we will try to get you connected somehow.

I have a couple of items of interest before we begin. First of all, we are saddened to learn of the death of Dr. Paul Schumann. Dr. Schumann was a member of the ACRS for 17 years, from 1977 through 1993, and served as ACRS Chairman in 1982 and

1993. He was an internationally recognized expert on metallurgy and materials science, a fellow of the American Society of Metals, and was elected to the National Academy of Engineering in 1979.

We gratefully honor his contributions to materials science and engineering and his dedication to nuclear safety regulation.

Second, Dr. Stephen Schultz is retiring from the ACRS, and this is his last meeting as a member of the Committee. Steve's leadership as Chairman of our Fukushima Subcommittee has been nothing short of heroic. By my count, he has provided lead contributions to at least 11 ACRS letters during this three and a half years as Subcommittee Chair. His technical insights, wisdom, and collegiality will be greatly missed.

I am also very happy to note that Steve has graciously agreed to continue as a consultant to the Committee, so we will have an opportunity to extend his suffering for a bit longer, but unfortunately on more of his own terms.

Steve, thanks. Thanks a lot for your service. We very much appreciate it.

(Applause.)

MEMBER SCHULTZ: Thank you, John. It has

been a distinct privilege and a pleasure to work with all of the members of the Committee.

Thank you.

CHAIRMAN STETKAR: With that, unless -- do any of the members have any other comments? If not, we will continue with the first item on our agenda, 10 CFR 50.46c rulemaking, and Ron Ballinger will lead us through that. Ron?

MEMBER BALLINGER: Thank you, Mr. Chairman. On November 3rd, our --

CHAIRMAN STETKAR: Turn your microphone. You can try to train them, but they just don't take.

(Laughter.)

MEMBER BALLINGER: Again, on November 3rd, our Metallurgy and Reactor Fuels Subcommittee reviewed 10 CFR 50.46 rulemaking activities, which would include the rule plus reg guides associated with that rule. During our meeting, NRC staff presented the new requirements for fuel cladding performance under loss of coolant accident conditions.

In the meeting, we also discussed the associated regulatory guides that have been developed to support this. In addition, the staff briefed us on the requirements and guidance for a risk-informed alternative to address the effects of debris on long-term cooling.

The meeting further discussed ongoing research activities regarding fuel fragmentation relocation and dispersal during a loss of coolant accident. During the meeting, industry representatives had an opportunity to present their views and comments on these requirements and associated guidance.

At the end of the November 3rd meeting, our Subcommittee recommended that these rulemaking activities be presented to the full Committee for deliberation. Since 2002, the staff has presented this topic to the full Committee several times -- and "several" is putting it lightly -- as the rulemaking efforts have progressed. Today we hear presentations from the NRC staff and industry representatives on this rulemaking.

I would like to add, and I believe I speak for the entire Subcommittee, that we have seen a great example of the staff and licensees working hard and successfully to close gaps between them to come up with a very workable rule and associated guidance. It has been a very long path since 2002, and I was commenting to Paul that where I come from the prime directive is "Don't kill the job." And so I was wondering what he is going to do after spending so much time on this process.

Anyway, I believe Tim McGinty will introduce the staff presenters.

MR. McGINTY: Thank you, Dr. Ballinger.

Good morning, and thank you for the opportunity to brief you today. I am Tim McGinty, the Director of the Division of Safety Systems in the Office of Nuclear Reactor Regulation.

The purpose of today's meeting is to provide you an overview of the 10 CFR 50.46c draft final rule and an update on the staff's progress. Later on the agenda, time is allotted to hear the perspectives on 50.46c from various external stakeholders, including the nuclear industry.

The staff has had the opportunity to brief the ACRS several times since the rulemaking effort began. I can't agree more with Dr. Ballinger's comments. He effectively has reflected some of mine. Since 50.46c was published for comment in March of last year, the staff has been working diligently on this draft final rule, having several meetings with stakeholders. The staff is on track to provide the draft final rule to the Commission for vote in February of 2016.

The staff and the Steering Committee believe this rule strikes the appropriate balance of ensuring safety and monitoring capability, while being mindful of the imposed burden. You will hear concerns from industry, including reporting requirements and the desire for the rule to be open-ended. Again, I reiterate the staff heard and considered these aspects along the way.

We look forward to briefing you today, as this rulemaking reaches its final stages. And we also look forward to your letter report on this draft final rule.

I'd like to introduce the staff presenters at the table today -- Paul Clifford from the Office of Nuclear Reactor Regulation, the Division of Safety Systems; and Michelle Bales --

(Laughter.)

Just has to make an entrance. That's all --

MEMBER POWERS: Just in time.

MR. McGINTY: And later we will hear from Steve Laur.

One final note, I did want to recognize -- but many of you have become -- have come to know and appreciate Alysia Bone's diligent efforts on this rulemaking over a long period of time. On Monday, she is departing for France for a new position with the ASN in France. Hopefully, Monday, provided there is no visa issues. And I wanted to express our congratulations and thanks for all of your efforts on this for such a long period of time.

With that said, I will turn it over to Paul. We look forward to hearing your feedback.

MR. CLIFFORD: Good morning. Well, it's been a long road, but I think there is some light at the end of this tunnel. With that, I will get started.

Okay. Today we will be talking -- well, first, I will introduce this 50.46 flowchart. It provides a lot of useful information. It kind of gives you some background on the research findings, shows you some past decisions, and really shows how we got to where we are today.

It also will describe why rulemaking is the most effective, efficient, and predictable approach for implementing new research when it becomes available.

Then I will be summarizing the major changes to 50.46c relative to the existing regulation of 50.46. Then, we will be describing some of the major public comments that were received, and how we disposition them, and describing changes in the final rule relative to the proposed package, and then we will finish with some conclusions.

I passed out a relatively large piece of paper here to the members at the table, which provides this flowchart. Sorry for the fact that it's relatively small on the screen itself. But I'll be walking through it. There we go.

So, to be dramatic, this rulemaking dates back -- well, at least the research, which is the underlying foundation of the research, dates back to prior to the turn of the century. Spent over 15 years and at a cost of over $15 million to the NRC to conduct this high burnup research program.

With respect to fuel performance under LOCA conditions, the research identified three significant new degradation mechanisms which are not included in the existing regulation, and that is up here in the first block.

In 2008, the staff published RIL-0801, which was the Office of Regulatory Research, along with accompanying NUREG/CR-6967, which details the work that was done at Argonne National Labs. In addition to Argonne, there was also work done at

Studsvik Labs and also the Halden Research Reactor.

The three new degradation mechanisms with respect to LOCA performance are hydrogen-enhanced beta layer embrittlement, which has to do to accelerated embrittlement due to the presence of hydrogen, which has accrued as a result of normal water site corrosion.

There is a burnup-related phenomenon, which is titled "cladding ID oxygen ingress," which also accelerates the rate of embrittlement of cladding under high temperature steam conditions. And, finally, there is a fabrication-related parameter referred to as breakaway oxidation.

Now, when faced with new research findings and new degradation mechanisms, the first thing the staff sought was stakeholder interaction. So, in 2009, we published an Advanced Notice of Proposed Rulemaking, an ANPR, to seek that sort of interaction with not only the public and the industry but also international counterparts from the research side and the regulatory side.

Specifically, we sought either validation or opposition to the research findings to ensure that what we are working with was beyond question. And, second, we requested comment on proposed performance-based regulations -- in other words, how best to incorporate the research findings into new regulatory requirements.

With that information, we are faced with our first decision point, and that is shown in this diamond. Are existing regulations adequate to protect safety? To answer this question, we used the -- not only the research findings, but also the response to the ANPR, and the question really is, in other words, do the existing prescriptive analytical limits in 50.46, the 17 percent, 2,200, in combination with the existing analytical requirements for an evaluation model, do they always ensure adequate protection?

If the answer is yes, then no further action is required. However, based upon the evidence, the NRC concluded that the existing regulations do not always ensure adequate protection.

So given that decision, we then move on to another very important decision. And the answer to this next question really determines the speed at which regulatory action is taken, not whether regulatory action is necessary or not. If an imminent safety concern exists, then the NRC would have proceeded to the left here towards either orders or direct final rules, and it would have been a rapid implementation of new requirements.

If the answer is no, no imminent safety concern exists, then the -- we would follow the preferred path, which is rulemaking.

Now, to help address this question of imminent safety, there was a safety assessment performed, which is identified in this green block here in 2011. First, the industry voluntarily provided a generic safety margin assessment through the PWR Owners Group and the BWR Owners Group.

However, that safety assessment represents a snapshot in time, and it's not maintained. The staff expanded that safety assessment right here with a plant-specific documentation of individual plant safety, and we maintain an annual update to that. However, the safety assessment provided by the staff is really an inference of safety. It's not an assurance of safety.

And the reason it's not an assurance of safety is because the safety margins are not being tracked by the licensees. They are not controlled by tech specs or core operating limits, and they are not even documented in the plant licensing basis documents, the FSAR.

In addition, the analytical credits which are used by several of the plants to show positive safety margin are not necessarily based upon approved models.

Armed with the safety assessment, the staff determined that there was no imminent safety concern. So we followed our preferred path of rulemaking, which is down at our next decision tree.

Now, there were several options available to implement the new research. As I mentioned, rulemaking is preferred because there are many benefits associated with rulemaking. First of all, there is substantial stakeholder interaction. We will be talking about that interaction later on with respect to the public comment periods, the comments received, and how we disposition those through a combination of workshops and webinars.

But, also, rulemaking allows you to provide clearly defined performance objectives and to specify analytical limits and analytical requirements, and also the opportunity to not only generate guidance to show how the new research would be implemented, but also allows you to interact with the stakeholders with respect to the best implementation approach.

The negotiations are very important, and we will be getting on to those, but one takeaway is we worked with the industry, we essentially adopted the industry proposal for implementation, and that is based around a seven-year flexible schedule for the fleet, existing fleet.

In addition, rulemaking provides a level of protection because you are in a process, a defined process, and that provides a level of protection against intervenors and staff inquiries.

And, finally, a prolonged implementation plan and rulemaking encourages improvements, both analytical improvements and physical improvements. Rulemaking encourages plants to migrate from -- I should say migrate to a better-performing advanced alloy to provide physical margin.

Now, going back to this decision, this last decision right here, if you read the regulatory analysis, you will see we described alternatives, because the part of the process we have with the regulatory analysis is this is the most effective and efficient means to perform this function. In other words, is there another option relative to rulemaking?

And so the regulatory analysis looks at other options. The first would have been a safe harbor. Now, there are burnup-related phenomena and corrosion-related phenomena that are not included in the rule right now. So one approach would be to define a limited operating space where these burnup phenomena don't come into play, and these corrosion-related phenomena don't come into play.

In other words, if you stayed within this box, the existing regulation would still provide adequate protection, and no further action would be necessary other than defining the box and then implementing this restriction on operation via text spec or operational restrictions.

We looked into that briefly, and it turns out that the increase in fuel costs would be dramatic. And, as a result, the safe harbor approach is not economically viable. Another approach would be on a case-by-case basis, and this would essentially involve orders --

MEMBER SKILLMAN: Paul, just a second here. "Not economically viable." Based on whose measuring stick?

MR. CLIFFORD: Based on my measuring stick.

MEMBER SKILLMAN: Was that vetted by industry?

MR. CLIFFORD: Nope.

MEMBER SKILLMAN: Can you give an example because -- maybe that will help.

MR. CLIFFORD: Okay. For instance, so there's a new burnup-related phenomena. That's cladding ID oxidation, which significantly reduces the time to embrittlement. That occurs at medium to high burnup, and it depends on rod design and it depends on rod design operation. But that could occur as early as, say, 35, 40, 45 gigawatt days.

So if you were to define a safe harbor, you would say that as long as you stayed below 35 or 40 or 45 gigawatt days, you wouldn't have to do anything. You wouldn't have to evaluate this, because this phenomena isn't there.

MEMBER SKILLMAN: I understand now. Okay.

MR. CLIFFORD: And if you just look at that example, that would be crippling from a fuel cost perspective. So it was just obvious that it was not economically viable.

MEMBER SKILLMAN: Thank you, Paul.

MR. CLIFFORD: So a case-by-case basis would involve potentially orders, and it would essentially be, "Here is NUREG-6967. Here is the new research findings. Industry, you need to account for these."

And what that does is it places the burden on the applicant, on the licensee, for defining all of the performance objectives and the analytical limits and the requirements that are currently in the rule. And, of course, there would be a tremendous amount of regulatory uncertainty and unpredictability with respect to individual plants and how they would each address the new research requirements, or research findings, I should say.

And this approach, this ad hoc approach, would be difficult to manage, it would be unpredictable. I think, overall, the scope of implementing using this approach would be roughly the same. You'd still need to update your models, and you'd still need to exercise your models. You'd still need to document it and submit it for NRC approval. So the scope relative to a regimented, well-laid-out rulemaking is roughly the same, but you don't get some of the benefits of rulemaking.

And, also, it would essentially discourage improvements, and I say that because you would develop some sort of triggering mechanism. Well, when this happens, then you need to redo your analysis, so you need to show compliance with the new requirements. So there would be some trigger out there, whether it be a power uprate or a change of fuel design or a change in vendors, or whatever.

But what that would do is it would -- someone who had, say, an older zirc floor cladding would say, "Well, I could move to M5 or optimize ZIRLO or some improved cladding alloy. But, if I do, then I'm triggering this reanalysis, so maybe I don't want to." So that would be the opposite of what we would want to pursue.

And one thing I forgot to mention up here in this yellow block, with rulemaking, in addition to providing a very clearly defined method for implementing research, it also provides you with the opportunity to achieve other rulemaking goals. And that is what is outlined in yellow here.

So the NRC is pursuing more performance-based regulations. We are looking at technology neutral regulations, something that would be applicable to more than a specified fuel design, and it wouldn't be prescriptive in nature.

We also had the opportunity with rulemaking to address these two petitions for rulemaking, the first one being from -- is from NEI, and that was a request to expand the applicability beyond Zircaloy or ZIRLO to more zirconium alloys.

And the second petition for rulemaking was from a concerned individual who was -- wanted to see the inclusion of crud and corrosion and the effects of corrosion in the LOCA models.

So we wrapped up these rulemaking -- additional rulemaking goals, along with a regulatory framework, to implement the new requirements in 2012, and it was sent up to the Commission.

MEMBER BANERJEE: Paul, what do you mean by risk-informed treatment of debris? This should be voice-activated.

(Laughter.)

MEMBER BALLINGER: Then it would always be on.

MEMBER BANERJEE: As I never speak. What do you mean by risk-informed treatment of debris?

MR. CLIFFORD: Okay. So, in 2012, the package went up to the Commission with these first three additional goals, along with implementing the research. And, in 2013, the Commission sent it back to us with an SRM asking -- well, first of all, they voted five-zero to go forward with the proposed rule, but they requested that -- or directed that we add an optional risk-informed treatment of debris.

MEMBER BANERJEE: What debris?

MR. CLIFFORD: This is for the resolution of GSI-191.

MEMBER BANERJEE: To this rule.

MR. CLIFFORD: To this rule. So this optional risk-informed treatment of debris, this isn't a methodology that describes how we do it. This will provide you with the basis of doing it without an exemption.

So the Commission wanted the ability of the industry to resolve GSI-191 using risk-informed methods without needing to seek an exemption.

MEMBER CORRADINI: But just to clarify, I think where Sanjoy is going is -- because I know he knows about it, but there is nothing in the current reg guides we are looking at that says how to -- the suggestion on how to do it. It just leaves option -- the option open for future application. That's how I interpret it. Am I misinterpreting?

MR. CLIFFORD: That's the way the rule is set up. The rule doesn't dictate a specific prescriptive methodology. It opens the door, so that you can use risk without seeking an exemption. And that's why in the rule you will also see changes to some of the GDCs that were included in the rule package, so that you could pursue this approach without a need for exemption, and that was key.

But there is guidance on how to do it, the one particular approach. There is guidance that was developed based upon the South Texas Project Pilot, but on one particular approach for using risk.

MEMBER CORRADINI: Now I'm going to turn to our current Chairman. But we're not approving or disproving that today.

MEMBER BALLINGER: We'll see this afternoon. That particular reg guide is still in review.

MEMBER CORRADINI: Okay. Okay.

MEMBER BALLINGER: And so --

MEMBER CORRADINI: So that's not in the scope of what we're discussing today. That's what I'm trying to ask.

MEMBER BALLINGER: It could be.

MEMBER CORRADINI: It could be. That's what I was --

MEMBER BALLINGER: In fact, there is a presentation on it.

CHAIRMAN STETKAR: It's part of the package, and we'll hear about it.

MEMBER CORRADINI: Okay.

MR. CLIFFORD: There's a presentation on that.

CHAIRMAN STETKAR: But at our Subcommittee, if I might, Ron, we had some problems with that reg guide. And we discussed with the staff and clarified that the rule -- and if you look at the rule, it's -- as Paul said, it does not tell you how to do it. It's separate from the reg guide.

So our -- the intent from the Subcommittee coming here was that the letter would focus on the rule, and at most we would say there is more to be done on that guidance. But we're going to have a talk on that later. So we can do whatever we want later.

MEMBER CORRADINI: Okay. I just wanted to clarify, because I thought that's where you were going.

MEMBER BANERJEE: Yeah. I didn't attend the Subcommittee meeting, so I missed all of that.

MR. CLIFFORD: So the takeaway from the flowchart is essentially it has been a long process, there has been significant decisions that have been made in the past that have led us down this road to rulemaking, and rulemaking is the most effective, efficient, and predictable approach with respect to implementing the new research.

And along this way, ACRS has been involved. I believe this is the fifteenth or sixteenth time I have been in front of this -- in front of the ACRS. And you can see, starting with -- at the top of this list, this is the validation of the technical basis, and then you're moving into the ANPR, and then the proposed approaches for rulemaking, and then here we are, and we are at the bottom here at the final rule stage.

So in this slide we just briefly summarized the major changes in 50.46 Charlie relative to the existing regulation. First off, the structure of the rule, the prescriptive structure of the rule was changed to be more performance-based. In combination with that, the applicability was expanded beyond just Zircaloy or ZIRLO, which is the limitation on the current regulation to all LWR cladding.

MEMBER CORRADINI: Zirconium-based?

MR. CLIFFORD: All -- not necessarily.

MEMBER CORRADINI: But, again, since I also wasn't on the Subcommittee, as industry is proceeding currently, it would probably be first tested with alternatives or different zirconium-based alloys. Nothing else is coming in the short term other than that, as I understand it.

MR. CLIFFORD: Correct. The short term is advancements in zirconium-based alloys.

MEMBER CORRADINI: Okay.

MR. CLIFFORD: Of course, there is a lot of research on accident tolerant fuels, but that is further down the road.

In addition to changing the major structure and applicability, the next three line items show how we have incorporated the new research finding, which is this burnup corrosion and fabrication-related phenomena. And then we have made an explicit requirement for debris. This isn't a change, because debris consideration is implicit in the current regulation. So it's not a new requirement. It's just explicitly added to the rule language to clarify.

Then, there was a change to the long-term cooling performance requirements, from a very generalized to more explicit, and we'll be talking about that in further detail. Then, we added an explicit requirement for crud, and this is in response to the petition for rulemaking, from a concerned individual.

MEMBER CORRADINI: And we'll have a discussion on that.

MR. CLIFFORD: There is no further discussion on crud.

MEMBER CORRADINI: But can I ask a question?

MR. CLIFFORD: Absolutely.

MEMBER CORRADINI: I am really curious on how explicitly the staff thinks that the licensees are going to address that. Is it going to be just an assumed penalty? I really don't understand that, because I'm not sure technically we understand it enough to address it.

MR. CLIFFORD: In the past, there has been several different analytical approaches for treatment of crud. Some of the more modern fuel rod performance models use the deposition rate.

MEMBER CORRADINI: Based on the data?

MR. CLIFFORD: It is based upon --

MEMBER CORRADINI: All the data I see is integral data, not local, which implies -- so I'm back to a penalty factor versus a computation that says it's all building up here, and I'm worried about this location.

MR. CLIFFORD: Well, it's going to depend on the specifics of the model. For instance, as you mentioned, the composition and the -- what's the word I'm looking for? The combined effects of crud and oxide are often lumped. In other words, there will be measurements, liftoff measurements, that are performed, but that will include both oxide and tenacious crud. So, in that case, you could argue that the combined effects of crud and oxide are already accounted for, because it's based upon a combined measurement of crud and oxide.

MEMBER CORRADINI: That's what I might -- I don't know enough about this technically. I'm just concerned about none too explicit without a technical basis to evaluate it, other than an assumed penalty for a particular fuel -- a cladding type.

MR. CLIFFORD: It wouldn't be a penalty per se. It would be a thermal barrier that would then feed back into fuel temperature and still --

MEMBER CORRADINI: And assumed general resistance.

MR. CLIFFORD: Correct.

MEMBER CORRADINI: Okay. But, so I'll stop after this. I'm sure the Chairman will tell me to stop. But, so is there a path forward here that both staff and industry see for this, now that it's an explicit requirement? Because this kind of -- I wasn't there, but I did send a few emails to consultants asking, and I didn't get a clear answer on how this is going to be addressed. And this could be an issue.

MR. CLIFFORD: There are approved models for both separate oxide and crud deposition models that have been acceptable to the staff based upon data. So it's there, and it's very plant-specific. It's very plant-specific, so there wouldn't be a constant deposition rate. Some plants see very little or really insignificant amounts of crud, and then other plants have seen more.

MEMBER CORRADINI: And everybody understands why.

MR. CLIFFORD: Hmm?

MEMBER CORRADINI: And folks understand why one plant gets it and one plant doesn't.

MR. CLIFFORD: There are -- certainly there are plant chemistry issues. There are issues with Admiralty Brass condensers in certain BWRs where you've got crud. Crud is a very plant-specific issue, and it depends on many parameters.

MEMBER BALLINGER: To my memory, the only real clear distinction between plants is what were used to be called silk plants, BWRs where you had feedwater heaters and things like that that had copper and things like that. That definition of "silk" has since morphed into a more broad definition, but those plants definitely had crud problems.

MR. CLIFFORD: Correct. And those have been resolved.

MEMBER BALLINGER: And those have been resolved. Yes.

MR. CLIFFORD: You know, online feedwater filtration systems that have reduced crud, or I shouldn't say reduced crud. They had reduced like iron oxide in the RCS, so that there won't be deposition on the fuel.

MEMBER BALLINGER: But Mike is correct in that there are some plants that for unknown reasons have a more severe problem than others.

MR. CLIFFORD: Right.

MEMBER CORRADINI: The only reason I'm asking in this regard is I -- your flowchart was very helpful on how you see how you kind of logically went through the what-ifs about coming down to the end. But this one at least is from a distance. It's not something that I do. But, from a distance, it looks like an ongoing research topic that strikes me as I'm going to put it in a rule explicitly.

Then, so you're saying there is accepted -- there is an accepted path forward between licensees and staff on how to address it.

MR. CLIFFORD: Correct.

MEMBER CORRADINI: On a local basis or a global basis?

MR. CLIFFORD: Well, it's generally based on empirical data at peak local conditions.

MEMBER BANERJEE: So you know that this has been quite an active research area for the nuclear hub.

MR. CLIFFORD: Right.

MEMBER BANERJEE: Where they are trying to model this computationally, and I don't know how much is --

MEMBER CORRADINI: But I hope that's not the approach used to deal with it.

MR. CLIFFORD: And that's -- we say "explicit." It's an explicit requirement that basically says that, if you have credit, you need to consider the effects, just like Appendix K has 20 or 30 different parameters that says that this is -- you've got to consider oxide thickness and everything else.

MEMBER CORRADINI: Okay.

MR. CLIFFORD: How it's addressed will be very dependent on how -- a lot of aspects of the model, you know.

MEMBER CORRADINI: So how was it -- so since there was accepted -- let me ask it this way.

MR. CLIFFORD: It's not universally accepted. There have been certain models, but then there are legacy models that may ignore it, so --

MEMBER CORRADINI: Okay. But in the current rule, if there is a plant that is experiencing it, let's leave those plants up. Ron noted that it has been understood and eliminated, and there is a plant where for reasons -- I almost think of it like when you go in for a dental cleaning, you kind of get a buildup, and nobody understands why. So they just say you're kind of a strange person, and you just get buildup.

If there is no root cause to -- there is no root cause, but there is an accepted way between the licensee and the staff, without a root cause, to at least address it in some sort of empirical way?

MR. CLIFFORD: I believe it would be based on observations. I believe each plant would say, "Okay. I'm going to set up a design deposition rate," which I know I won't exceed."

MEMBER CORRADINI: Okay.

MR. CLIFFORD: Based upon historical observations.

MEMBER CORRADINI: And then, let me just follow up, so let's say they do that --

MR. CLIFFORD: Right.

MEMBER CORRADINI: -- do they then have to at every fuel reload examine all the rot? What I'm trying to get to is, what do they do to confirm or deny what they just assumed or what you are going to hold them to?

MR. CLIFFORD: Well, I mean, it's a lot like oxide if you think about it. You have a design oxidation growth model, and it's based upon data, and you use it -- you don't go in every cycle to measure oxide thickness and say whether you've confirmed or denied.

MEMBER CORRADINI: So, then, how do I know what I'm assuming is --

MR. CLIFFORD: But, realistically, crud is not a first- or second- or third-order effect anymore. So while there may be an analytical requirement, it's not necessarily going to mean any significant impact at all to peak clad temperature.

MEMBER CORRADINI: Okay. So, then -- okay. I got you. So, then, why include it?

MR. CLIFFORD: Well, we've got --

MEMBER CORRADINI: If it's not a first or a second or even at third, you include it just to be honest that it's there, but we don't -- but we are going to have a small penalty or a small --

MR. CLIFFORD: I mean, we receive a lot of petitions for rulemaking. I mean, it's nice to accept some. I mean, it's a legitimate -- it's a legitimate case, and it could be -- we don't see it as being an issue today, but it could be an issue if chemistry changes, or whatever happens.

MEMBER CORRADINI: Okay. Okay. Okay.

MEMBER BALLINGER: You might think about waiting for the industry folks and ask them.

MEMBER CORRADINI: I'll stop, and I will ask them, too. Thank you.

MEMBER BALLINGER: But one last thing is that it's -- I think they still do this, but do licensees in some cases take active measures to eliminate crud between -- during refueling outages and things?

MR. CLIFFORD: I mean, we could ask the industry more, but there are -- sometimes there's chemical additions at the end of a cycle --

MEMBER BALLINGER: EPRI has done some work about --

MR. CLIFFORD: -- crud burst to clean up

the --

MEMBER BALLINGER: -- ultrasonically, you know, cleaning fuel elements and things like that between cycles, during a refueling outage, which basically sort of resets the clock to something close to zero.

MEMBER CORRADINI: Okay. All right. Thank you. Sorry to --

MR. CLIFFORD: Okay.

MEMBER CORRADINI: But that helped. Thank you.

MR. CLIFFORD: And the last item which will be talked about in a separate presentation later on this morning is the optional risk-informed treatment of debris.

Now, we received over 830 comments and 43 separate submissions on both the proposed package and the four associated reg guides. Here we have this colorful pie chart, some takeaways. More than half the comments were on the optional portion of the rule, which I found a little strange.

And then here the pie chart shows the distribution of public comments in the various sections of the rule from the cost-benefit to the implementation to the various post-quench ductility criteria to the different post-quench ductility reg guides, et cetera.

MEMBER CORRADINI: What is a PQD?

MR. CLIFFORD: Post-quench ductility. Those are the requirements -- that's effectively the 17 percent, 2,200, from the past regulation. Yeah, there's a lot of acronyms probably still embedded in this.

MEMBER CORRADINI: Okay.

MR. CLIFFORD: Okay. So we are going to be walking through kind of some of the major comments we received on implementation and on breakaway, on various guidance, long-term cooling, how to address legacy fuel reporting requirements, and Appendix K. But I think what is really important is what is shown in blue here. There were no industry comments really challenging the need for new requirements to address the research. I think that is very important.

So what did we do on implementation? The proposed rule included a three-track staged implementation plan, whereby the roughly 100 existing reactors were divided up into three stages with defined compliance dates.

The industry was concerned that this approach would lead to exemption requests, because clients may have various ongoing changes, be it a change to their alloy or their fuel vendor or they may have a power uprate or something else going on in the plant that would require them to seek an exemption. Or just because of scheduling and manpower concerns, plants may not be able to meet this regimented, codified implementation.

So the industry proposed an alternative whereby each licensee would submit a detailed plan and schedule for compliance within six months. There was a two-day public workshop followed by three webinars, which were conducted between the industry and the staff in an attempt to develop a more effective and efficient implementation strategy.

In the end, the final rule adopts the industry proposal, and here are some of the details. Each licensee submits the implementation plan within six months. The NRC and the licensee would negotiate a schedule, which would be used to prioritize and to balance the workload. There are some strict dates in the rule. The first one is that all license amendment requests would be submitted within 60 months, and that the fleet would be in compliance within 84 months.

One key aspect of the implementation plan is it excludes debris considerations. The resolution of GSI-191 and a counterpart for BWRs have their own life, their own schedule, and they're on their own path. So these dates and the implementation of 50.46c are not directly related to debris resolution.

We believe this approach avoids --

MEMBER REMPE: I'm sorry to interrupt, but, okay, there was a workshop or some sort of meeting, was it last week or something after our Subcommittee meeting?

MEMBER BALLINGER: Thanksgiving week.

MEMBER REMPE: And does that bullet encompass what was --

MR. CLIFFORD: No.

MEMBER REMPE: -- determined there?

MR. CLIFFORD: We'll be getting to that. That's on the reporting.

MEMBER REMPE: Oh, okay. Okay.

MR. CLIFFORD: So, you know, working with the industry to develop this, what we believe is an effective and efficient implementation strategy, certainly a seven-year flexible schedule is pretty generous for an adequate protection rule, and we believe that this approach will avoid unnecessary exemptions, as well as providing the flexibility that the industry requested, and it allows the NRC to then balance resources and workload.

The rule also includes established implementation requirements for new reactors for COLs and DCDs.

The next item was on breakaway oxidation testing requirements. The proposed rule required testing and reporting for each reload batch. The industry opposed codified, repetitive testing and reporting requirements. There was a public workshop to address these testing protocols and the testing frequency.

The final rule eliminated the reporting requirements and eliminated the defined frequency for confirmatory tests. So we addressed the industry's concerns for flexibility. In the end, each fuel vendor would establish a breakaway oxidation testing program, probably based upon the reg guide. What number reg guide is that, the breakaway?

MS. BALES: The 224.

MR. CLIFFORD: 1.224. And inside that approved testing program they would identify what barriers have been put in place and the frequency of confirmatory testing.

MEMBER SCHULTZ: Paul, before you go to the next segment of this, could you describe briefly what the background information is, the data that supported the overall approach to breakaway oxidation? My understanding is that this didn't occur in the United States. It occurred on foreign cladding, and has not been really seen here. But we've gone forward and have developed a substantial program to test for it.

So, and I also understand that this could have been a relatively isolated case of cladding that was produced, and no one really knows why it happened to have the characteristics it did. And, in fact, the problem has been either discarded so it won't happen again in fabrication or, you know, changes were made. In other words, there was some material out there that no one knows why it behaved the way it did, but it got us -- it got the industry excited about a phenomena that may not be ever repeating. Are we chasing something that really isn't there? We haven't observed it, as far as I understand.

MR. CLIFFORD: Right. So the basis for the breakaway or the research supporting the breakaway oxidation testing is found in that NUREG-6967, which is based upon the work that was done at Argonne whereby they tested M5, ZIRLO, Zirc-2, and Zirc-4, and also this Russian alloy E110.

The Russian alloy E110 is chemically identical to M5. So from a -- you know, from a high order definition, they are the same material. So we identified significant differences in E110.

MEMBER SCHULTZ: Is there general agreement on that? In other words, that the material that was -- that, again, saw this problem was in fact identical to M5, or that --

MR. CLIFFORD: From a major alloying element, it is identical as far as what's -- the published material that is out there, and the material specifications.

Maybe I'd get the next slide, because I think it helps set the tone here. So --

MEMBER SCHULTZ: I didn't understand that was the case. I thought it was really an isolated incident that led to the results, and certainly additional testing may have demonstrated it, if you found that cladding again, but --

MR. CLIFFORD: Well, so the NUREG concluded that there were effects in the zirconium production process that impact the susceptibility. There is effects of minor alloying elements that aren't stipulated in the regulations. In other words, there are beneficial minor alloying elements.

And, finally, there is the effect of surface finish and surface preparation. So if we walk through this slide, this is a good illustration here.

MEMBER CORRADINI: So what I interpret that to mean is there is a recipe, and if you don't follow a certain recipe you could be in trouble.

MR. CLIFFORD: Well, and that's the issue. That's really the issue. And let me -- I'll get to that. I think I'll address all of these issues.

MEMBER BALLINGER: More importantly, though, there is a recipe which, if you follow it, you don't get into trouble. But nobody knows how much margin you have in the recipe and where that margin needs to be before you jump off a cliff maybe.

MR. CLIFFORD: So this slide kind of gives you a high level illustration of zirconium production, you know, beginning with mining of zircon sands down to tube reductions at the end here, a step down here. And here are some of the key steps I think to notice.

First of all, you mine your zirconium sands. You then have to separate hafnium because hafnium and zirconium are always cohabitating. So here you see the Kroll process, which is the process used in the United States, these steps here.

And this brings you to zirconium sponge.

And then once you get to zirconium sponge, you then add your major alloying elements, you generate your ingots, you remelt your ingots several times, you get to a billet, you do your beta quench on your billet, you go through several tube reductions with intermediate heat treatments, then to your final heat treatment and finish it.

This is very simplified, very high level. But the issue is where does the susceptibility to breakaway enter this equation. We know there is aspects of the initial material. We know there is aspects with the Kroll process, and then we know there is aspects with the final heat treatments and finishing.

Our research program was not -- what's the word I'm looking for? Was not as comprehensive as to identify all variabilities. And, really, what you're left with is right now there are no existing barriers to prevent a poorly performing cladding material with respect to breakaway. There are no barriers in place.

Now, we could conduct more research, go into here -- into the various steps in here, and look at various sensitivities, and then start to prescribe what those fabrication processes need to be. You have to use the Kroll process. You have to get your zircon sands from Australia.

You have to go through this -- all of these steps. You have to finish it in a certain way. We could do that. It would take us years, and then we would be getting into the shop, and I don't think the industry wants us into the shop. An easier approach, especially one that's in line with the performance-based rule, is to just describe a performance-based requirement. Run a test.

We're not going to get involved in all of these steps. You're just going to run a simple, in expensive test at the end, and it's going to show you that you didn't introduce something in your process, either advertently or inadvertently.

MEMBER CORRADINI: And then the way the rule, as you've summarized it two or three slides before, is it's up to the vendor to demonstrate to you and the licensee that what they are delivering on some periodic testing basis meets that performance.

MR. CLIFFORD: Right. So they have the flexibility of saying, you know what? We're not going to tell you anything about our process, but we're going to test frequently. We're going to test every million tubes, whatever, whatever we agree with, whatever we can agree to.

Or they could get into the point where they say, you know, what? We're always going to get our sands here. We're always going to use this process. We're going to set up all of these barriers. We're going to prescribe exactly how we do this process. And then our frequency is going to be diminished because we have these other controls, these other barriers in place. It's up to them. I'm getting --

VICE CHAIRMAN BLEY: So you'd still have testing but not as often.

MR. CLIFFORD: Not as often. Correct.

MEMBER BALLINGER: The industry has argued -- industry, I -- Carol is not here, so I can use the word "industry." On the BWR side, if I recall, with respect to nodular corrosion, they instituted a test at some point in the process -- well, I think it was a high temperature steam test -- to look at if this material was going to be susceptible to nodular corrosion.

And they incorporated that into their QA program, so the industry would say -- or would argue that, can we put this into our QA program and, since that's an inspectable, program, do it that way.

MR. CLIFFORD: Absolutely. I mean, that's what --

MEMBER BALLINGER: This allows that to happen?

MR. CLIFFORD: Yes. But then you're --

MEMBER BALLINGER: That's new, I think, to me.

MR. CLIFFORD: Well, but then your frequency would be tied to your design change process.

MEMBER BALLINGER: Okay. You've got to believe that folks don't intentionally put bad fuel into a reactor.

MR. CLIFFORD: But we haven't identified all of the sensitivities. So there has to be an initial assessment, a breakaway sensitivity, and there has to be some periodic confirmation.

Now, as we mentioned, the frequency of those periodic confirmatory tests are very flexible, and it depends on how involved in the industry wants us to be in their manufacturing specifications and quality -- manufacturing quality control.

MEMBER BALLINGER: But you already inspect the quality control program. You do, right? Right?

MR. CLIFFORD: I don't personally. I think the region does.

MEMBER SCHULTZ: Paul, because it's

performance-based, does that also mean that if the testing is not showing any propensity for the phenomena that then the testing frequency can be altered?

MR. CLIFFORD: Yes. So we've set it up so there is a default that we would find acceptable, but the reg guide clearly states that this is an evolving --

MS. BALES: Like a learning feature. You can have --

MR. CLIFFORD: Right. There's a learning feature, so the initial frequency for testing could certainly evolve over time after they have tested more lots.

MEMBER SCHULTZ: Thank you.

MEMBER BALLINGER: Do we envision that the testing would be done by the vendors, or is it a specific requirement on the licenses?

MR. CLIFFORD: It's on the vendors. It's part of the vendor-approved topical reports for the cladding material.

Okay. Next topic.

MEMBER SCHULTZ: One more thing. If it's performance-based, and we haven't seen this in the United States, it would seem that you could start off with a fairly infrequent testing frequency, but --

MR. CLIFFORD: I don't disagree. It really depends on what is -- it provides as much flexibility as the industry wants with respect to defining that. But, remember, this rule will be in place for a long time, and we are looking at cladding alloys coming from different international partners now, especially, you know, the Korean design reactors and, you know, so we have other players coming into the U.S. now.

MEMBER POWERS: Paul?

MR. CLIFFORD: And, realistically, the fuel vendors, they don't necessarily control these processes. It's, you know, vendors. They get tubing vendors, and they have ingot vendors. So, and they may decide to change their vendors. They may say, "Well, I don't want to buy this ingot from France anymore. I want to buy this ingot from the Russians, because they have a better price."

MEMBER BANERJEE: Is the testing very elaborate?

MR. CLIFFORD: No.

MEMBER BANERJEE: It's a steam environment or --

MR. CLIFFORD: Maybe you could --

MS. BALES: Yeah. The testing that is done when a material is initially characterized is a series of tests at various temperatures, and the temperature is held at a constant for a certain amount of time. And then there is a visual inspection. And if the visual inspection shows any kind of delaminate -- well, not necessarily even delaminate -- decoloration, or anything, you can make a hydrogen sample, a hydrogen measurement to understand exactly what hydrogen has been picked up.

But we expect that a lot of the examinations will just be visual, so it's a series of tests at different temperatures followed by a visual examination to confirm that the material hasn't experienced breakaway. And then, the periodic testing would be at a single temperature, and then also could be confirmed just by visual examination.

MEMBER BANERJEE: So how do these tests take typically?

MS. BALES: So we have a maximum temperature -- or, sorry, time of 5,000 seconds. That's the longest duration that we would ever require testing. There is no need to test past that. But I think many of the cladding alloys -- some cladding alloys can go to 5,000 and not see breakaway. Some can be more like 3,000, 3,500 seconds. And so those tests would be --

MEMBER BANERJEE: Are these just coupons or tubes or --

MS. BALES: We would test the final cladding product.

MEMBER BANERJEE: Final --

MR. CLIFFORD: Small segment.

MS. BALES: Yeah.

MEMBER BANERJEE: So it's not a very onerous test you are talking about.

MR. CLIFFORD: No.

MS. BALES: I wanted to add something, because I think the word "poor" breakaway oxidation performance is really key on Paul's slide. The principal investigator for this work at Argonne would argue -- and has said before that all materials will experience breakaway oxidation at some point. The concern that really drilled the staff's requirements were instances where breakaway oxidation occurred very early, after maybe 500 seconds, 1,000 seconds.

But the phenomenon of breakaway oxidation is not something that is -- I mean, it's expected after a certain amount of time.

MEMBER POWERS: The breakaway phenomena is intimately related to the stress in the oxide and the stress that's in the metal when it occurs. In all alloys, if you oxidize them long enough, there seems to be some misunderstanding on maybe the Committee's part.

The breakaway is an inevitable result of the Bedford-Pilling ratio between zirconium metal and the oxide that E110 simply exhibited in a catastrophic fashion very early in the process, and there are various hypotheses on why that might be.

And the testing that is being proposed here is to preclude whatever that might be or anything else that comes along and affects this in a deleterious fashion that might not be anticipated. Even if you got your zircon sands from a particular mine and a particular continent, that ore deposit evolves with depth, and may not preclude catastrophic early oxidation.

So it is not a case of we have never seen it in -- we have seen it a lot. In fact, a notable laboratory in Chicago, they seem to get it with a regularity. And a notable laboratory in France, they get it regularly, deliberately, with malice of forethought.

MEMBER BANERJEE: So does it depend -- the test can be done on tubing without stress conditions which are typical, or other things which are more --

MEMBER POWERS: They'd put an end -- they have ends on these things to hold them in place.

MEMBER BANERJEE: I see.

MEMBER POWERS: This is not -- to say that -- there is a substantial technology in doing these tests that is -- it is a known technology. It is not a trivial technology in doing the test. That is, once you know how to do it, you can do it. But if you walked into a laboratory on day one, Michelle handed you a segment of tubing and said, "Test it," you would probably screw it up.

MS. BALES: That might be true, but we also have a reg guide that documents the process that was used.

MEMBER POWERS: Have you ever tried to do an experiment based on a reg guide?

MS. BALES: Fair enough. But I --

MEMBER POWERS: There is a substantial technology --

MS. BALES: -- there was an effort by the staff and by the principal investigator to document the process of the testing, and Reg Guide 222 defines an acceptable test procedure. That has been used successfully by other labs, so not only at the vendors, but also at Oak Ridge, and it has been used -- and internationally as well.

MEMBER BANERJEE: And the results you are -- you know, I know nothing about this field. But the results are such that they are indicative of how the fuel would perform in actual accident conditions? Is there some --

MS. BALES: Well --

MEMBER BANERJEE: -- correlation between the lab test and --

MS. BALES: -- there is correlation between the lab tests. I mean, there have been instances where two entities get different performance, and there was a particular instance where there was extensive discussion between two organizations to try to resolve what might be the cause of the discrepancy.

And some of the lessons learned from that exchange are incorporated into the reg guides. But there is the potential for some small variability, but, again, the concern really is with poor-performing alloys that are dramatically -- breakaway oxidation at dramatically low temperatures. And, in that respect, there hasn't been an instance where a lab has seen really poor performance while another one sees very good performance.

MEMBER BALLINGER: To clarify a little bit, the stress is internally generated.

MS. BALES: Right. And a lot of it has to do with the phased transition temperatures of --

MEMBER BANERJEE: Within the cladding itself.

MEMBER BALLINGER: Well, the different density between the oxide -- that's what Dana has been talking about. A broader density between the oxide and the metal.

MEMBER BANERJEE: Even though he said it in the most obscure way, even I --

MEMBER BALLINGER: In the unlikely case where the oxide density is the same as the metal density, no problem.

MEMBER POWERS: It's very slight.

MR. CLIFFORD: All right. Do you want me to move on?

Okay. Well, this is a perfect segue to what Michelle was just -- was talking about. So there were two -- there were three draft guides, 1261, 1261, and 1263, which provided guidance for conducting the post-quench ductility and the breakaway oxidation testing, interpreting the data and defining analytical limits.

The industry commented -- there were well over 100 comments on these reg guides, but the themes were they wanted greater flexibility in testing protocols and data evaluation. There was a request to reduce or eliminate the need for irradiated testing. There was some concern with compliance of legacy fuel. That's fuel that was manufactured years ago before these regulations -- before 50.46 Charlie was in place. And, finally, there was a lack of hydrogen -- approved hydrogen pickup models.

There was a public workshop conducted at Oak Ridge National Labs to address the testing protocols and the applicability of the analytical limits. In the end, the guidance documents were significantly updated to provide the flexibility requested by the industry. In addition, we provided a clear regulatory path for legacy fuel, and we also provided default hydrogen pickup models for the existing commercial alloys.

MEMBER BANERJEE: You can actually have a model for this hydrogen pickup?

MR. CLIFFORD: Correct. We provided models based upon the available data for each of the alloys, and it is very alloy-specific.

MEMBER BANERJEE: It would be, yeah. Yeah.

MR. CLIFFORD: So the next issue is long-term cooling fuel performance. Now, instead of the post-quench ductility during the short term, this is long-term recirculation period we're talking about here. Debris considerations introduce new concerns and necessitates an explicit fuel performance objective. The existing regulation requires continued effective core cooling. If debris were to interfere with ECCS coolant delivery, such that core temperatures increase, then long-term performance objectives may no longer be satisfied.

The proposed rule required testing to an established and analytical limit to maintain cladding ductility. In other words, the proposed rule added a new performance-based objective during the long-term recirculation period, and that was to maintain cladding ductility, just like you need to maintain cladding ductility during the initial phase and quench.

However, the long-term cooling fuel performance was outside the scope of the existing NRC research program. The statement of consideration requested input on long-term cooling performance and available research data and testing procedures. The information received in response to the statement of considerations in the proposed package was that the industry opposed the ductility performance metric, they opposed the singular PCT analytical limit, and they opposed required testing.

MEMBER BANERJEE: So, at the moment, for practical purposes, there is some temperature that is set as a limit, right, in this? That you don't want the cladding temperature to go above this, whatever.

MR. CLIFFORD: Correct. In the absence of debris, you would expect you would quench the core.

MEMBER BANERJEE: I'm saying for long-term cooling.

MR. CLIFFORD: Right. After you quench the core, you would maintain temperatures at acceptable -- what the regulation calls acceptably low values, which you would expect to be --

MEMBER BANERJEE: But that's --

MR. CLIFFORD: -- well below the point of additional degradation mechanisms.

MEMBER BANERJEE: -- sort of limit, which is set essentially --

MR. CLIFFORD: Yeah.

MEMBER BANERJEE: -- which really all work to --

MEMBER CORRADINI: But just to clarify Sanjoy's point, under the current role, it is qualitative language without a numerical goal.

MR. CLIFFORD: Or even a defined performance metric.

MEMBER CORRADINI: And what has changed explicitly is now to put a performance metric based on a to-be-determined measure for computed quantity. That's what I'm struggling with.

MR. CLIFFORD: So before we need -- before we were concerned about debris interfering with ECCS delivery, the expectation is you would cool and quench the core, you'd maintain inventory, and you would remove decay heat, and core temperatures would continue to decrease.

We are put into this unusual situation where they are trying to resolve GSI-191, where plans are showing that there may be a very temporary minor reheat. And if you do have a minor reheat, you ask yourself, do you meet the existing requirements? Because you are no longer removing decay heat, and you no longer have continued effective core cooling, which is the words in the existing regulation.

So what we're doing is we are trying to provide a path for the resolution of GSI-191, which would allow higher fiber plants that have debris to then resolve the issue with the regulatory framework that defines what the performance metric is, because right now there is no regulatory framework. So --

MEMBER BANERJEE: Effectively, it's something which the staff has accepted, right, as being -- maintaining adequate ductility, and which, you know, I won't go into the details, but there is a temperature limit --

MEMBER CORRADINI: Right. That's --

MEMBER BANERJEE: -- effectively which --

MEMBER CORRADINI: That's what I'm remembering is that when we had these discussions in various other subcommittee meetings, there is a stated value that if I go above that stated value there is some concern.

MR. CLIFFORD: Correct. And what --

MEMBER BANERJEE: I mean, for long-term cooling, with or without debris. It doesn't really matter.

MR. CLIFFORD: And 50.46 Charlie follows that example. We're building off past experience with the resolution of GSI-191.

MEMBER BANERJEE: Okay.

MR. CLIFFORD: In other words, they would stipulate a temperature, but from a regulatory perspective, what were they trying to preserve? What was the performance metric? Why is that the agreed-upon temperature acceptable? What is the regulatory basis of that agreeable -- of that acceptable temperature?

MEMBER CORRADINI: And this explicitly being -- and this explicitly being put into the rule would then have them develop such a basis.

MR. CLIFFORD: Correct.

MEMBER BANERJEE: Well, but effectively the reason that temperature was set was to maintain ductility if the fuel was exposed to these conditions over a very long period of time.

MR. CLIFFORD: With debris or you're saying --

MEMBER BANERJEE: With or without debris. Didn't really matter.

MR. CLIFFORD: Well, historically, there were no specified requirements, and there were no specified analytical limits on temperature.

MEMBER BANERJEE: But if you're looking at boil-off, for example.

MR. CLIFFORD: That's all it was. It was boil-off.

MEMBER BANERJEE: Yeah.

MR. CLIFFORD: You exceed boil-off, you maintain inventory, and if you do that over a long-term period, then you're done. It was more of a hand calculation, and that hand calculation for the majority of the plants that are clean, or that can demonstrate either deterministically or in a risk-informed fashion that the amount of debris is insignificant, that's still in play. That's still the preference path.

MEMBER BANERJEE: Yes. But, in fact, what really happens is there are scenarios where, for example, you could refill loop seals and things which could lead to uncovery and some level within the core. The question is, then, does the fuel above this level remain at conditions which are below this temperature, whatever. I won't quote it, because I don't have total recall. It was around 800 degrees, right?

If you have that condition, then, you are okay. You know, you do the calculation. And in rough terms, if you have 50 percent exit quality, you will maintain a temperature something like that. That's what you want, even if the core has uncovered.

MR. CLIFFORD: Right.

MEMBER BANERJEE: So that's what is practically used. I could be wrong with these numbers, but in rough terms right.

MEMBER CORRADINI: But I just want to make sure -- to make sure my understanding, since I want to understand as well as our -- my colleague, given a temperature, given a void fraction, whatever, for quality, what you're saying is there is not a traceable regulatory technical basis as to why all of this is acceptable at this point. That's what I hear you saying.

MEMBER BANERJEE: It would be different for different fuels. That's what he is saying.

MR. CLIFFORD: Well, certainly.

MEMBER BALLINGER: I need to interject a little bit here. It is now in this time zone 9:45, and we are -- are we on Item 3 now? Or are we way away from Item 3 on the agenda? Item 3 is the risk-informed alternative.

MR. CLIFFORD: Risk-informed? We're not on Item 3. That's a different presenter.

MEMBER BALLINGER: So you want us to be quiet. It's a very, very important topic. Lots of information has been --

MR. CLIFFORD: Okay.

MEMBER BALLINGER: -- the decade, but I'm not -- we need to be mindful that there are hard stops here.

MR. CLIFFORD: Okay. With that, I only have three more slides, so --

MEMBER BALLINGER: Okay. I have 50 on my list.

MR. CLIFFORD: Oh. So this -- we can go through this fast. So the staff is concerned about legacy fuel, in other words fuel that resides in their spent fuel pool for which they may not have cladding segments available to test. So we added guidance to Reg Guide 1.224 on how to address legacy fuel, either fuel that's still commercially available or fuel alloys that are no longer commercially available. So there's a way for them to continue loading older fuel.

The next is reporting. In the proposed rule, reporting corrective action paragraph was rewritten to clearly state the requirements. However, the fundamental approach for reporting corrective action is unchanged from 50.46. However, clarification was needed based upon past experience where the industry and the NRC staff has misinterpreted/misapplied existing regulations.

The NRC did not intend to restrict existing flexibility with respect to estimating an effective change of a change or error, or defining the scope of a reanalysis or negotiating the schedule for reanalysis.

And this is to your point. We held a public webinar Thanksgiving week to address the industry concerns. The final rule language in the statement of consideration were revised to clarify that existing flexibility and the flexibility of 50.46 Charlie with respect to defining the scope and schedule for reanalysis.

Ultimately, we believe the final resolution relies on guidance documents, which we encourage the industry to develop and which we can endorse.

Appendix K -- Appendix K, as you know, provides the regulatory framework for LOCA evaluation models and is part of the majority of plant licensing basis. There were no changes to Appendix K included in the proposed rule.

The industry requested that the required and acceptable attributes of an evaluation model be moved to a reg guide. The industry raised this concern during several public workshops and webinars, and even at the ACRS Subcommittee. The industry goal was to provide flexibility with respect to generating long-term cooling evaluation models.

MEMBER BANERJEE: What does that mean? What does that "provide flexibility" mean?

MR. CLIFFORD: Well, that gets to our next bullet. The NRC is concerned with the selective implementation of acceptable features. So if you move Appendix K to a reg guide, since a reg guide is not a requirement, you could kind of cherrypick what you want to -- which portions you want to apply and which portions you don't want to apply. That's the flexibility.

The regulation -- the current regulation, as well as 50.46 Charlie, continue to allow the use of a realistic plus uncertainty evaluation model in addition to an Appendix K model for both long-term and short-term demonstration. We do not believe that any change to the regulation is necessary, and that any acceptable features of a long-term cooling evaluation model should be developed in new guidance. So all of this can be addressed in guidance.

MEMBER BANERJEE: Well, under your fourth bullet, we are now extending that to the full spectrum break of looking at it, right? Full spectrum, not just large breaks.

MR. CLIFFORD: Right. But even full spectrum, which covers all of the breaks, doesn't get into long-term cooling.

MEMBER BANERJEE: Yeah. Agreed. But that would be a whole different --

MR. CLIFFORD: So the existing regulatory guidance documents for realistic plus uncertainty evaluation models, 1.157 I believe, does not really have a separate discussion on what are the acceptable features of a long-term cooling model.

MEMBER BANERJEE: Well, there is some guidance, but it's not --

MR. CLIFFORD: Right. So we think the ultimate resolution of this issue is just to update and expand that discussion on long-term cooling models. All this can be addressed with those. It's not needed in the rule.

And, finally, conclusions. Last slide. Here are some important ideas and conclusions I think. With or without 50.46 Charlie, the research findings must be incorporated into the plant licensing basis to ensure adequate protection.

The ECCS safety assessment, which is performed for the staff with input from the industry, supports the NRC decision to pursue rulemaking, along with a flexible and efficient implementation plan. In other words, this assessment, which is updated annually, allows us to have a flexible seven-year schedule.

The staff has conducted a series of public workshops and webinars to encourage stakeholder involvement. Many changes were incorporated into the SOC rule language and guidance to improve clarity, expand flexibility, and to reduce the burden, overall burden to the industry. And, finally, the staff requests that the ACRS provide a written endorsement of the 50.46c rule package and reg guides.

MEMBER BANERJEE: Sounds like a plan.

MEMBER BALLINGER: Any questions? Who is next? Steve, it's you, right?

MEMBER BANERJEE: Steve is up?

MR. LAUR: Okay. My name is Steven Laur. I'm with NRR, Division of Risk Assessment, and my colleagues are C.J. Fong from the same branch and Steven Smith from DSS in NRR. And they're going to answer all the hard questions.

And this is a brief presentation on -- first, on the rule portion of the -- that covers risk-informed alternative, and then on the reg guide. And

Paul already gave this slide, the highlighted rows. We are going to talk about -- this was added by actually two different SRMs. I believe one was on GSI-191, the other one was on the rule, but they both said the same thing -- to allow a risk-informed alternative for addressing debris effects on long-term core cooling without need for an exemption under 50.12.

Okay. So this is most of paragraph (e)(1). An entity can request by a license amendment, and the NRC can approve, a risk-informed alternative to address the debris for long-term cooling, in which case for the ECCS evaluation model they can ignore that debris for the long-term cooling part.

Okay. We basically codify the Reg Guide 1.174 principles of risk-informed regulation, which have to do with maintaining adequate defense-in-depth, safety margins. Any risk increases are small and consistent with the Commission safety goal policy statement, and performance measurement strategies will be employed to make sure this decision doesn't result in unintended consequences.

That is basically all that's in the slide, except I am going to add one -- this is how the rule looks in the package you got. The actual rule has changed since then as a result of comments and a non-concurrence, and currently the second sentence in this would read, "An entity may request to use the alternative risk-informed approach for design modifications or new reactor designs only if the entity demonstrates there is a significant safety or security issue that cannot be practically addressed by other means.

With the statement's consideration, it explains that it's not our intent that this risk-informed approach be used to bring debris new to resources in or significant new debris sources in to a plant that is already clean.

VICE CHAIRMAN BLEY: I didn't completely understand that. Could you --

MR. LAUR: The SOC part? That should be really -- I'm sorry.

VICE CHAIRMAN BLEY: It has been changed. It's -- so you can only use this approach?

MR. LAUR: It says an entity may use it, only if they can justify there is a safety or security issue that it cannot be practically resolved otherwise. In other words, if you have an emergent condition --

VICE CHAIRMAN BLEY: That's really odd, I mean, compared to the other rules I've seen. You can't go to a probabilistic approach unless there are some safety issue you can't resolve any other way. That's what it says?

CHAIRMAN STETKAR: That's what he's trying to say.

MR. LAUR: No. No, no, no.

VICE CHAIRMAN BLEY: Well, that's what I hear.

CHAIRMAN STETKAR: You've got their attention.

MR. LAUR: If you have -- well, we covered this in the subcommittee, but I -- and you were there for that. But if you have an emergent issue, GSI-191 is an emergent issue. Nobody thought about this. There was an event. We said, "Okay. Debris can clog this up." This is what it's in here for. Okay?

What we're saying is you can't use it for a future modification or a new reactor design to bring in new insulation. In other words --

VICE CHAIRMAN BLEY: Oh. As an excuse to bring --

MR. LAUR: Right.

VICE CHAIRMAN BLEY: It's okay if we bring in a lot of debris.

MR. LAUR: No. It's okay if you --

VICE CHAIRMAN BLEY: Into the containment.

MR. LAUR: -- inadvertently -- if you inadvertently uncover a situation where, you know, it -- you have introduced debris sources. That's what this is intended for. It's not intended to say it's okay to load up your plant with problematic debris up to this level and no more.

VICE CHAIRMAN BLEY: Okay. I think I get it.

MEMBER BROWN: I was reading one of the documents, and the way that it reads in this -- I'm not so sure how current. This was like an August SECY or draft, whatever it was. And it says the NRC does not intend to -- for this approach to be used to justify the use, not inadvertent but to justify the use of problematic debris sources in new designs.

MR. LAUR: Okay.

MEMBER BROWN: That's different from inadvertent introduction.

MR. LAUR: Oh, I understand. Those words or similar are -- they may have changed somewhat, but are similar -- are in the statement of consideration. But the problem was, what do you put in the rule? And what we put in the rule is very legalistic, and had some advice from a legal representative on our Committee.

What we're saying is, in other words, if you're designing a new reactor and you say the core damage risk is very low, and this other insulation is much cheaper than reflective metal insulation, or something, and so, therefore, the risk of this insulation increases you to 1E minus six, which would be many times your core damage frequency for some of these plants, and, therefore, please grant me this use of the alternative risk-informed approach.

We're saying that's not the intent of this. The intent of this is for already built or already established conditions where it would be costly, it would be a lot of men rem or whatever, personal rem to remove the insulation, then we are allowing a reduction in the margin that was there when you intended it to be.

CHAIRMAN STETKAR: Steve, why shouldn't I be able to do that? If the risk is low, the risk is low.

MR. LAUR: That's true.

CHAIRMAN STETKAR: okay.

MR. LAUR: You shouldn't be able to do it, because -- for several reasons. One is --

CHAIRMAN STETKAR: No.

MR. LAUR: -- it's poor engineering practice.

CHAIRMAN STETKAR: No. No. That's your interpretation.

MR. LAUR: That's my opinion, yes.

CHAIRMAN STETKAR: That's your personal interpretation. Why shouldn't I be able to use risk-informed performance-based information to manage the risk for my plant? And some place, some conditions, as long as I manage that risk, I might be able to introduce insulation. Why can't I do that? Why won't the NRC allow me to introduce flexibility by using risk-informed approaches?

MR. LAUR: Okay. Well, I --

CHAIRMAN STETKAR: Why do I only need to use risk to reduce things?

MR. LAUR: Oh, no. No, you don't need to do that. And, in fact, we're not doing that on --

CHAIRMAN STETKAR: Oh, I do in the new plant.

MR. LAUR: We're not doing -- well, okay.

CHAIRMAN STETKAR: You're telling me I have a design constraint, that I must use something that is prescribed by the NRC, that may be very expensive, and I can't use risk information as a justification for --

MR. LAUR: Okay.

CHAIRMAN STETKAR: -- managing the risk.

MR. LAUR: Okay. Here is what --

CHAIRMAN STETKAR: That is what you are telling me.

MR. LAUR: Let me give you my answer, and then we will see if it -- it has to do with risk-informed as compared to risk-based. Okay? You're saying you're going to manage the risk. And when we say "risk-informed," we say Reg Guide 1.174 has those -- I've mentioned four of those principles. The other one is compliance with regulations, unless an exemption is --

CHAIRMAN STETKAR: Do you see any regulation that says I have to use reflective metal insulation?

MR. LAUR: No, I understand that. Hold on. So the other parts -- defense-in-depth, safety margin -- say that safety margins, it is kind of ill-defined, but we say safety margins are generally achieved through compliance with codes and standards. Okay?

So you could say, why can't I reduce all of the seismic hangers on a plant because the risk is low? But the codes and standards say that you have to have these hangers for the seismic and for dead weight and for the otherwise -- so it -- to me, it goes to -- more to the non-risk portions where defense-in-depth and safety margins would say you don't design a source of water, a tank of water, that can be clogged by the very scenarios that you designed it for.

Now, I'm not a pump expert, but we've got one here I guess.

CHAIRMAN STETKAR: Do we install meteorite catchers?

MR. LAUR: No. I'm not talking about meteorites.

CHAIRMAN STETKAR: But the analogy is -- I used the analogy of meteorite catchers because we don't do that, because everybody accepts that risk. It's sufficiently low.

MR. LAUR: Right.

CHAIRMAN STETKAR: Why can't I use risk -- as long as I'm introducing the notion of a risk-informed performance-based approach to evaluate this issue, why I use it uniformly for new plant designs and allow me some flexibility in that new plant design.

MEMBER BANERJEE: He's got the answer, because figures don't lie, but liars figure.

CHAIRMAN STETKAR: I'm not trying to be glib here. I'm actually trying to challenge the staff in terms of applying consistently the notions of Reg Guide 1.174 and the use of risk information consistently. It is not only used to show that I've got something bad that I need to add things. It can be used to in fact allow me to manage the risk appropriately and the cost of managing that risk.

MR. LAUR: That's a true statement. Almost all -- almost all of the risk-informed applications that we have approved have been risk increases. There are --

CHAIRMAN STETKAR: You are operating within the very narrow confines of the things that you have seen for currently operating plants. I'm trying to -- this is a rule that will apply for new plant designs, and you're saying that I can't come in with a new plant design and say in a particular location I want to install a certain type of information -- insulation.

And I can justify based on risk-informed, performance-based methods that that's okay, even though it might not meet your desired reflective metal insulation or barriers where --

MR. LAUR: We're not specifying what kind of insulation. But the point is, for specific locations, it's likely that the entity can justify it deterministically. But what you're saying is it -- well, first of all --

CHAIRMAN STETKAR: Maybe I can install a really expensive meteorite catcher deterministically.

MR. LAUR: I would personally support the Commission or somebody coming out and saying, "Here is the de minimis or below regulatory concern" -- I know we don't use those words -- "frequency." Okay? And we do that in the standard review plan for external hazards where we say, "If frequency is less than 10 to the minus seven, or if it's less than 10 to the minus six, and conservative or demonstratively conservative, then you can exclude it." That's on the deterministic side.

And so if you're doing GDC-2, and you can show something is less than 10 to the minus six and it's a conservative estimate, you don't have to consider it. I'm totally in favor of that.

So your meteorites fall under that category, but the -- there is a couple of other reasons why --

CHAIRMAN STETKAR: Now, don't dwell on the meteorite. I use it to pique people's curiosity about very low frequency events, and the fact that we accept certain things, but in certain areas we suddenly become very deterministic and it's, oh, no, you can't use risk arguments to provide me a little more flexibility, because, well, here you have to follow deterministic rules.

MR. LAUR: I guess it's fundamentally different than that. If we want to say that -- to change this rule to say instead of all -- up to and including the largest double-ended guillotine rupture of, you know, the largest connected pipe, whatever, change it to say up to the size of pipe that is commensurate with 10 to the minus five per year rupture frequency, which is similar to another rule that has a similar name but different letter at the end, 50.46 alpha, then that would be fine, you'd say okay, but those aren't even in the licensing basis anymore.

But if you remember, back to that rule, we still glommed on to other requirements to make sure there weren't unintended consequences, because that was much broader than what we're doing here. But let me -- I'll give you an example. Tornado missiles.

Some people have parts of SSCs that are unprotected from tornado missiles. I think we have written recently an EGM, an enforcement guidance -- anyway, but said, you know, this is a compliance issue. If you can show certain things, you don't have to fix it. Anyway, but these guidelines cannot be used to justify building plants without the tornado missile protection.

You can make the same argument, but let's get rid of that, you know, if the frequency is low enough. At some point, you have to rely on the fundamental traditional engineering codes and standards that say, "Here is the margin of building the pipes. Here's the margin of building the buildings." It goes to the defense-in-depth side as well as the safety margin side, which makes this risk-informed rather than its low frequency, do anything you want.

It also compensates for uncertainties and certainties, as things do fail, so you have two trains of them. And the uncertainty is where we really don't know that the PRA model has captured everything.

MEMBER BANERJEE: Can I ask a question a question for clarification only? Just to --

MR. LAUR: I've enjoyed this. But, yes,

go ahead.

MEMBER BANERJEE: This second -- the first bullet, risk-informed approach, what does that mean? That you don't have to worry about debris and doing a long-term cooling --

MR. LAUR: What it means -- it's a dichotomy between deterministic and risk-informed. But it -- in the deterministic LOCA analysis, you don't melt the core. You don't see certain parameters following this very prescribed set of parameters. Okay. Single failure criteria, you know, so many sigmas on the decay heat and you say, "You don't melt."

In the PRA world we say, "Well, actually, you do melt." Okay. You do have common cause failures. You do have random failures. You do have equipment -- and so there are actually -- they are not exactly the opposite of each other. What we are saying is, if the licensee demonstrates that the risk increase to debris is small, defense-in-depth is still maintained, safety margins are adequate, and you have a performance measurement thing to make sure that the analysis still holds over time, then we can approve that the debris is not a significant contributor to risk.

Okay. It doesn't mean you'll melt a core on some small frequency under some certain --

MEMBER BANERJEE: And you've had all these incidents where debris made the strainers bend. And, you know, why do we have all this GL-2004.2 letter? I mean, it's based on all sorts of incidents.

MR. LAUR: Why do you have all of that? Well, first of all, if they hadn't done some of those --

MEMBER BANERJEE: I have a whole report with about 20 incidents which have led to that. So, I mean, what is this all about?

MR. LAUR: Well, what does it do?

MEMBER BANERJEE: Well --

MR. LAUR: May you can ask --

MR. SMITH: So I think because those incidents did happen, you know, we have taken action. And the risk-informed evaluation takes into account the improvements that have been made in the plants. Basically, what the first bullet says is you still have to do your long-term cooling evaluation. You just don't include the effects of debris on it, if you do a risk-informed evaluation of the effects of debris.

MEMBER BANERJEE: Taking into account,

because we have had to increase strainer areas and everything.

MR. SMITH: Yes.

MEMBER BANERJEE: Okay.

CHAIRMAN STETKAR: And we have to be a little -- a lot cognizant of time. I want to switch gears a little bit, because I made the other point.

One thing you didn't dwell on here, and something that I hung up on, Steve, is in the slide there, that third sentence, it says, "If an entity desires to change the methods employed in the systematic processes," yada, yada, yada, "entities shall obtain NRC review and approval."

Later, you're going to have another slide, M8 -- I think it's M, Section 8, that says not only is it NRC approval, but you have to submit a license amendment for that, the way I read it.

MR. LAUR: Okay. Let's see, where was I at?

CHAIRMAN STETKAR: It's in 8I in the rule, and it's on -- it's going to be on your slide -- that last little bullet, that last blue bullet, license amendment required to use --

MR. LAUR: If you change the method, yeah.

CHAIRMAN STETKAR: Well, okay. So if

instead of a standby failure rate model that calculates the failure on demand of something based on a latent exposure period, I want to change to a demand failure, that's a different method. So I have to submit a license amendment because I've changed that method? If I want to use a different method for calculating the conditional probability for spurious actuation of a valve that might cause a LOCA, I have to submit a license amendment?

MR. LAUR: I would say no.

CHAIRMAN STETKAR: Well, the rule tells me I do, in two places now.

VICE CHAIRMAN BLEY: Unless you define a method more --

CHAIRMAN STETKAR: Unless and until the water changes --

MR. LAUR: Well, the NRC-approved method, the safety evaluation for the approved method will likely or should provide the basis for the staff's acceptance of the --

CHAIRMAN STETKAR: So we're going to codify the fact that I can't -- we're going to codify now incentives to not improve methods because, my God, I've got to submit a license amendment if I want to use an improved method.

MR. LAUR: I guess there was a big debate. The word "method" obviously applies to what you're talking about. We're talking about the approach -- this is method and approach. We're really talking about the big picture, the phenomenological model, how it feeds into the risk. You're talking about details within the --

CHAIRMAN STETKAR: You'd better either tell people that, take it out of the rule, put it in the reg guide and explain what you mean by that, because I will tell you that somebody is going to argue, I cannot change the way that I calculate a number because that's a change in the method, and I'll net to submit a license amendment to do that, and, therefore, I cannot do that.

It's not cost beneficial to me, and the staff is going to hold me to this requirement to submit a license amendment, because that's what it says in the rule.

MR. LAUR: We have somebody to answer your question, I hope.

CHAIRMAN STETKAR: Okay.

MR. MIZUNO: This is Geary Mizuno, Office of the General Counsel for the NRC. And I'm not going to answer all of that question, because I see that there are two aspects of this question.

The first is whether a change -- sorry, whether NRC approval is needed to change in a method and what is a change in a method, that's a technical issue. I am not going to address that. That is something that you have to explore with the staff.

However, there was -- you first started off by saying why is a license amendment needed for an NRC review and approval of the change? Assuming that you've made the policy or regulatory decision that an NRC regulatory approval is needed for that change. Okay?

The reason for that is basically it's an outgrowth of the Commission's decision -- adjudicatory decision in a Davis-Besse case, I think it's about 15 years or 20 years old now, at this point where it says that if the NRC is approving something where there is some level of discretion afforded to the NRC or the NRC has to make a determination that is not strictly saying, yes, you are conforming with an objective standard, that that has to be done through a license amendment process.

So it's basically a legally driven thing, that the approval must be in the form of a license amendment. But whether the approval is needed or not, or what is the nature of that approval, that's what she is expressing.

CHAIRMAN STETKAR: Yes. I mean, what I'm arguing about in terms of the technical part is what threshold sets that bar for what is a change.

MR. MIZUNO: Right.

CHAIRMAN STETKAR: And then I did --

MR. MIZUNO: And that would be --

CHAIRMAN STETKAR: -- I get the legal end of once I reach that far, but --

VICE CHAIRMAN BLEY: But given the legal end, it's real important to be clear on what it means to change a method, or somebody is going to be forced into what you didn't intend them to be forced into.

CHAIRMAN STETKAR: Well, and there's then a legal -- I'm concerned that there is a legal incentive, a legal -- a legal disincentive to not improve methods, because, my God, I'm not going to go through the regulatory hassle and the expense of filing a license amendment request because I want to change the way -- there is an approved methodology for evaluating spurious actuations or, you know, pick any issue that is evolving.

I've got a digital I&C system that I put in, but I can't improve my methods of evaluating that, so --

MR. LAUR: And when you approve those methods and change the methods, if you have a PRA model update process that follows the industry consensus standard, and if you -- that has nothing to do with this, but you are then -- it's incumbent upon you to have a peer review, a focused peer review, because you have -- that's an upgrade, not an update.

And, in fact, in new reactors there is a -- the rule on the PRA has -- uses the word "upgrade," which is -- I don't know if that's what they meant, but they're the same thing. But I go back to what I said before. The safety evaluation will provide the basis for the staff's approval.

We're not going to say, yes, you use these methods in a PRA, because we're going to look at the general -- the big picture, which includes not only the plant response model, and some of the simplified approaches don't use that very much and, most of us, the phenomenology and how you determine whether the debris does or does not fail the strainer or the core.

CHAIRMAN STETKAR: But that's a much different perspective than what I'm talking about. Suppose somebody applies the seismic margins method, which seems to be allowed explicitly here in the rule.

MR. LAUR: Yes, it is.

CHAIRMAN STETKAR: I don't know why that is in the rule language other than the reg guide -- that's a different comment -- and then decides that they want to use an actual probabilistic method. Well, that's a change in the method. Oh, my God. I've got to file a license amendment because I want to improve a better probabilistic model, because the SER was written against that simplified margins.

Where I used FIVE for my -- F-I-V-E for the transcript -- for my fire analysis, well, it seems like I can do that because I don't need a good model for fires, and now I want to do a real risk-informed fire analysis. Well, it's a change, but I can't do that because it's a change.

VICE CHAIRMAN BLEY: I'm taking a look at the first part of the reg guide, which deals with lots of things but in one place it's dealing with the LOCA frequencies, and there it talks about there are several methods that are -- methods that are possible for assigning LOCA frequencies. And they are listed in Appendix C in decreasing order of conservatism.

Well, that -- if those are methods, and that's what they are defined as in the reg guide, that would mean that if I wanted to use an alternative one, would I need a license amendment, or would I just submit an analysis and you guys would review it and say, "Yeah, this is reasonable," or "It's not."

Usually, that doesn't require a license amendment for that kind of thing, but this language sounds like it would.

MR. LAUR: I have to defer to Geary Mizuno again, but I don't know what they would submit and what we would find if it weren't a license amendment. But I --

VICE CHAIRMAN BLEY: But if you called those things "methods," then --

MR. LAUR: Well, that is how --

VICE CHAIRMAN BLEY: -- do they fall under this --

MR. LAUR: In that example, that is our intent, that if we -- because a lot --

VICE CHAIRMAN BLEY: If they don't use the conservative one, they'd have to file a license amendment.

MR. LAUR: Well, no. For the initial -- well, first of all, they have to -- you have to file an initial license amendment to be granted this risk-informed --

VICE CHAIRMAN BLEY: Okay. Yeah.

MR. LAUR: So if someone comes and says, "Here is our approach. We're taking exception to your reg guide, because your reg guide only has this one very conservative method in it," okay, and they say, "Here is how we're going to partition. We're going to do go down the smallest sized break or equivalent break that can produce too much debris," and all of these pipes are -- in that class of size are exactly the same in terms of degradation mechanisms, and all that, and, therefore, we can divide the number of bad actors by the number of -- total number of pipes in that set, and we think that's acceptable, we would probably be able to find that acceptable because they're all the same degradation mechanism, same service conditions, whatever, and say, "Okay. Yes, you can divide." That's not in the reg guide. It's an exception.

So that would be their method. But if somebody did that and then they came back and later and said, "You know, actually, we have -- we've discovered a new source of -- we missed a source of debris." So there's another weld over here, and we can't divide because that's a different degradation mechanism.

In fact, it's far more likely than any of these -- it's a, you know, bad actor weld -- then they could update their analysis and say, "Yeah. We still meet your acceptance criteria." And what we're saying is, no, you -- that is a change of method. You have changed. We want to see it. If you look at our --

VICE CHAIRMAN BLEY: Well, "want to see it" is different from filing a license amendment. And Gary is throwing this back on you, saying you have to define what the method means, what a different method means.

MR. LAUR: Let me try a different one.

MEMBER CORRADINI: Can I just -- can I just try something? All I think I'm hearing is is that there is a screen -- you have implicitly a screening process in your mind that if they bring you something you're going to say this rises to a level where it's going to need an amendment, or this doesn't rise. The words don't say that. Somehow the words have got to say that in the rule. Otherwise, it implies that anything has to have an amendment. That's what I heard from --

MR. LAUR: The original thought was that 50.59 would cover this, and then we decided that it wasn't -- it wouldn't necessarily, because it talks -- anyway, Geary --

MEMBER BALLINGER: I need to interject here. I hate to be the bearer of bad news, because I know I'm treading on sacred ground here. The Chairman has a gavel, and he's going to use it, probably on me, but we really need to give the industry their due, and we're right up against that, and I see a whole bunch of slides here.

So without an exemption from the Chairman, we pretty much have to stick to this schedule. So there is a hard stop pretty close to like three minutes from now.

MR. MIZUNO: I just had one -- this is Geary Mizuno again from the NRC. I'd just like to make one point. The approved method can also define what is the level of allocation. Does it require an NRC approval? So there is flexibility that allows the NRC, as well as the licensee, to define what they think they are going to be allowed to change without an approval.

So it isn't that every change may necessarily require approval. The approved method itself may define the amount of flexibility that is required -- that would have required a license amendment.

CHAIRMAN STETKAR: But, Larry, a strict

reading -- or, Geary, I'm sorry. A strict reading of the rule language doesn't give me that, because even if I used one of, let's say, the three approved methods in the regulatory guide, and I desire to change, instead of Method A, go to Method B, it's in the reg guide. That is still a change. A strict reading of this rule language would say, "I have to file a license amendment," even though under the regulatory guidance, it's still one of the approved methods there, because I changed it.

MR. MIZUNO: Yes. See, however, let's just say the licensee wanted to provide itself the maximum amount of flexibility. They could in their application say, "I want to use A or B or C, and these are the ways that I will control it."

CHAIRMAN STETKAR: That sounds like an awfully convoluted -- I mean, I have to play -- as a licensee, I have to play an awful lot of gamesmanship and forethought in terms of casting my original --

MR. MIZUNO: That is correct. But I think the staff also indicated that why they were wanting to have that level of control, I believe I -- they said that. So you are correct. The staff intended that level of control. There are ways of ensuring that the staff understands what is going ahead, but, yes.

CHAIRMAN STETKAR: Okay. Thanks. And, in the interest of time, I'll be quiet.

MR. LAUR: So how do you want to -- do you want me to go to the next presentation on the reg guide or finish this one or what?

CHAIRMAN STETKAR: We've only got one more slide, so you can go to your --

MR. LAUR: I blew through all the other ones. We have reporting and corrective action requirements, which are basically the Reg Guide 1.174 full limit. So as long as they do not exceed those rather generous limits, they don't have to -- the licensee would not have to report or take corrective action.

I didn't hear the answer to the decision. You want to go to the next presentation?

MEMBER BALLINGER: Keep going. Keep going.

MR. LAUR: Well, I don't know what's on this one anymore. Let's see. Conclusion. There you go. We had over half of the 800 comments -- half of them were on the rule part, half of them were on the reg guide. Very popular. Basically, I have already covered what this allows. It allows you to take off the table the debris for the long-term cooling portion of the ECCS analysis, and we are finalizing Reg Guide 1.229, which is the next subject matter set of slides.

MEMBER BALLINGER: I have just received a dispensation, and so we can go a little bit over. We don't have another topic until later on, so -- but let's try not to abuse it too much.

MR. FONG: I'd really like to say one thing on Bullet 3. I kind of wish I had spoken up sooner. This is C.J. Fong with the staff. We talked quite a bit about the non-concurrence and the basis for limiting the rule to existing plants or, you know, not allowing the introduction of new debris. And I wanted to go back to what Reg Guide 1.174 says and talk a little bit about what the Commission told the staff.

They said -- the reg guide says, "For those cases in which risk increases are proposed, the benefits should be described and should be commensurate with the proposed risk increases." We went back and very carefully read the direction we received from the Commission, and they talked extensively about dose challenges with removing the insulation. There is asbestos, et cetera. So they kind of identified a number of those benefits for us, and the staff is mindful of that. We felt that a lot of those benefits would not necessarily apply to a new reactor that doesn't have any -- there is no dose to remove insulation from a reactor that doesn't yet exist.

And, furthermore, we felt that some of those benefits wouldn't apply to an existing reactor that chose to introduce problematic debris. So we didn't want to slam the door on those entities. We left that open. But we wanted to put the onus on them to describe what benefits they would be obtaining, whether it's safety or otherwise, for using this rule and having a risk increase.

So I think we got into meteorites and all kinds of stuff, but I wanted to bring it back to what the Commission told us to do.

CHAIRMAN STETKAR: See, I read the statements of consideration about the intent. I have no problem, because it's in the statement of considerations. I've studied the sentence that Steve threw at us, because I haven't seen it before. But his oral presentation of that statement -- that sentence sounds much more limiting and prescriptive than even what you just said orally.

MEMBER BALLINGER: Can we get that exact statement, the exact quote from --

(Simultaneous speaking.)

CHAIRMAN STETKAR: It's also difficult for the ACRS to write a letter on something when there are changes made in that document, especially if it's a rule. And, you know, we're now given the task to write a letter report to the Commission on a proposed rule that the Commission will see. And if we're writing our letter on something that is different from what the Commission will see, that's a real problem. That's a real problem.

MR. LAUR: I may be wrong, but I believe this is the only new sentence, Alysia? This is the only sentence that was --

CHAIRMAN STETKAR: You believe it's the only -- but even if there is only one, and it changes the intent or our interpretation of the intent of the rule, that's enough.

MR. LAUR: Yeah. I -- it didn't make it in time for the Subcommittee. I'm not aware of why we didn't put it -- change it, because we brought it up at the Subcommittee meeting, but it didn't make it in that document package. So now --

CHAIRMAN STETKAR: You don't want a letter from the ACRS saying, "Well, the Commission is saying, well, we didn't see the final version of the rule that you people are seeing. So we'll tell you what we're writing our letter on, and you go figure out how it applies to what you see."

MEMBER REMPE: Well, actually, what Paul mentioned with reporting, hasn't something changed, too, since what we saw at the Subcommittee meeting? So there's two instances. Is that a true statement? am I confused?

MR. McGINTY: Yes. There were some changes.

MEMBER REMPE: Okay.

MR. McGINTY: But the changes weren't fundamental changes. They were more clarifications.

MEMBER REMPE: But I'd like to see the clarification. I think there's two instances is what I'd like to --

CHAIRMAN STETKAR: But, see, the problem we're getting into is you think there's -- you're aware of one, and Steve said, well, he thought there was only one other. And the fact of the matter is the Committee has not seen the final version of the document that is being sent to the Commission. That's a fact. We don't know whether there is -- might be other changes.

MR. LAUR: Well, in fact, I believe the

document is still in concurrence. Is that correct? And so do we have comments, editorial -- I don't know what else. This one is a substantive comment for sure.

CHAIRMAN STETKAR: That is -- and some of the reporting might be considered substantive.

MEMBER REMPE: I think industry might think it's --

MEMBER BALLINGER: But with respect to Paul's changes, I thought that --

CHAIRMAN STETKAR: Talk into your mike.

MEMBER BALLINGER: -- I thought we had two documents. One was a redline short document, and I melded the two together thinking that they were one document now. They aren't?

CHAIRMAN STETKAR: No.

MR. McGINTY: We provide you with a redline strikeout of what was changing in the rule language. It's publicly available.

MR. LAUR: But did it have this change?

Mr. McGINTY: No. It was only the change pages associated with the reporting for the deterministic --

MR. LAUR: Okay.

CHAIRMAN STETKAR: Let's -- we're not

going to get this resolved in five minutes. It's on the record, so we should go on.

MR. LAUR: Okay. Reg Guide 1.229 provides acceptable methods for doing the risk-informed alternate approach. It leans heavily on existing staff-approved methods. The two examples here are basically saying we have some approved guidance for -- that applies to PWRs. Okay.

It also heavily basically uses Reg Guide 1.174, Reg Guide 1.200, the risk-informed portion, and for the risk-informed portion we try to only provide in the reg guide guidance on either the phenomenological portion, which is unique to this application or, in the case of defense-in-depth, where Reg Guide 1.174 provides seven key principles, or seven elements that might help you demonstrate you have adequate defense-in-depth, we try to flesh those out a little bit here for debris considerations.

And I'm not sure we were 100 percent successful, but I think we did a pretty decent job. And we have -- right now we have three appendices, but two of them are of one method, a simplified method. Hopefully, we will be able to add BWR considerations, et cetera, in appendices and not have to make major changes to those regulatory positions in Section C.

VICE CHAIRMAN BLEY: Yeah. What I have now and what we had at the Subcommittee, the last draft didn't have Appendix C in it anymore, but the draft before that that had Appendix C, Appendix C had a bunch of caveats at the front of things that weren't worked out yet that you are still working on.

So you're not expecting a letter from us on the reg guide at this time, are you? Are you going to bring us back the fixed one after you address those caveats?

MR. LAUR: I don't think we are going to have -- well, Appendix C was in the version that you received for the Subcommittee, and it is -- I think it's --

VICE CHAIRMAN BLEY: It came as a separate document. You're right.

MR. LAUR: Yeah.

VICE CHAIRMAN BLEY: It came as a separate document.

MR. LAUR: And then it's --

VICE CHAIRMAN BLEY: With five or six caveats at the front saying, "There's a bunch of things we haven't resolved yet we're still working on."

MR. LAUR: Right. And the version we have now that is in concurrence and we --

VICE CHAIRMAN BLEY: And we don't have, by the way, right? Or is it the same one?

MR. LAUR: It -- no, it's the one that you got -- the one that was received I guess a week ago and put in ADAMS for your review is the latest. That's in concurrence -- it's different than what we saw at the Subcommittee.

VICE CHAIRMAN BLEY: Since the Subcommittee.

MR. LAUR: Right. It's not significantly different. What we've basically done is pare out any option other than the very conservative approach that we talked about at the Subcommittee.

VICE CHAIRMAN BLEY: So in Appendix C --

MR. LAUR: Appendix C is in there.

VICE CHAIRMAN BLEY: As it was or --

MR. LAUR: It's very short.

VICE CHAIRMAN BLEY: You took out much of it.

MR. LAUR: Yeah. It -- we have examples of all of these methods, and there is only one method in Appendix C, right.

VICE CHAIRMAN BLEY: And all of those caveats are gone. You're not planning to resolve those.

MR. LAUR: Yes.

VICE CHAIRMAN BLEY: You have resolved them by throwing everything else away.

MR. LAUR: Right. And we are -- we left some of the text in Section C to -- for placeholders for future revisions, assuming we get a technical basis for how you partition break frequencies across welds and how you consider whether pipes can break. You know, if a 30-inch pipe can break half inch, all the way up to 30 inches, is that possible, to have that range of -- that's where most of the discussion was.

MR. FONG: And, I mean, what I would describe it is that the Appendix C we originally envisioned had a very conservative upper bound approach, more realistic approach, and then something kind of in the middle. And I was hoping to have all three of those ready to go.

As we went through the concurrence process, we determined that we could only really get alignment on the most conservative -- go figure, right? -- upper bound approach. So we decided to move forward with that, keeping that in the appendix, with the option of down the road hopefully we can align on another method to --

VICE CHAIRMAN BLEY: So you're planning to issue the reg guide that is in concurrence. You know, when we left that Subcommittee meeting, my impression of our discussion -- and I've looked back at the transcript -- was that it was possible and reasonable to separate the rule from the reg guide, because the rule doesn't have the kind of details we are talking about here.

MR. FONG: Right.

VICE CHAIRMAN BLEY: And that we would review the reg guide later as you made improvements to it and changes. But you have improved it by throwing away a bunch of stuff, and now it's going to be coming out, so rather expecting --

MR. LAUR: What we've thrown away it's --

VICE CHAIRMAN BLEY: -- comment from us.

MR. LAUR: Yes. But the version you saw in the Subcommittee was a redline -- had a redline strikeout, and it had already thrown all of this away, right? I mean, the changes between that, what you saw, and what you got to review here are very negligible. We found we had --

VICE CHAIRMAN BLEY: But we were left with the impression that you were going to improve that, and that was wrong, if you read the transcript.

MR. LAUR: I will have to defer to our project manager. I think the -- isn't the expectation that the reg guides come out concurrent with the rule, the reg guides that --

MR. FONG: I believe, Dr. Bley, that the version of the reg guide that we have right now, although it's still in concurrence, is acceptable and does provide a path for a licensee to implement the risk-informed alternative. It might not be perfect and, like I said, I think we can add to Appendix Charlie and offer some flexibility there.

VICE CHAIRMAN BLEY: Is that work planned on continuing?

MR. FONG: I'm sorry?

VICE CHAIRMAN BLEY: Are you planning to continue trying to develop that?

MR. FONG: Yes.

VICE CHAIRMAN BLEY: And issuing a revision at some point in the future?

MR. FONG: Yes. And the bulk of that technical revision will take place in Appendix Charlie, and will offer alternative methods for partitioning the LOCA frequency.

VICE CHAIRMAN BLEY: Do you have any idea when that might happen?

MR. FONG: I don't know right now, no.

VICE CHAIRMAN BLEY: Okay.

MR. LAUR: Okay. So

VICE CHAIRMAN BLEY: Five years? A year? No hints. Okay.

MR. LAUR: Okay. So I'm going to skip over the background in the interest of time.

Okay. So Section C, which is the regulatory positions, this is just an outline, but it is intended to be applicable to any entity that has a risk-informed approach, whereas the appendices, as I said, are PWR-focused and fairly specific guidance.

The systematic risk assessment of debris, we say it has to cover all hazards and all operating modes, but we recognize most of them will be screened out. We expect them to be screened out. And most of the ones that remain screened in we expect to be LOCAs, but -- and that's the experience from the pilot as well.

So we -- because of that, we have a whole section on initiating event frequencies, which jumps fairly quickly to LOCAs. But, you know, it could be a main steam line break or a main feedwater break inside containment for some plants, and it -- so we talk about in general, and then we jump into the LOCA frequencies.

And then, as I mentioned --

MEMBER BANERJEE: What is the bottom line here? Do we have to -- so are we having to write something on this reg guide at this meeting, or -- I mean --

MR. LAUR: What's the answer to that question? Yes.

MEMBER BANERJEE: So, in our letter, we have to comment on this reg guide?

CHAIRMAN STETKAR: We don't have to -- we have to do what we decide to do.

MEMBER BANERJEE: What we decide to do. All right. But --

MR. LAUR: You're asking what we're asking for. Yes. We're asking for a letter on 50.46c and the --

MEMBER BANERJEE: Which includes this.

MR. LAUR: -- reg guides. Yes.

MEMBER BANERJEE: Okay.

MR. FONG: I'd like to go back to what I was saying a second ago, which is that I think our vision for the reg guide would allow more options, more ways to partition LOCA frequency. But I really don't think -- I firmly believe that the product we have given you guys, and the product that is out there right now, is a solid technical product that will allow a licensee to implement the rule.

So, because there are a few pieces that aren't quite there yet, I view those as enhancements that we are going to try to do. But I don't think the current reg guide is insufficient or lacking in any way.

MEMBER BANERJEE: And if we wish to, John, we could separate the reg guide out to --

CHAIRMAN STETKAR: Sanjoy, we don't --

MEMBER BANERJEE: -- need to --

CHAIRMAN STETKAR: -- right now, in this meeting, we don't need to discuss what our options are.

MEMBER BANERJEE: Okay.

CHAIRMAN STETKAR: We decide what we put in our letters, and how we write those letters. And that's -- you know, that's for our discussion and our deliberations later.

MEMBER BANERJEE: Okay. So, Dennis, you've seen this reg guide, I mean, in detail?

VICE CHAIRMAN BLEY: Yep. We discussed it at the Subcommittee meeting. We had a lot of comments from our consultant.

CHAIRMAN STETKAR: We can discuss also that in our deliberations. I think in the interest of time here that -- I don't think we want to get into internal Committee deliberations --

MEMBER BANERJEE: No. But --

CHAIRMAN STETKAR: -- you know, interrupting the staff's presentation, and especially cutting out time for the industry.

MR. LAUR: Okay. We have a section on uncertainty where we reference pretty much NUREG-1855. We give guidance on the monitoring program. We talk about quality assurance for the risk-informed submittal and the periodic update of the analysis. We mentioned reporting corrective actions, and then we talk about what -- submittal guidance basically for the license amendment request.

And, again, in the interest of time, I -- unless you have questions on this, the detailed approach is much more detailed than a simplified approach, which big difference between -- a simplified approach uses tests to establish what I will call a critical value, but basically an amount of insulation that if generated and transported to the sump would fail the sump.

And using that as -- has conservatisms built into it. And using that as a threshold you can simplify the analysis by saying, "These particular scenarios do not generate to have these thrown off the table," and then they are deterministically compliant, if you will. And the other ones you assume that they go to core damage.

Resolving comments -- at the Subcommittee, we mentioned we had substantive comments from Office of Research having to do with the technical basis, and we have resolved this in kind of a minimalistic way by taking out any method that wasn't yet technically justified, and that we'll be working on that in the future, to add those to the reg guide in future revisions.

And, as a conclusion, we did learn a lot from the South Texas Project pilot, and that's where pretty much Appendix A came from. And then the simplified method also came from a change in the pilot approach.

We did update this to incorporate over 200 comments on the reg guide itself, and this leverages -- I say leverages -- it basically uses Reg. Guide 1.174. There's nothing new about the overall risk-informed approach, strictly the details on the phenomenology. And that's it.

MEMBER BANERJEE: So the pilot is evolving at the moment, right? I mean, it's very much in a state of evolution.

MR. SMITH: We think the current submittal from South Texas is a viable one. So it's -- I don't think it is going to evolve a lot more.

MR. LAUR: Right. And that came in in August, and it's a product of a whole lot of give and take with -- between meetings and RAIs and responses. So --

MEMBER BANERJEE: And you've got a -- your determination coming out when?

MR. SMITH: The middle of next year.

MEMBER BANERJEE: And then it will come to us.

MR. SMITH: Yes.

MEMBER BANERJEE: Because we have seen a project in flux.

MR. SMITH: Yes.

MEMBER BANERJEE: Okay.

MEMBER BALLINGER: Is that it?

MR. LAUR: I'm done, unless you've got more questions, have Steve or C.J. -- would like to answer.

MS. BONE: This is Alysia Bone from the NRC staff, and I just wanted to give a quick perspective on where we are globally with the project in general, if that would be helpful. So currently the package -- the 50.46c rule, the SOC, and all of the regulatory guides are still in concurrence. So, as normal process, we have a couple of legs left -- OGC, NRR, front office, and EEO.

And as we continue to shepherd the package through concurrence, we are resolving comments and refining the language in the SOC accordingly. So everything right now is still draft, but I just wanted to give you that kind of overall look of where we are, because the package could change between now -- and we're happy to provide you whatever you need at this point, just so you can see a snapshot of where we are now, but just because of where -- how the process normally works, it could continue to change up until it is provided to the Commission in February.

So I just wanted to give you kind of the legs of what -- when it might change again. So we have about three more. We have already made it through about, you know, five or six stages. So the version we gave you was kind of at the best stable state, but just because of the nature of the process.

MEMBER BALLINGER: Thank you. In the interest of time, we should just continue with the industry side. I mean, I know we've gone a long way without appropriate breaks and things, but -- and industry has to get their full time, wherever they are.

MR. CLEFTON: Dr. Ballinger, we'll give you five minutes of the industry time, so we can all take a break. I mean, it has been --

(Laughter.)

MEMBER BALLINGER: Now you're introducing a complication.

MR. CLEFTON: It has been a long time.

MEMBER BALLINGER: It has been a long time? Okay. Five-minute break.

(Whereupon, the above-entitled matter went off the record at 10:40 a.m. and resumed at 10:49 a.m.)

CHAIRMAN STETKAR: We are back in session. We'll try to get everybody assembled here again.

And, Ron, I'll turn it back to you since you're doing such a stellar job.

MEMBER BALLINGER: Hey, if anybody can get a special dispensation from you, I'm doing a stellar job.

Okay. I don't have to say anything but go ahead.

MR. CLEFTON: Good morning. I'm pleased to see there's some relieved faces in the audience.

(Laughter.)

MR. CLEFTON: This is Gordon Clefton from NEI and I'd like to first thank the NRC for cooperating so well with the industry and the fact that we've had hundreds of subject matter experts on this at work since the year 2000 when we submitted the petition. And in the past year after we put our 200 pages of comments in on the draft rule we have had numerous interfaces with the NRC and had surprisingly effective responses up to, as Doc Ballinger pointed out, Thanksgiving week. We were still responding comments from the industry to make the rule more acceptable to both sides to give us a value associated with it.

Go onto the first slide, if you would, or do I have control of that here?

Oh, okay. What's been alluded to already is the fact that this history has gone on for 15 years. Significant changes have occurred with that. We had an ANPR that was pretty obnoxious to the industry. We provided a lot of comments on that. It refined itself into the draft version, which was certainly improved. And then with multiple face-to-face interface improvements we've brought it up to date.

But during that time, since the year 2000, economics have hit the industry, and it's hit the industry hard. I'm sure most people here are familiar with FitzPatrick, with Pilgrim, with Vermont Yankee. We've lost some significant power plants based on the economics associated. These weren't in place when we started this rule. This rule was developed even before these plants have hit the financial issue.

Of note significantly right now is the industry has been working on the cumulative effects of regulation to try and identify those so that we're getting the most bang for the buck, to be the safest operating plants that we possibly can, but we still have to amortize the cost of improvements and modifications, license amendment requests and such over the life of the plant.

We are intensely looking at alternative methods to do that. Likewise, the NRC is working on its Project AIM now, 2020, and that's right-sizing the budget and the staff of the NRC. That's going out to prioritize work load for not only the industry but the

NRC, conservation of resources if you will. Additionally, we have in the industry developed a new process with the chief nuclear officers to try and bring our costs down. It's an internal effort to be more efficient, identify those work items that will bring us the best bang for our buck, the safest operation.

This rule, as you can tell because we've been living comfortably on 46 for the year 2000 and earlier, and it extends out to the year 2023 for full implementation based on our survey that we put out to each of the utilities, we don't see that there's a rush to get into it. We'll have a slide later on where we'll propose a different implementation plan. Paul alluded to it.

Tom's got some specifics here. We're going to try and keep our presentation down. As we've clarified with Alysia and Paul, we've provided a significant amount of comments along the way. We've seen many of those as improvements and we're happy to see those. We are continuing work with them. This isn't a finished product. We're very concerned that the product as we know it is changing quite a bit. We're cognizant of the fact that the final version going to the Commission will be different than what we're looking at today and what we saw in October, what we saw last August. So that's a concern that the industry shares with the ACRS, that it's a moving target and it's tough to justify full support of what's not yet solidified.

Going to the next slide here, and I'll introduce Tom Eichenberg, who's the chairman of our EPRI Reg-TAC, and the EPRI Reg-TAC brings together licensees, vendors, utility folks, individual consultants. And as a result we've had literally hundreds of people, subject matter expert; some more passionate than others, but subject matter experts on this that have worked with us to get the comments to the NRC, to meet on technical aspects, to help get the Reg Guides as good as they are. And so, we will continue with that organization, if you will, to work with the staff. We've got scheduled work shops in January already to refine some of the templates that we pursue for reporting aspects. We've got it scheduled out into the spring of 2016.

So Tom's got a couple things here we'll bring up and then we'll turn it over to questions, if we can.

MR. EICHENBERG: At the end of the Subcommittee meeting there was a very brief discussion about how do we have an adequate protection rule that's not a safety issue?

MEMBER REMPE: Is your microphone on?

MEMBER BALLINGER: Bring it in closer. Press at the bottom. There we go.

MR. EICHENBERG: Yes. So at the end of the Subcommittee meeting there was a very brief discussion about how do we on the one have an adequate protection rule and on the other hand it's not a safety issue? And so I wanted to try and clarify that and to also bring up a broader picture about what is adequate protection and how do we avoid going from adequate protection to perfect protection, because it can be a slippery slope.

So what we wanted to reiterate to everyone was that we have a fleet operability assessment showing margin to the phenomena described in research. And I use the term "operability assessment" to differentiate from a licensing analysis. So in an operability assessment you're doing more of a best estimate, here's our best guess at how things perform. And that's different from a reviewed and approved methodology based on analytical limits with what we talk about in the next bullet, which are retained margin. So industry --

MEMBER CORRADINI: Just to clarify --

MR. EICHENBERG: Yes?

MEMBER CORRADINI: -- what you call as an operability assessment on Paul's flow chart was the industry's generic margin assessment?

MR. EICHENBERG: Yes.

MEMBER CORRADINI: Okay.

MR. EICHENBERG: The owner's groups provided those assessments.

So we just wanted to bring to people's attention that the analytical limits which the NRC is proposing do have substantial retained margin. There's nothing best estimate about the limits. And there's two bases to that. First if that we're going to protect brittle failure by setting a ductility standard. So by definition you've qualitatively created margin.

The second aspect of this is the testing methodology, particularly for what we call the ECR limits. The testing methodology itself is conservative in the sense that it did not distinguish between different types of heat-up transients. It was run the samples up to a temperature and hold it there and go and go and go at 2,200 Fahrenheit. So those of us who are familiar with LOCA analysis know that the

LOCA doesn't behave like that. So there is also inherent margin in what is tested.

And we also wanted to bring up the fact that this early breakaway oxidation phenomenon was only observed for the older Russian material, the E-110. And in fact, the Russian vendors no longer use the electrolytic process which produced those material samples and it is to our knowledge the Russians no longer see this particular problem. Informally we've heard that the Russians believe that excess fluorine from the reduction process of the initial material is probably to blame for what was going on. So that leads us to the observable, which is that in the United States we just have not had this problem, and that's because we used a different process from what the Russians used.

MEMBER SCHULTZ: Tom, in the --

MR. EICHENBERG: Yes?

MEMBER SCHULTZ: -- implementation then of what has been proposed you not only have the testing, but you also have new limits? And then you have new analysis approaches that need to be developed in order to --

MR. EICHENBERG: In the original --

MEMBER SCHULTZ: -- assess those limits?

MR. EICHENBERG: Yes, in the original concept of the rule the idea was that licensees would be reporting a breakaway oxidation time similar to the way you might report a PCT or an oxide limit. And this didn't make any sense since the licensees don't necessarily do the manufacturing themselves or the testing. So we worked with the staff to put the onus of this early oxidation testing into the vendor's hands where it can be more easily implemented.

As part of that idea that we were going to report something, it meant you had to know what it is you were going to report. In other words, the expectation was not that you would say you met some 5,000-second idea. It was you're going to go do literal testing and tell us how many seconds you support. So it was not a go/no go type situation.

So what we said is by getting it into the vendor's shop the vendors will test and they will turn it into a go/no go type of assessment where let's say your particular methodology only requires you to support 500 seconds under the conditions where this phenomena could occur, but you're having a go/no go test out to say 3,000 seconds or 4,000 seconds so that you just say it meets it. And each vendor then quasi-certifies the material provided to the licensee meets the requirement under the approved program.

MEMBER SCHULTZ: I think you said what I was getting at, and that is the analysis methodology needs to change also in order to incorporate the evaluation of the breakaway oxidation.

MR. EICHENBERG: We're going to have to look at how much time the analyses, which are to be developed -- how much time do they need to defend such that we know how long we need to run these tests and know what we're defending. So there is a piece of that puzzle, but I don't think it's substantially larger than the bigger issue of putting together a program to do the testing and getting that reviewed and approved.

MEMBER BANERJEE: So is it --

MR. EICHENBERG: But it --

MEMBER BANERJEE: -- just related to time and temperature or just --

MEMBER BALLINGER: Push your button.

MEMBER BANERJEE: The most annoying thing.

So is there a -- your issue is not with the test itself, but how it's conducted, like the time and temperature, or is it more fundamental? Like that saying --

MR. EICHENBERG: I think --

MEMBER BANERJEE: -- whether it's 3,000 seconds or 5,000 seconds --

MR. EICHENBERG: Right.

MEMBER BANERJEE: -- or whatever, yes.

MR. EICHENBERG: So at a 50,000-foot level --

MEMBER BANERJEE: Yes.

MR. EICHENBERG: -- our concern is why are we doing this, because it isn't an issue in the United States. A little bit lower down, maybe a 5,000-foot level, is, well, we're going to conduct testing. The testing itself is not necessarily difficult. It's a fairly straightforward test. But because it's straightforward and it's simple doesn't mean it's not expensive. It's a very capital-intensive activity, particularly for production facility. And you've got to be able to keep the production facility running, therefore you have to have sufficient test equipment in place should something go wrong with one of your testing --

(Simultaneous speaking.)

MEMBER BANERJEE: Well, what's typically the cost of one of these things?

MR. EICHENBERG: I do not know the literal costs of these furnaces, which are the big drivers, but they are not cheap. Yes, the vendors would be able to give us a better idea because they're in the process of procuring these devices right now. But, yes, something in the -- anywhere from 300 to 500,000 per unit.

MEMBER BANERJEE: And how many units are needed?

MR. EICHENBERG: At a minimum you're going to want two units, because for a production facility if one should fail or has to go down for maintenance, you still got to be able to function.

MEMBER RICCARDELLA: How frequent during the production would you anticipate that these tests need to be performed? I mean, is it just once every six months, or is it like every week?

MR. EICHENBERG: One idea is that it's going to be performed on an ingot basis. We'll certify the ingot as good. What comes out after the ingot will be good. This is something that needs to be worked out between the vendors and the staff and in development of the program that they're going to put together. But we also envision an opportunity to have a variable frequency. In other words, as -- I think we used the term "a learning environment." As we learn something, we're going to say, well, we've been testing this for six years now. There's no reason to test every single ingot. Nothing materially has changed in the process to indicate a problem.

MEMBER BANERJEE: How big is an ingot? Is it like you have to sample it?

MR. EICHENBERG: You would sample the ingot, but an ingot produces something like, what is it, 20,000 rods? About 10,000, yes.

MEMBER BANERJEE: So you would sample every ingot, is that it?

MR. EICHENBERG: Right, as opposed to randomly pulling out a finished product and saying I'm going to test five finished products out of 10,000, if you just test the ingot, the material is the material.

MEMBER BANERJEE: Yes.

MR. EICHENBERG: But we could have one of the Westinghouse people clarify anything.

MEMBER BANERJEE: Go ahead.

MR. MITCHELL: This is David Mitchell from Westinghouse. Right now Westinghouse currently produces around 100 ingots a year, and the Reg Guide basically requires a number of -- you don't do just one test per ingot. You do several tests back to back to confirm that the ingot exceeds the breakaway time. Now you do it on the finished tubing. So what we have to do is set up a system where we don't really track -- I mean, we know for each tube that's produced what ingot it came from, but they may be interlaced as they go through production. And so we have to keep track of that. Then we would have to do a number of tests. I think right now it's like three tests per -- reruns per ingot. That's four tests.

So we'd have to do 400 of these tests a year. And you're going to take -- you've got to basically heat up the equipment, run the test for close to an hour in length, extract the sample, let it cool, inspect it if necessary. If it showed any indication, send it out for hydrogen analysis. And then at that point you release -- once you have the test done, you release those tubes for production. So you've got to keep track of all of this.

And as we said, we have to have two of these furnaces. Even if you could keep up with one, you can't have a facility suddenly come to a stop because your one furnace breaks. You have to have a backup there. And it's not like buying a autoclave to do the standard ASTM testing. There's no off-the-shelf equipment for this. We're having it custom designed for us by an outside supplier right now. And all the equipment together is -- per furnace it's hundreds of thousands of dollars, close to a half a million. So you buy two of these and it's a lot of money. Plus you have to train the operators and change all of your internal procedures and software to accommodate this.

MEMBER BANERJEE: So it would significant add to your sort of QC costs? What sort of --

MR. MITCHELL: Well, it adds to -- you have to interlace it into your existing QC process --

MEMBER BANERJEE: Right.

MR. MITCHELL: -- because it is going to be a no go test. You're not going to release the tubes for production. So now you have to arrange your QA system so that you track the first TREX for an ingot. And then that ingot, that TREX becomes a lot of tubes and now you have to say, okay, I'm going to have to test those tubes, get the repeat test before I can release any of the tubes from that ingot for production.

MEMBER BANERJEE: So how much would it add to your QC costs in percentage, existing QC costs.

MR. MITCHELL: We're not sure. I mean, we're still trying to run down the cost because we haven't completely implemented that.

MEMBER BANERJEE: So give me a guess.

MR. MITCHELL: Well, you're going to be -- it's going to affecting it on the order of 50 to 100,000 per year on an ongoing basis, or more. Plus by the time you put everything in place, it's going to be over a million dollars for each tube facility that you have.

MEMBER BANERJEE: That's your capital investment?

MR. MITCHELL: Well, capital and labor. I mean, you --

(Simultaneous speaking.)

MEMBER BANERJEE: So I'm just trying to get an idea of what the actual cost is.

MR. MITCHELL: -- if you walk into a production plant and you go say I've got this piece of equipment that costs this much money, they still have to -- the facility's engineers at that site have to then put that equipment into place. So they've got to have a breaker box, they've got to run cables, they've got to go through safety review boards. There's a whole series of stuff that has to be done. Plus you have to find space for this. So by the time you add up all these costs, they become considerable by the time you put this in as a production piece of equipment.

MEMBER BANERJEE: So if you -- what, you typically amortize this over 5 or 10 years? Some number like that, right? So, I'm trying to get an idea of what the real cost is per year. Is it 100,000 per year? What is the number? Taking everything into account. Roughly. I mean, we're arguing that this is going to be very, very expensive. So I just want to know the number.

MR. MITCHELL: Well, it's going to be the -- the overall cost I think is --

MEMBER BANERJEE: What is it, roughly?

MR. MITCHELL: Well, the overall -- well, I can't give you an amortized figure.

MEMBER BANERJEE: Give me a rough number.

MEMBER BALLINGER: I'm going to have to institute adult supervision here.

(Laughter.)

MEMBER BANERJEE: Sorry.

MEMBER BALLINGER: We got to --

MEMBER BANERJEE: No, I'm just --

MEMBER BALLINGER: Can we get --

(Simultaneous speaking.)

MEMBER BANERJEE: -- number.

MEMBER BALLINGER: Yes.

MEMBER BANERJEE: Is it 100,000, 500,000

per year? Twenty thousand? What is the number?

MR. EICHENBERG: It's probably something in the 200 -- 250,000 a year.

MEMBER BANERJEE: All right.

MR. EICHENBERG: Because you're going to have some amortization cost, plus you're going to have your annual O&M for performance.

MEMBER BANERJEE: Yes, sure. So this is added to your QC?

MR. CLIFFORD: I mean, excuse me. Paul Clifford from the staff. All these costs have been amortized in the regulatory analysis, which is made available with the rule. So if you want to go dig through it and -- and this is based upon input we received from the industry.

MR. CLEFTON: We did have two closed door sessions with the staff and the vendors to be able to talk specifics that were proprietary information, which I think is what your pointing out here, is that figures have been then cleaned up to put into the regulatory analysis so that it's reasonably available. There's a frustration with that one. It's got an ML number, but we can't get to it from the public side. But we got a copy last night, thanks to the staff, and we processed it through our prep meeting yesterday, and we still have some issues.

MR. EICHENBERG: Okay. On this next slide here we just wanted to highlight that we still have a few potential concerns, but we've essentially come down to its guidance. As far as the rule and the rule language are concerned, we think that certainly we can live with it. And the discussion we had just at Thanksgiving, we heard some very good things about where we were going to go in reporting space, although yet we've only seen the redline version, so we don't yet know how the final thing all falls out. But we certainly are willing to work on bridging those gaps. And we've got a lot of things that we've put on our own plate to work with the staff.

One area of interest here that I put on the potential concerns is the review standard. We typically would not be involved in a review standard per se, however, we do want to write guidance for all the licensees about how to develop the license amendment requests. And so, if we aren't aware of how the review standard is going, it could potentially be difficult for us to build that guidance.

So that was really the essence of what we had for concerns.

MR. CLEFTON: And this just further

supported the fact that it's an ongoing effort, and even though Paul would like to say it's over, it certainly is not. We're going to be working this for some time, and we'll be working it together. And as the Reg Guide for the risk-informed identified; that's Rev. 0 that's coming out, as we see need for use and such, talk with CJ and Steve that will be assisting in revisions to it to get that as more workable items. But it's key here that the policy industry has -- or that NRC has now to put Reg Guides out with the current rules. It's a great one. We support that. But we're in a state of flux here as we're going into the final stages. And the Reg Guides aren't finalized. The rule language isn't finalized. And it's a challenge for all of us to accept what's out there.

The last slide that we had here was just an implementation proposal. And this is supportive of our nuclear promise, the AIM 2020, and the cumulative effects of regulation is the fact that we've identified that 50.46 gives us a wide margin of safe operation continuation. There's going to be a transition over the next 84 months that we identified when we went out -- or survey of when the plants could put this into effect if they were required to implement 46 Charlie.

But it comes to a question of why does a plant need to implement to 46 Charlie if they're just going to run to the end of their licensing life or if they're going to not make any changes that require a new evaluation model? Perhaps that they could have a conditional compliance to 46 Charlie, that they could include that with a site improvement evaluation model requirement or something else that would be cost effective to at that time roll to 46 Charlie. Otherwise, just continue on 46.

We've had one RIS meeting that identified the reporting aspects of 46 by itself, so there's a RIS coming out on that. Paul identified in his slides that the reporting requirements are effectively the same in 46, although they could be slightly enhanced. There's improvements as we've identified that we can live with in 46 Charlie, but if we can make it conditional to the power plants that don't need to roll to 46, that gives them a cost savings of perhaps a million dollars a site for round figures of implementing the 46 Charlie. Because we have LARs involved. We have licensing, we have letters, we have compliance, we have evaluation models, LOCA analysis models, all the expenses that accumulate. And that doesn't give us anything different in safe operation or commercial operation. So it's almost a penalty to roll to 46 Charlie without a real need for doing it.

So it's proposed here, and what we saw in simplest form was in that paragraph P. If you deleted the first sentence and just left with the sentence that existed, it would say that the utilities could -- until such compliance is achieved the requirements of 46 would still apply. We think that's a reasonable suggestion. The 84 months was confirmed with our survey with feedback from the utilities, so we feel confident we can live with that if necessary, but we'd certainly like to make that an option for a plant that doesn't need an effective evaluation model to be able to stay with 46.

We've been at this 15 years already on 46, and longer, and we've got another 8 years before the last play steps into 46 compliance. So if we could go 23 years without a new rule safely, it's questionable whether we need to force it on the utilities.

MEMBER BROWN: Would this be -- put that back up. Would 46 Charlie be a decision item in terms of whether you requested a license extension or not? I mean, based on all the stuff you read about the difficulty of maintaining an economic set of plants and plants shutting down, would this -- before they -- I mean, not going into a extended period would this drive them -- would this be an item that would tend to drive them to say, okay, we'll just shut the plant down and not -- when we're finished with our currently licensed period?

MR. CLEFTON: By itself, probably not.

MEMBER BROWN: Okay.

MR. CLEFTON: Because it's an acceptable dollar amount. In a cumulative effect it becomes an issue if we have other issues that are minimum gain for safety or for performance evaluation. So by itself, no. And as you identified over here, it was going to be amortized over many years. That's acceptable, too. But we have plants that are right on the margin of what they are allowed to sell their power and what they're being able to charge for their power. And losing FitzPatrick and Vermont Yankee and Pilgrim all here at once in New England is going to affect the cost of power. And we don't want to see plants going away anymore than the NRC does.

MEMBER SCHULTZ: Gordon, do you have an idea of how many plants would be affected in that way, or could be affected in that way?

MR. CLEFTON: The one fleet that stepped

up said that they had almost six plants that were running very close to the dollar values. And part of it's the economic arrangement that they can sell power and the competition that we have with the price of natural gas. Natural gas bubble goes away and it suddenly becomes expensive, then we become more attractive as a baseline power source.

But we have a number of plants that are -- I would say a dozen at least that are in the neighborhood of financial concern, and that's why the AIM 2020 and the nuclear promise to cut our costs back by significant percentages of operation, and then the cumulative effects of regulations where we've worked with the staff at a management level to prioritize work that's ongoing, prioritize work that we're available to handle.

We're going to have to be aware that whenever we expend resources, either in the NRC or in the industry, on a topic of minimal gain, that we're taking people away from something that maybe is more important. Plates are full, staffs are reduced at the plant. So this is significant to a plant because of the personnel involved, the resources that the vendors are somewhat limited, and the resources at the NRC are not huge to be able to process maybe 100 LARs for risk-informed modifications and changes if we were to start doing that. We want to stay in the 50.59 for modifications. We want to use LARs for appropriate purposes. So the points that we had earlier in the day for the risk-informed rule prospect is significant.

MEMBER RICCARDELLA: Gordon, I'm trying to understand if we went with your proposal here, what would drive the decision to either stay with 46 or go with 46 Charlie? Would it be purely economics or is there something else that --

(Simultaneous speaking.)

MR. CLEFTON: No, in simplest form it would be when you needed a LOCA analysis evaluation model. And what we'd have to work with the staff is to define exactly what criteria would lead you to put a new model in place. And we just used the term here generically as a new evaluation model, but I think if we got into a point of a fuel change from a vendor, going from one supplier to another, to a power up-rate, to a significant change to the flow through the ECCS systems, it could be because the ops lessens pumps or valves or flow circuits, anything that made a physical change, then this would tag on to a other modification that's going on as opposed to being just to make compliance with the rule. And so, there would be a purpose or a reason that you'd have at the utility that would drive you to it. And then it would be an add-on cost. And as Doc Brown or --

MR. BROWN: Member Brown.

MR. CLEFTON: -- Member Brown, sorry -- Member Brown pointed out it would be a smaller amount when it's compiled to say an upgrade, which is a significant amount of money.

MEMBER CORRADINI: So, I'm still a little bit fuzzy, so let me put it in start terms. So 15 years ago something was discovered that there's a change in the physical phenomenological process in terms of new cladding. And there's three mechanisms. So two of them, as I understand them; and I could be wrong, are burnup-related. So as I increase burnup, I could potentially see an effect. The breakaway oxidation is something that you said on one of your slides was peculiar to some particular batch by some particular place in the world. So there is no current activities by the industry to make sure any three of these mechanisms is not interfering with current clad integrity? All is good? You're giving that impression and I'm not sure that's an exact impression.

MR. CLEFTON: We have confidence in our quality assurance programs at each of the vendors. And they are not going to deliver fuel rods to us that are unacceptable at all. So within their QA programs already are addressing this issue. And as you pointed out, we got 15 years of operating 100 plants, no problem.

MEMBER CORRADINI: But I want to be real specific: So in this time period as this rule is being developed are there things that industry is doing to make sure relative to burnup or to breakaway oxidation, since as I understand it that's not burnup-related, that make sure you have margin? And are those efforts essentially any less or more -- I don't want to use the word expensive, but I'll use comprehensive, than what is being expected here? Because what you're asking with this deletion is we're going to stick with our current practices so we don't need 50.46c, but I'm not exactly sure where the breakpoint is as to where I would switch and I would need it. And I'm not clear by what you said where that breakpoint is. It seems very vague.

MR. EICHENBERG: I think one of the things that we're saying is that -- we'll use breakaway oxidation or breakaway -- yes, oxidation as an example. The vendors do do testing on this phenomena. It's not a every single ingot and every single polished rod testing, but they have done testing on the material they've produced over the years. And they haven't found this to be an issue. I think in the case where we have the lowest time to breakaway test measurements which are related to Zirc-4, it still is something that's on the order of above 3,000 seconds.

MEMBER CORRADINI: Okay. And now the burnup issue. Are you saying that if you don't want to be in the ballpark of 46c, you will keep all your burnups less than something? And what is that something?

MR. EICHENBERG: Well, the implied something coming out of the example -- regarding inside oxidation phenomena, the implied example is that as you get to the 30 or 35,000 megawatt base burnup. That was where they discussed the safe harbor concept. Obviously the phenomena doesn't appear until you get to a certain point. So from that aspect you could say it's not going to happen below those values. However, as was pointed out, those are not economically viable exposures for fuel.

MEMBER RICCARDELLA: Would that be

something that would trigger going to 46c?

MR. EICHENBERG: That could be something that's triggered going to 46c. There may be ways of providing information to assess the effect independent of an entire wholesale methodology swap-out.

MEMBER CORRADINI: So you're getting to where -- what Pete's asking is kind of where I -- what's the trigger point, if you want to say I have two -- sorry. I hit the wrong button. What's the trigger point that you say I'm in the non-c world versus the c world? If it's burnt. Leave breakaway oxidation off the table. Let's deal with things that are burnup-related. I'm trying to understand the trigger point.

And my next question is going to be, okay, now you're going to sharpen your pencils and show you got to be in the non-c world. If you're going to spend all that money to go through that, is it better to simply accept that the advance in technology and all the associated stuff is -- you might as well be in the c world and get all these benefits. Potential. Potential benefits.

MR. EICHENBERG: Right. There may well be a cost benefit analysis that shows you are better off making the jump early to 50.46c as opposed to not doing it.

MEMBER CORRADINI: Okay.

MR. EICHENBERG: But I think the gap that we're concerned with are those plants -- let's hypothetically assume that the plant has six more years left on its existing license. All right? Why would they spend the effort? Or let's say the rule comes into effect. We've got 84 months to get to the end. The license expires in 88 months. Why do I make the effort type of thing? So there's kind of this uncertain zone.

MEMBER CORRADINI: Yes, I understand.

MR. EICHENBERG: Yes.

MEMBER CORRADINI: I get that.

MR. EICHENBERG: Yes.

MEMBER CORRADINI: Okay. Thank you.

MEMBER BALLINGER: Okay.

MR. CLEFTON: Did we leave you enough time?

(Laughter.)

MEMBER BALLINGER: Well, it's problematic now.

MEMBER SKILLMAN: Gordon and Tom, I would like to ask one question. You haven't really discussed it here. The effort to change to 50.46c is conducted by a small population of very highly qualified people. This is not something that's done by a brand new engineer or a couple of contractors that have no experience. This is delicate work. It's important work. Would you speak for a minute to the resources that are required and the resources that are available?

MR. CLEFTON: Yes, sir. As you know we've done personnel reductions at the sites. We've got a lot of knowledge transfer and retention challenges, the site, as does the NRC. We have people retiring right now, and that's affecting us. The ability to do good modifications at the site without vendor assistance or engineering AI firms is challenging right now because there haven't been modifications. We've got the plants up and running very well. We're sitting 90 percent, 95, 98 percent performance. There's no changes needed, no modifications until we go into a second licensing going from 60 to 80, or something like that.

So right now we're at a stage where personnel on site is limited to do this. We'd have to count heavily on vendor support. And talking with the vendors, as we have through the EPRI Reg-TAC organization, is that they have limited resources available.

That led to our survey results of why we came up with a request to go from the 60 months that was originally proposed in the language of the rule to 84 months, because we had blocks of time that we needed to allow for appropriate -- not multi-tasking, single-tasking, but not quite single because we've got three vendors, but stretched out over a period of time to allow the people on the site to take time to do it, the NRC to review it with their reasonably limited resources, and vendors to provide the work. And that's without the expense of capital improvements that we were talking about earlier.

So, yes, the resources and availability is an issue that affected our schedule and it drove us out from 60 months to 84 months on putting a survey together of how long it would take the plants to do it.

MR. EICHENBERG: Back even before the draft rule came out there had been discussions informally about what would implementation look like? This was when we were trying to develop tracks and tiers and who would do it and how much time would be involved. And that was one of the very first things that came to my head, was if we've got a track that requires everything done in 24 months, can it even be physically supported?

And so over the years now, as this has progressed, it's a continuing discussion that we have with the vendors. Can you support this? And it's a strong emphasis out of the group that I chair in speaking to the vendors, and to the members themselves: the licensees need to be talking to the vendors like last year about how they're going to get across the finish line, even though we don't know where the finish line is because the vendors will have to undertake some sort of training and mentoring activities.

It's just that the duration of this activity we can't assume that everybody involved is still going to be in the same chair, that they're doing the same thing 10 years from now, or even 5 years from now. So it's a big consideration on our plate and it's driving us to think about we need to put money up front earlier than we otherwise would precisely because there are training issues out there that need to be addressed.

MEMBER SKILLMAN: Thank you.

MEMBER BALLINGER: Any other questions form members?

(No audible response.)

MEMBER BALLINGER: Okay. Questions, comments from the public here?

(No audible response.)

MEMBER BALLINGER: Can we open the bridge line as well? Is it open? I don't hear any crackling.

VICE CHAIRMAN BLEY: Good digital technology. No crackling.

MR. CLEFTON: That's a go/no go. That's a go/no go test.

(Laughter.)

MEMBER BALLINGER: That got you, Dennis.

CHAIRMAN STETKAR: If you were an electrical engineer, you'd understand why we can't have a filter.

VICE CHAIRMAN BLEY: I still don't hear any crackling.

CHAIRMAN STETKAR: Chris, can we confirm that we have it open?

VICE CHAIRMAN BLEY: There's a sound. Something happened.

MEMBER BALLINGER: If you're out there, can you please identify yourself as being there?

CHAIRMAN STETKAR: Just somebody just say hello, please, because that's the only way we have positive confirmation that it's open.

MR. LEWIS: Yes, there are a number of us.

CHAIRMAN STETKAR: Great. Thank you very much. So now we know it's open.

MEMBER BALLINGER: Ah, okay. So please make your comment.

MR. LEWIS: Hi. Marvin Lewis, member of the public. Are you talking to me?

MEMBER BALLINGER: Yes, we are.

MR. LEWIS: Wonderful. Okay. I didn't know that you heard me previously. All right. Look, I'm looking at the Reed report, of course, and a lot of these issues came up back then, which was back in -- oh, long time ago. Let me see what year. NUREG-1285. It was back in -- oh, boy, oh, boy, when did the Reed report come in? I don't see a date. Oh, here it is. '87. And they had the same problems. They handled it differently. Of course they didn't have much PRA in that day. And they point out a heck of a lot of things that I'm hearing.

Now, I don't know if you've looked at this. I don't know if you looked at the reactor sub-cooling, reactivity spikes, loss of feedwater. Yes, you would have looked at that one, of course. Fuel failures due to pellet cladding interaction. And now we say that pellet cladding is going to be bonding and it's going to be helpful. Well, you know, the things that are helpful one day can be a problem the next day.

For instance, the cladding has a lot of features that -- I followed 10 CFR 50.46 Charlie, but -- and I did not see a lot of the things that I wanted to see looked at. The answer I got -- and you have one of them on, from Michelle and Tara Inverso was that, oh, they're looking at the change in the phases of the underlying zirconium, or zirconium alloy, which may or not be helpful. What I'm trying to say is things change. What is helpful one time can be a problem the next.

For instance, Russian iron won't rust in ocean water unless it's scratched, and then it goes real fast. And we can have that same problem, as you point out already, from fluoride in manufacturing. Luckily we don't us fluoride supposedly in manufacturing. That doesn't mean it can't get contaminated and give us that same problem unexpectedly. We didn't expect a 9 earthquake with a tsunami that was actually increased by a sea wall rather than being decreased by a seal wall over in

Fukushima. And Fukushima goes on. And I don't see any more information coming out of Fukushima except they're having a few problems. A lot of problems.

I am just saying the staff and the industry have a certain outlook, and that outlook is the staff and the industry's right. My problem is I don't believe they're always right and I'd sure like to see that attitude, which I do, that the industry and the staff may not always be right in the ACRS.

Yes, I have to congratulate you. Yes, you do try, but not overall, to look at it from the attitude of the people in the lifeboats, namely the public. But what I am saying is overall you do have a propensity toward the industry. You do ask the question how much? And I'm wondering if that's the right question to ask when you're looking at what may be a disaster for the country. Thank you.

MEMBER BALLINGER: Thank you, Mr. Lewis. Others out there?

MS. GILMORE: Yes, this is Donna Gilmore. Now when you're doing the assessment of the fuel, are you decoupling that from the dry storage part of this? There's a relationship between problems, you know, with high burnup in the reactor and the storage, and there seems to be a disconnect. So to me any approval or evaluations should be taken in the back end and not just the front end. Is there any efforts to do that?

MEMBER BALLINGER: We're allowed to receive comments, but not take action or answer questions. I'm sure that's correct. So if you have questions that you need answers to, we can give you Chris Brown's number here, and we can get the answers for you.

MS. GILMORE: Oh, okay. All right. Thank you.

MEMBER BALLINGER: Any other members of the public out there that want to speak?

(No audible response.)

MEMBER BALLINGER: Going once? Going twice?

Over to you, Mr. Chairman.

CHAIRMAN STETKAR: Thank you. We'll get the bridge line re-closed so that the pops and crackles stop bothering us.

Thank you, all, again staff and the industry, for a very good discussion. We obviously had a very active discussion.

A couple of administrative things. For the purpose of everyone, including the public, we're kind of in a state of flux a bit for our schedule, so on our agenda for the time period between 11:15 and noon today we had a topic scheduled of discussion of potential topics for our meeting with the full Commission in March. We're going to postpone that topic to the end of our planning and procedures session tomorrow morning, so it will be held around 10:00 or 10:15 tomorrow, Friday morning. That will give us some flexibility for dealing with things that we need to do in real time this morning.

And with that, we will recess until 1:00 this afternoon.

(Whereupon, the above-entitled matter went off the record at 11:39 a.m. and resumed at 1:02 p.m.)

CHAIRMAN STETKAR: We are back in session and the topic of this afternoon's session is the Lee Combined License Application and Harold Ray will lead us through that topic. Harold, you have the floor.

MEMBER RAY: Thank you, Mr. Chairman. This afternoon we will receive presentations from the Applicant and staff concerning the Combined License Application for, full name, William States Lee Nuclear Station Units 1 and 2.

The COLA incorporates, first, the Westinghouse Electric Company AP1000 certified design; second, standard plank content material from the

AP1000 reference Combined License Application, and, third, Lee plant-specific information.

Our AP1000 Subcommittee held a two-day meeting on October 21st and 22nd, 2015 to review the plant-specific information in the COLA and the staff's advanced final safety evaluation report.

We also had the benefit of review and comments in the areas of geology, seismology, and geotechnical engineering from our consultant, Dr. Bill Hinze.

The application informs to the design-centered review approach, which is a Commission policy that allows the staff to perform one review and reach a decision for all plants which reference a designated design center. The first COLA that receives a complete NRC staff review for a design center is designated as the R-COLA or Reference COLA. Any subsequent application referencing the same design is designated as a Subsequent COLA. In this case, the Reference COLA is that for Vogtle Units 3 and 4. Summer and Levy are Subsequent COLA plants. Lee will be the third Subsequent COLA.

So, the process of reviewing plant-specific information while referencing requirements that have been previously reviewed and approved in a design certification and Reference COLA is not new but it has been four years since we have done so.

I would like to highlight two items which are new to us before we begin. One is that the seismic inputs at this site exceed both the spectra which are included in the AP1000 design certification. This exceedance has been addressed in accordance with explicit provisions, which were included in the certification and this will be the first time we will be reviewing use of these provisions.

The second new issue is that we have been informed of several matters which affect multiple plants from the design center and which are expected to be addressed using the design center review approach as generic departures from the certified design in the Reference COLA. These matters will not be part of our review of the Lee Subsequent COLA today but we expect they will come to us following submittal and staff review.

So, we will proceed with the presentations, keeping in mind that these two items, which are new to our review under Part 52 were scheduled for two hours. I would ask that everyone make best efforts to adhere to that. And I will turn it over to Larry Burkhart.

MR. BURKHART: Thank you, Mr. Ray and Mr. Chairman.

I am the Branch Chief of the AP1000 Project Branch in NRO's Division of New Reactor Licensing. I want to thank the subcommittee and the full committee for working with us. This does mark a significant point in the completion of the staff's review of the site-specific issues, as Mr. Ray said.

We had a very vigorous exchange of information in the subcommittee. I'm sure we will have the same today. And just to note that we are currently on the ACRS's subcommittee for AP1000 to talk about the design issues, the five design issues in March under the Levy docket.

So with that, I just want to say thank you. Thanks to the Applicant for all of their effort and the staff's efforts. And we look forward to the exchange with you.

MEMBER RAY: Thank you. If that is all, Larry, we will turn the floor over to the Applicant. So, Bob.

MR. KITCHEN: Yes, sir. Good afternoon, Mr. Chairman and the members of the ACRS. I'm Bob Kitchen and I'm the Director of Licensing for Nuclear Development of Duke Energy. John Thrasher is the

Director of Engineering for our Nuclear Development at Duke Energy and we are going to talk through Lee overview and also quite a bit of discussion, as you will see, on the seismic evaluation that Mr. Ray mentioned in his introduction.

Just to give you a perspective of location, Duke Energy Carolinas Nuclear Fleet is shown here. We currently have three sites with nuclear plants in operation, Oconee, McGuire, and Catawba. You can see that the Lee site is located in South Carolina. It is about an hour southwest of Charlotte.

Interestingly, we will talk about this a little bit, but this site was also previously selected for a three-unit system 80 plus that was abandoned in the early '80s and it is the same site we have selected for Lee.

Just the site layout. This is a typical AP1000 standard layout. You can see the Unit 1 and 2 park island is in the center there. One item of -- just to note the cooling tower arrangement. You can see the Broad River in the upper right corner of the slide. That is the source of water make up for the plant. We also have three make up ponds, Make Up Pond A, which is the primary source for make up to the plant and Make Up Pond B, which provides backup. As we developed the site and looked at the situations, particularly with some droughts and things like that, we determined to add a third make up pond, Make Up C, which is actually off of this figure. It is about two miles to the northwest. And Make Up Pond C provides make up backup, additional make up for the site capability.

So, the ability to not withdraw from the Broad River, it has been restricted in terms of withdrawal requirements, the Make Up Pond B will provide about 30 days of backup and then Make Up Pond C would provide about another 160 days. So, we have the capability with this site and this plant design to go about six months without withdraw from the Broad River.

So, that is basically the layout. Nothing there that is particularly unique, other than the make up situation I discussed there.

Looking at COLA changes that we have made since the reference COLA, which of course was Vogtle, the committee reviewed that in 2011, Fukushima being the biggest item. And the biggest impact from Fukushima for AP1000 was the seismic design. And the bulk of our discussion today is going to be to walk you through what we have done and the direction we have had to go to address seismic considerations for the Lee site to implement the central eastern U.S. seismic update, including the EPRI ground motion model. So, we will talk through there. And as Mr. Ray indicated in his introduction, we did have exceedances of over the envelope, CSTRS, and hardrock high frequency envelopes in the AP1000.

The other thing that has occurred since the reference COL emergency plan rule was changed and we had to implement that by December 2013 and that is included in our COLA. It is, frankly, a lot of that is license condition to implement some things that would bring that into alignment, after we get the plant procedures and training in place.

Another activity that has been implemented in the Lee COLA is the electrical bulletin. This came out of an event in the industry referred to as the Byron Event, which is the loss of phase, one phase on offsite power and presented a pretty good challenge for Byron. It is a significantly different design and, of course, it would be an active plant design. The response of AP1000 would be different. But we had to take actions to be able to identify the occurrence of a loss of phase event and provide alarms in the control room so the operators could address. And that is addressed in our COLA as well.

The other item that Mr. Ray mentioned in the introduction are things that we have identified were either fortunate or, depending on the perspective, unfortunate position of dealing of things that are identified during construction of detail design. Some of these we feel need to be addressed in our license if those are in process. Because of the standard design, as Mr. Ray indicated, our plan is to address that on the Levy COLA. And that change, additions, revisions to the COLA that are to reflect those standard design changes would then be rolled into Lee.

There is five most significant, in terms of work and effort to do. Condensate return, which is associated with the ability for the passive system to collection condensate and containment, to maintain the containment refuel water storage tank level to support cooling operations. That is ongoing.

We have got main control room operator dose, which we identified that there were some errors in calculations, most primarily a filter that was not included. And that results in the operator dose exceeding the 5 rem GDC-19 requirement.

Main control room heat load, we have got some heat load considerations where the load assumptions, DCD did not reflect the AP1000 requirements. I mean if they do, then that results in the control room operational environment that needs to be addressed.

Hydrogen vent is a situation where the ITAAC can't be accomplished as written because of the design changes that need to be addressed. So, we are doing calculations. Westinghouse is working calculations to address the hydrogen diffusion flame and the impact of structural containment.

And then the last is the plant monitoring system, a feature called Flux Doubling, which is, frankly, a compliance with IEEE code that we need to correct and it is specifically addressed in Part 50. So, we need to do that to comply with regulation.

Those are in progress. Those are the items that we expect to finish and support March ACRS Subcommittee review, again, on Lee docket.

Looking at areas for Lee specifically, focus areas for discussion, I guess the first one is really a summary of the site characteristics. We are looking at the Lee site with the bounding parameters specified by the AP1000 certified design. They are all bounded with the exception of seismic, again, we are going to discuss. So, that would include all of the meteorology, offsite hazards, hydrology considerations. And in working through all those for the site, they are bounded by the AP1000 envelope. So, not a concern for the Lee site.

The one item I want to mention really just so you understand what we are talking about, we have, as I mentioned, the Lee site was also previously the site for the Cherokee station. And actually construction was started at Cherokee in the late '70s and early '80s and then abandoned.

So, we have the Lee site located essentially over the centerline over Cherokee. And one of the units on the northwest corner, there is the hardrock layer dips. And as we look at that more and more in doing the site studies, we have determined that it was going to have more of an impact than we had really thought originally.

So, frankly, with the delay in the license due to the Waste Confidence Rule, we took advantage of that time. We will go ahead and make the correction to move the location of the Lee site to eliminate this significant construction impact, to excavate, to get down to hardrock, and then come back up.

So, that is a positive. It is not a

safety issue. It is simply a consideration for construction impacting commercial.

So, that does have a plus for us in that the site is now uniform foundation of hardrock either through the natural rock or the Cherokee foundation, which is there. And I will show you in just a minute a picture of that relocation.

So, the seismic evaluation is, again, where we plan to spend most of our time today. Of course, we have a much shorter duration with the ACRS today but we wanted to make sure we walked through how we dispositioned the seismic issues.

And as you will see, the methodology that we applied is not something we invented. This is specified in the DCD. And so really, it is just an alternative method to comply with DCD requirements.

This is the plant relocation. This gray area you can see is the Cherokee footprint. The original location of the site, Unit 1, is shown and you can see here on the left this dashed line. So, all we did was we moved Unit 1 50 feet to the east and 66 feet to the south. And then we moved Unit 2 66 feet to the south. So, the net, the plants are 50 feet closer. They still meet the minimum separation requirement. And then we moved them to the south, which results in the footprint of the site be completely underlain by the Cherokee foundation.

So, plant relocation sounds pretty ominous. It is the net of about a 60-foot change. We did have to go through all of the considerations in terms of the license application, to make sure that we didn't have a change somehow in the geology, meteorology, security, et cetera. So, we went through a very rigorous review of all of the requirements and the staff, we appreciate the significant effort on the staff that even though it is not, in the end, such a big change, it does require a significant amount of work for you. So, that is why we made this change.

That is kind of an overview of the site. We are going to go ahead and step through the seismic evaluation and, hopefully, address some questions you might have there.

John.

MR. THRASHER: Thank you, Bob. Again, I'm John Thrasher, Director of Engineering and Nuclear Development at Duke Energy.

So, the seismic evaluation the first thing we will talk about is the Lee site laboratory ground motion.

The Central Eastern U.S. seismic source

characterization model was updated or updated seismic source information for NUREG-2115 needed updating to evaluate that information. So, we updated the laboratory ground motion evaluations for the site. We were implementing that model directly. We also ended up implementing, along with that, the updated 2013 update that EPRI made to the ground motion model.

Also, as part of that evaluation, the seismic source data was updated through I believe the end of 2008. And so when we started doing that review and updating the site seismic hazard evaluation, we looked at new information that had been issued since NUREG-2115. And two particular items that were looked at were Eastern Tennessee Seismic Zone. There had been some recent papers out discussing potentially to consider the Eastern Tennessee Seismic Zone as a repeated large magnitude earthquake. We reviewed those papers and determined that that was not necessary. There was not enough evidence showing that Eastern Tennessee Seismic Zone needed to be considered in that manner. And the way that it was considered in the seismic source characterization model in NUREG-2115 was appropriate.

We also had the Mineral, Virginia earthquake in 2011 that occurred. And while that was some miles from the site and outside of the normal region of evaluation, we looked at that. That was a magnitude 5.8 earthquake. And looking at the seismic source data that was in NUREG-2115, that magnitude earthquake was bounded by that and it was already in the seismic sources. But basically, those evaluations were made and confirmed that there was no change really required to the seismic source data that was presented in NUREG-2115.

So, we updated the probabilistic seismic hazards analysis for the site and those results show that we have low frequency hazard contribution from Charleston and New Madrid, repeated large magnitude earthquakes and also from local background.

We see at the Lee site we have high frequency contribution. It is almost completely from the local background sources.

Basically, we will see in a minute, we ended up developing, for Unit 1, as Bob mentioned, Unit 1 nuclear island will found and over top of legacy Cherokee concrete. We will actually have to put some additional, about five and half feet of fill concrete on top of that old basement that will be left in place to get to the bottom elevation of the nuclear island base mat.

And so we ended up calculating for Unit 1 a foundation input response spectra, which would be the seismic response, input at the base of the Unit 1 nuclear island. For Unit 2, we calculated a ground motion response factor Unit 2 will be founded on hardrock. And so for the evaluations that we had to perform for site-specific evaluations, we basically enveloped the Unit 1 foundation input response spectra into Unit 2 ground motion response spectra to come up with the design. Even those spectra were fairly similar to each other, we enveloped those to develop what we called an NI or a nuclear island FIRS or foundation input response spectra. That one spectra was used in the site-specific evaluations that we ended up performing.

MEMBER RAY: John, I just want to say again what I said in the introduction. We did have the benefit of review from our consultant in these areas, Dr. Hinze, and he participated in the subcommittee meetings.

MR. THRASHER: Thank you.

So, those are fairly complex evaluations or steps that we had to go through. But as Bob Kitchen mentioned earlier, we followed the methodology that is in AP1000 DCD, Design Certification Document.

And so what I would like to first do is kind of step through that methodology, the different steps and then we will look at a flowchart that we developed to try and kind of simplify getting to an understanding and then we will look at actual site-specific evaluation results and we will keep referring back to that flowchart as we kind of step through the process and see the extent of the evaluations that had to be performed to qualify the Lee site for deployment of the AP1000.

So first off, if you look at the certified design, the AP1000 seismic design basis is the certified seismic design response spectra or CSDRS. So, if you have a site where your ground motion response spectra is enveloped by the CSDRS, that is acceptable. And so you can stop, basically, comparisons. At that point, we know that AP1000 design is robust and adequate for your site. And that is called out in DCD 2.5.2.

And to hardrock sites in the southern U.S., we ended up seeing spectra that had a lot of high frequency content. So the DCD was revised to allow an alternate acceptance criteria called the HRHF or hardrock high frequency spectra. That was developed by a supporting evaluation that Westinghouse performed in Technical Report 115 and the document number is listed there on the slide.

So, an alternative acceptance criteria, if you are not bounded -- if your site spectra is not bounded by the CSDRS is to look and see if your site specter is bounded by the hardrock high frequency spectra.

And if you don't satisfy you with those criteria, the DCD allows you to step into site-specific evaluations and its two-step alternate methodology there to qualify the site.

If you look on this slide, we put together a flowchart to try to kind of simplify these complex issues. Again, the standard qualification would be above the dashed purple line here in the middle of the slide.

So, the first thing, again, you would compare your site response spectra and you would look to see if you were bounded by the certified seismic design response spectra of the CSDRS. And we will look at results and see where the Lee site falls on that.

The second step, if you don't meet that qualification criteria, you would look and see if the hardrock high frequency spectra bounds the site spectra. And again, we will see in a moment where the Lee site didn't satisfy either one of those criteria. So, we had to go to the methodology below the dashed line or site-specific analyses had to be performed.

That two-step methodology again, the first step is to look at in-structure response spectra developed in the CSDRS and the HRHF spectra and compare those to the in-structure response spectra at six key locations developed from the Lee site spectra. And you could qualify the site in that manner.

Those six key locations provide a good representation of plant structural responses and overall results.

If you cannot satisfy that criteria, then you go to the second step of the alternate site-specific evaluation analysis methodology. That evaluation is outlined in DCD Appendix 3I. And basically you end up looking at force and movement comparisons for structures, major equipment, and piping and supports. And then you look at test spectra comparisons for high frequency sensitive equipment and qualifying that high frequency sensitive equipment.

So first off, before we move into looking at specific results, again, AP1000 DCD has two spectras that you can compare to. And on this curve we see the red dashed spectra is the AP1000 CSDRS or certified seismic design response spectra. In a low frequency range between 1 and 10 hertz. You can see you have pretty high spectra influence there and low frequency areas between 1 and 10 hertz is where you typically see high displacements that lead to higher building forces and higher equipment forces.

The blue dashed line on this curve is AP1000 hardrock high frequency spectra. And again, you can see in the low frequency range 1 to 10 hertz. That hardrock high frequency spectra is, those results are fairly low. That content is fairly low. However, if you look between 10 and 100 hertz, you see higher frequency values. But then the high frequency range that typically is associated with low displacements, they typically result in lower or smaller forces on buildings and equipment. It can be seen to be non-damaging.

So, the CSDRS spectra for the AP1000 was developed using Reg Guide 1.60 criteria. Again, the dominant energy in that spectra is between 2 and 10 hertz.

So, that is the design spectra for the AP1000 results and a very robust design spectra rich in energy in that frequency range and gives you a robust structural design and robust design of structure systems and components.

In the hardrock high frequency area, again, you are going to see lower forces and moments so it would not be a good practice to make a plant design using just the hardrock high frequency spectra because you would have a much less robust structure system and component design.

All right, so let's look at Lee specific results.

As Bob mentioned, after the plant relocation, the Lee Nuclear Station has uniform hardrock site with configuration -- uniform support configuration just as described in the AP1000 DCD.

However, if we look at and in just a moment we will look at the nuclear island FIRS, foundation input response spectra, that was developed for the Lee site, that that nuclear island FIRS is higher or is not bounded by the CSDRS. Also, the nuclear island FIRS is higher or is not bounded by the AP1000 hardrock high frequency spectra. So, we cannot use either one of those direct spectra comparison methods to qualify the AP1000 for deployment at the Lee site.

So, the next slide will show us the actual spectra comparisons. So, again, the curves on this slide, the blue dashed curve, again, is the AP1000 certified seismic design response spectra CSDRS. The purple curve is the AP1000 hardrock high frequency spectra. And the red curve is the Lee nuclear island FIRS.

So, you can notice particularly in the high frequency ranges that Lee nuclear island FIRS is not bounded by the blue dashed curve or the purple curve.

MEMBER RAY: Hence, a departure.

MR. THRASHER: Hence, a departure and we go into a site-specific evaluation. So yes, there is a departure for that.

We go back to the flowchart. We kind of update the flowchart as we step through it. So, we have made the first two comparisons. The nuclear island foundation input response spectra at the Lee site is not bounded by the CSDRS and is not bounded by the HRHF. So, we do not satisfy either one of those qualification criteria. That is the red x's on this slide. And we will have to move into site-specific analyses.

So, the first part of that site-specific analysis is to look at site-specific and structure response spectra at six key locations. So the corresponding in-structure spectra from the CSDRS and/or the hardrock high frequency spectra and see if the standard plant spectra bound the Lee in-structure spectra.

Site-specific analysis was performed. Those results were submitted in a report to the NRC as part of the NUREG-2115 COLA update that Duke provided. And that report is in ADAMS as report WLGGWGLR-815.

Again, when we looked at those six key locations, we noticed that there were several exceedances and figures are in the Lee FSAR showing those in-structure spectra comparisons at the six key locations.

So, let's look at some actual results so you can understand the exceedances. So, at one of the key locations, this first line shows the comparison of spectra, in-structure spectra results at the control room floor, the northeast corner of the office building at elevation 116.5 feet. And so we have spectra in the three different directions.

The black curve is the in-structure spectra from the AP1000 CSDRS spectra. The red dashed curve is the in-structure spectra resulting from the

AP1000 hardrock high frequency spectra. And the blue spectra is the in-structure spectra resulting from applying the Lee nuclear island FIRS.

In most cases, the Lee nuclear island FIRS in-structure spectra is bounded. However, if we go to the next slide, we will kind of look at one of those, the Z direction or the vertical direction. And if you look on the right most side of that out 50 hertz and above there is exceedances. So, the blue dashed curve, again, is the in-structure spectra results from the Lee NI FIRS and we have exceedances of the CSDRS and HRHF in-structure spectra.

MEMBER RAY: So, if I can interrupt, this is where we go beyond Summer into something we are doing for the first time here, you will discuss, of course.

MEMBER RICCARDELLA: This is just one of the six locations and this one is way up at like 50 hertz.

MR. THRASHER: Right.

MEMBER RICCARDELLA: Were there more significant exceedances at any of the other locations?

MR. THRASHER: We're looking back at the six key locations, and there were exceedances at four of the six locations. The majority of the exceedances were in the 40 to 100 hertz range or a couple very minor exceedances in the 15 to 20 hertz range in a couple of those areas.

MEMBER RAY: John, I want to be clear to everybody. You are talking here about the seismic class 1.

MR. THRASHER: That is correct.

MEMBER RAY: The seismic class 2 structures are somewhat different in that regard. But I just want to be clear these are six places in the safety-related structure.

MR. THRASHER: Okay, so back to the flowchart again. So, now we are down in the two-step methodology site-specific analyses. And as we mentioned, we did not have site-specific in-structure response spectra that were bounded by the in-structure spectra from CSDRS and HRHF. So, comparing those six key locations, and as you ask the clarifying question at those six key locations, we had some minor exceedances. Most of the time it was in one direction in four of the six key locations.

So, that leads us into having to move to the second step of that methodology, which is evaluations in accordance with DCD Appendix 3I. And basically the same type of sampling evaluations that

Westinghouse performed when they updated the DCD to add the hardrock high frequency spectra. So, that evaluation is really focused on making comparisons of forces and movement for structures, major equipment, and reviewing stresses and piping analysis, and then looking at high frequency sensitive equipment and looking at equipment qualification test spectra compared to required spectra for that site, for that location.

CHAIRMAN STETKAR: When you said all one -- mostly, you are being appropriate because that wasn't at the subcommittee meeting.

The example you showed was Z direction, vertical.

MR. THRASHER: Right.

CHAIRMAN STETKAR: Were they all vertical or were they combinations of horizontal and vertical?

MR. THRASHER: I think they were mostly vertical. I think there was one --

MEMBER RAY: While you are looking, of course, the building is stiffest in the vertical direction.

CHAIRMAN STETKAR: Yes, well that is why -- I was just curious.

MR. THRASHER: Well, it looks like we had, they were kind of somewhat scattered.

CHAIRMAN STETKAR: Okay, thanks. Just curious. Thank you.

MEMBER RICCARDELLA: But they were all nothing lower than above 40 hertz you said?

MEMBER RAY: Your mike is not on.

CHAIRMAN STETKAR: I think he said a couple down in the 50 hertz.

MR. THRASHER: There were several of these that were in the 17, 18 hertz range and another one that was in that area, in the 15 to 25 hertz range.

MEMBER RICCARDELLA: Thank you.

MR. THRASHER: All right, moving to the next slide. So, again, at the six key locations we didn't pass that criteria. We go into an evaluation methodology. Again, this is Westinghouse TR-115 and so we used a similar methodology when they developed the hardrock high frequency spectra and revised the AP1000 DCD and they incorporated that information in Appendix 3I. So, we get into a sampling methodology.

So, the next slide. Site-specific analysis ends up showing that the high frequency exceedances do not control design and qualification that the results from the CSDRS control and those results are based on reviewing a representative sample of structures, major equipment and piping to end up reaching that conclusion.

Also, the safety-related piping design for the standard AP1000 standard design practices were to evaluate that safety-related piping for the CSDRS spectra and then run a separate evaluation for the HRHF spectra. So, there was a sampling of piping for the Lee site that was performed using the Lee nuclear island FIR spectra to look at that and see what those results look like.

We also had to review high frequency equipment qualification practices. Appendix 3I has a table that was added in that appendix of all the high frequency-sensitive equipment in the AP1000 design. And so we reviewed completed tests, the actual test response spectra that were used and determined that the actual test response spectra bounded the required site-specific spectra.

Duke also ended up making a commitment to ensure that all future test response spectra enveloped the Lee site-specific required response spectra in case later on we build the plant, if a different component was procured, it had to be tested, we would make sure the test spectra envelope, the Lee-required spectra for that equipment. Or if years down the road we did a plant modification or an engineering change and had to change out a piece of equipment, we would make sure that that test spectra was bounding.

MEMBER RAY: And that last bullet and the two sub-bullets are not a sampling scheme. You used the word sampling.

MR. THRASHER: Right. Excuse me. That was not a sampling. That was looking at all --

MEMBER RAY: All equipment qualification.

MR. THRASHER: -- the high frequency-sensitive equipment that is listed in Appendix 3I, looking at all that equipment.

MEMBER RAY: Yes.

CHAIRMAN STETKAR: John, I am quickly trying to -- again, I have to apologize. I didn't attend the subcommittee meeting. So, it may have been addressed there.

I'm quickly trying to scan through that 28-page table here. Help me out. I'm not quickly seeing things like digital instrumentation. I have to be careful. I don't want to call it instrumentation because I am seeing instruments but the digital protection and control cabinets. Other people might call them the things that the computers live in. Are they in that list and did you have test results for them?

I see main control room things.

MR. THRASHER: Right.

CHAIRMAN STETKAR: But those are control boards. Those are operator work stations.

MR. THRASHER: Right.

CHAIRMAN STETKAR: I'm talking about the --

MR. THRASHER: I know some of the equipment that was on that list and I know that the actual spectra from the report that we got from Westinghouse evaluation in comparison looked at some of the plant monitoring system, PMS, cabinets and some of those types of cabinets. And particularly since we saw exceedances at one of the key locations in the area of the control room, at that elevation, we specifically made sure that all of that equipment at that elevation that had already been tested, that those test spectra end results were --

CHAIRMAN STETKAR: Well, what I am asking is, the cabinets that I am looking for, because I can't digest 28 pages of individual line items of things, those particular cabinets, the PMS, the protection monitoring system cabinets, they were tested at these high frequencies?

MR. THRASHER: Yes.

CHAIRMAN STETKAR: They were, okay. That is what I was looking for.

MEMBER RAY: As I read it, it was complete, as I said, it wasn't sampling. But if you want to ask somebody to --

CHAIRMAN STETKAR: Well, they carefully said on the record today that everything in this table. And I see things like operator work station. I don't necessarily see PMS cabinets but I am trying to do this in real time.

MEMBER RAY: I wasn't reading the table. I was reading the words separately and then listening and I asked the question about sampling.

Like I said, if there is any -- you have made a definitive statement. I think if there is anything you want to check you can perhaps ask somebody to do that and give us an answer at the end. But I understood it to be everything that was affected by the high frequency exceedance.

MR. THRASHER: That's correct.

CHAIRMAN STETKAR: Is that everything in the table or everything in the plant?

MR. THRASHER: Well, all the equipment in the table was what was --

CHAIRMAN STETKAR: And that is -- I'm trying to find out whether everything in the plant in the sense of safety-related digital protection and monitoring system cabinets satisfies that intersection that I am looking for.

MR. THRASHER: I mean I guess we can take a follow-up and check on that but that table was added -- well, the whole Appendix 3I was added when AP1000 DCD was updated for the hardrock high frequency. And that table identified all of the high frequency equipment in the standard plant.

MEMBER RAY: Well, just let me make a request. If there is any correction to what you have told us, which is inconsistent with what I have read, please get back to us.

MR. THRASHER: All right. So, if we look at some specific results, first off, again, we were looking at a sampling of structures, major equipment and piping and looking at force comparisons. So, this is actually the shield building at the connection region between reinforced concrete and steel composite concrete.

The resulting forces from the certified seismic design response spectra bound the site-specific forces. So, in the table that is shown below with four elements that are outlined in this model, the resulting forces from CSDRS are shown on the right side of the table. And you can see that those bound the results from the Lee spectra, those elements.

So, this is not the only location that was looked at. This is a representative sample just to show in the presentation today. So, there was sampling done based on where we had exceedances at the six key locations. There was a lot of other evaluations that went back and looked at further elevational groups of in-structure spectra and then structural evaluations were done at a multitude of locations throughout the structure and this is just one example to show.

And again, if you remember back to where we showed the curve of the certified spectra and the hardrock high frequency spectra, in a robust design in the 1 to 10 hertz range for those structures, in that 1 to 10 hertz frequency range and the hardrock high frequency spectra is fairly low in the 1 to 10 hertz range. So, as you would expect, the resulting forces from CSDRS envelope, the resulting forces from site-specific. This is one structural evaluation.

MEMBER RAY: Maybe this is one point, since you took that digression, for me to ask, or ask you before you finish and looking ahead, it doesn't look like you have planned to touch on it.

At the subcommittee meeting you talked about what I think is the same consequence, which is the HCLPF results being more robust than in the DCD here.

And if you would comment on that because it was part of your secondary presentation just to add it to this discussion, please.

MR. THRASHER: Right. So, our end results when we get all the way through this, we will end up showing that with the Lee spectra, even though it exceeds the hardrock high frequency spectra and the certified design spectra, the design with the Lee spectra input is really still controlled by the certified seismic design response spectra.

So, if you look at the seismic margin and everything, it is still basically the same because we are saying the standard design per the certified seismic design response spectra is still bounding, even with the Lee spectra input. Or actually you could consider it there is probably more margin there.

MEMBER RAY: Well, that is what you said earlier. And that is what I was --

MR. THRASHER: Right. So the CSDRS still

governs. So, you have got at least that same seismic margin, if you look at Chapter 19 type evaluations and you really have more margin, since you can see in some of these comparisons it will show that you have got quite a bit of margin in some of the comparisons there.

Okay, looking at the next slide looking at, again, primary equipment was an area that several evaluations were performed looking at primary equipment. This is a comparison of reactor coolant loop primary equipment nozzles. And again, the resulting bending moments on those nozzles from the certified seismic design response spectra shown on the right side of this table; the results from the Lee site-specific spectra are on the left side.

You can see the CSDRS forces and moments bound the site-specific forces and moments. And even the one there for the reactor coolant piping cold reg nozzle is probably the closest one shown here, 3,809 kip-feet compared to 3,081 kip-feet. And you have still got even with that one 23 percent lower results there.

Okay, we also compared several piping analysis problems. And again, with the AP1000 standard design, a safety-related piping is qualified using the CSDRS spectra and the piping is also analyzed for the hardrock high frequency spectra.

So, the piping analysis several models where we saw in-structure spectra exceedances, some of the piping that was connected at those locations, evaluations were performed, and the CSDRS and the HRHF was bounding. So, again, CSDRS forces, moments, stresses bound the site-specific forces stresses.

Probably the more significant area for being concerned with high frequency content is with the high frequency sensitive type equipment. And so we have got an example curve here of equipment qualification testing for the transfer panel at the main control room elevation. The red and green curves on this chart show the test response spectra that was used and this panel was tested in two directions. So, the red curve is the front to back direction for the panel. The green curve is the side-to-side direction.

The AP1000 methodology for equipment qualification, the envelope, the AP1000 required test spectra for the CSDRS and the HRHF and that is represented by the blue curve on this chart and then the required spectra for the Lee site is shown in purple.

And in most cases, the standard plant,

CSDRS HRHF spectra exceeds the Lee spectra. There is a slight exceedance of the Lee spectra, the purple curve over the blue curve at about the 30 hertz range. But you can see that the test spectra, the TRS, based on CSDRS and HRHF bound the site-specific required response spectra for testing this equipment.

MEMBER RICCARDELLA: But these are two horizontal curves instead of vertical. Was it tested to a vertical curve, too?

MEMBER RAY: Microphone.

MEMBER RICCARDELLA: I'm sorry. I'll repeat. These are two horizontal curves. I'm sure there must be --

MR. THRASHER: Yes, there was vertical curve. This is just representative. But we went back and looked at those. And again, in all of these tests that were reviewed, the test spectra that was used enveloped or clearly had margin above what was required for the AP1000 equipment qualification and that margin provided sufficient margin to also bound the Lee required response spectra for testing.

And then again, this is the area that we said that Duke Energy would ensure that all future test spectra if we had equipment placements or we start building the plant and we can't get a piece of equipment the same as was originally qualified, when that replacement equipment is found or we replace equipment on mods down the road, we will ensure that the test spectra bounds that is required for the Lee site.

So, in summary, our site-specific analysis results, again, the two-step method, the first step of the method at six key locations we saw exceedances over the corresponding spectra, in-structure spectra for the certified seismic design response spectra and the hardrock high frequency spectra.

We moved into the second step of that evaluation methodology that is presented in the DCD and the results show that high frequency input is non-damaging. The AP1000 is suitable for deployment at the Lee site.

As we reviewed a sample of structures, major equipment and piping, we determined that the CSDRS controls design. Looking at piping analysis, the CSDRS or HRHF spectra controlled the design still.

And the test spectra that were reviewed, all completed test spectra, were higher than the required site-specific response spectra. And Duke made a commitment to ensure that future test spectra would also be higher than Lee site-specific required spectra.

So, then we go back to the flowchart. It was a long journey with a lot of qualifications that were attempted, not successfully, but we were able to finally arrive at success.

So, again, going through the flowchart, our site spectra exceeded CSDRS and hardrock high frequency spectra, so we moved to the two-step methodology on the bottom here. Six key location exceedances moved us to the second step of that. And evaluations similar to that in DCD Appendix 3I, the evaluation looking at structures, major equipment, piping and support, mainly forces and moment comparisons. And then high frequency-sensitive equipment qualification, looking at test spectra, compared to the required spectra and we were able to show that the CSDRS is governing and the AP1000 standard plant can be deployed at the Lee site.

And that is the seismic evaluation information we had.

MEMBER RAY: Okay, well I would have appreciated it if we would have had a vertical comparison like Dr. Riccardella inquired about. But you have been unequivocal that the same thing would be observed with regard to the vertical dimension if we had a display of that.

MR. THRASHER: That is correct.

MEMBER RAY: Okay. Any other questions at this point, before we go on?

MEMBER RICCARDELLA: In the subcommittee, you went through some stuff on the high confidence low probability of failure margins.

MEMBER RAY: Yes, that is what I asked about a little earlier.

MR. THRASHER: I mean as we have shown that the CSDRS being governing, then basically, the standard plant design and we have still got that same level of margin or more. Kind of felt like further explanation was really not required.

MEMBER RAY: Yes, it is the sort of thing that is of interest. You are right that it relies so much on the portion of the spectrum that you don't have a problem with that it perhaps shouldn't be a question. But, nevertheless, it is reasonable. Since the point was made at the subcommittee meeting, we thought we would ask it again here.

Any other questions, again, before we move on? You have got other stuff, Bob, that you want to address here at this time?

MR. KITCHEN: Actually, we had just a

place keeper, essentially. We had some questions for the ACRS subcommittee that we responded to. They were questions about the geology around Make Up Pond C, which we provide geological maps.

There was a question the topographical features in the area surround Lee to help their community look at if there were concerns about transportation, say of a leak, intact, without dilution. And then there were questions about the potential for delay, decommissioning of a propane tanker or other type of spill that was explosive.

We provided that. I don't know if you have any questions on that but basically, we looked at the geological map was provided.

MEMBER RAY: Yes.

MR. KITCHEN: The topographical map, we think, pretty clearly shows that I guess the most likely propagation path that would be due to contours were along the riverbed. That is about a five-mile transition to the site and the elevation at the site at the river is about 60 feet above. So, there would be quite an elevation change. I guess the concern was a toxic gas like chlorine.

We looked at, we considered all the other conservatisms there in terms of the realistic probability of dilution just from atmospheric stability, wind, et cetera.

The other thing we looked at was an explosion hazard. If a realistic tanker or transportation vehicle could have an accident and result in ignition near the site that exceeded the pressure limit, I think one pound over pressure. So, we looked at that and actually transporting and detonated at the site and it didn't exceed the --

MEMBER BANERJEE: And by site you mean at what location, at the site?

MR. KITCHEN: We ran the --

MEMBER BANERJEE: You mean the valley that I think somebody asked you? Did you transport that cloud or was it at the location where it was released?

MR. KITCHEN: We looked at it at zero --

MEMBER BANERJEE: Zero transport.

MR. KITCHEN: At the site and detonation.

MEMBER BANERJEE: But wherever it was released or where?

MR. KITCHEN: At the site, as if it were --

MEMBER BANERJEE: Oh, it had been transported to the site.

MR. KITCHEN: Leaked at the highway or in transport to the site.

MEMBER BANERJEE: Okay, without dilution. Okay.

MR. KITCHEN: And then the overpressure there I think was 0.925 with a limit of one.

So, the standoff precedence is not an issue for that.

MEMBER BANERJEE: Somebody asked you that question, right, in the last subcommittee meeting?

MEMBER RAY: It was Dick.

MEMBER BANERJEE: I was talking about toxic.

MR. KITCHEN: I am looking at chlorine.

MEMBER SKILLMAN: I reviewed your submittal and you satisfied the question that I asked.

Thank you.

MEMBER RAY: It was also, I think, you might have touched on it Bob, but there was a question about the new Reservoir C and the possibility that it could induce seismicity. That has been addressed and also that it could somehow flood the site but the topography makes that not a practical threat.

So, I think you have touched on things that were outstanding. You will be around here, I am sure, for a bit, if we have to come back to you.

MR. KITCHEN: I will. We will stay.

That's all we have for presentation.

MEMBER RAY: Very good. If there are not any other questions, we will ask them to stand by and bring the staff in. You did well in getting done under an hour. I'm sure the staff will do the same.

Welcome, Brian. Check your microphone and proceed.

MR. HUGHES: Okay. Chairman, members, subcommittee Chair Ray, my name is Brian Hughes. I am the lead Senior Project Manager for the Lee Project. I work in the Licensing Division and we are going to talk a little bit about the William States Lee III Nuclear Station Units 1 and 2.

Duke Energy Carolinas, LLC, by letter dated December 12th, as supplemented in January 2008, and then two letters in February 2008, and on and on. Then there was another letter that they submitted that they talked about oh, we have to build Pond C, which came further.

Lee Nuclear Station Units 1 and 2 are Westinghouse AP1000 PWRs. This is the third subsequent COLA that has been to the committee. It is located in the eastern portion of Cherokee County in north-central South Carolina, about 35 miles southwest of Charlotte and about 25 miles northeast of Spartanburg, South Carolina, and about 7.5 miles southeast of Gaffney, South Carolina.

The Lee site is located at the former Cherokee site, which received a construction permit for three 1,280 megawatt electrical PWRs. Cherokee 1 started construction and then was canceled in 1983.

The Cherokee Unit 1 construction was mechanically demolished and no explosives were used. And that left the original concrete in place and Lee Unit 1 will be built on top of the existing concrete.

And now I would like to go to the slides.

Again, the philosophy here is not to go over the standard certified design and standard content. We have some emerging issues that are generic to this certified design. I believe they will be presented to the ACRS schedule for March this year and they will be on the Levy docket.

And we are going to provide you a high-level description of the site and we will brief you on a subset of some of the issues described.

We are not going to talk about material incorporated by reference or the DCD.

MEMBER RAY: There is one thing, Brian, before you go any further, that doesn't fall into one of the categories, conveniently. It is the EOF proposal to consolidate at a more distant EOF. Did you plan to speak to that at all or what the status of that is?

MR. HUGHES: We have someone from NSIR here who will address that. We have some slides on that.

MEMBER RAY: That's fine. Enough said.

MR. HUGHES: That will address the SECY and the Commission SRM.

MEMBER RAY: Okay, it isn't a departure, of course. It is in some other category and that is what I was trying to understand.

MR. HUGHES: Yes, it is a very unique category because the Commission said they want to approve it. So, we will bring that up at the hearing also as part of the SECY.

MEMBER RAY: Okay, thank you.

MR. HUGHES: What I would like to do is go to slide 6.

We were talking about the hydrology, as far as the plant elevation. And if we start on the left in the blue, you can see the elevation of Make Up Pond C. Then we have the green. It is, I don't want to call it a mountain but it is basically a rolling hill that goes up. And then at the end of that hill, it is a pretty good drop and that goes down to where Make Up Pond B is. Make Up Pond B was designed to be the ultimate heat sink for the Cherokee Units 1, 2, and 3.

Then you go up to where the plant and yard area is and that is considered elevation ground zero for the AP1000 which would be 100 or actual elevation is 593 above sea level.

And then you go continuous right, you see it drops off and it goes to Make Up Pond A. Make Up Pond A is really also a clarifying pond. The water will go there. It will stay there, settle, and then it gets pumped, used as make up into the plant from that point.

And then you see another green and that one is a cofferdam that holds back the water. And then you see the Broad River on the right. And that is held up by the dam, Ninety-Nine Island Dam, which is in red. And at the bottom of that dam in blue is the Broad River.

So, a failure of the Ninety-Nine Islands Dam would not affect the site. It may drain the river but it won't affect the flooding on the site.

We go to the next slide. We have a

picture of that dam. As you can see, it is a small hydroelectric, which is also owned by Duke. Along the inside of that dam is going to be the discharge piping for the rad waste and it is going to be down about eight feet and it is going to go almost the length of the dam. And there is a diffuser on the end of that so it will get plenty of mixing when it goes through the hydroelectric plant.

The next slide, please. This is a picture of some of the concrete that they were building, adding more concrete on top of it. As you can see, the circular area was the previous containment building. That was there. When they did sell the site, it was used for a movie; I think it was called *The Abyss*. And inside the containment they flooded it and used that for a movie site. Then they abandoned the site.

Next slide, please. We have some more concrete. And as you can see, it is pretty extensive. And we checked for aliens and we didn't find any. The staff looked in case so-and-so were in there.

We had a question from the subcommittee about the met tower. And this is an installation of a met tower. As you can see, the ground -- the trees were removed. The ground was cut up.

On the back side of the met tower, as it slopes down, on the right-hand side of this picture is what I will call the overflow site for Pond B. And there is a requirement that they will periodically clean that to make sure that that is maintained, particularly after a storm. So, if anything gets in there, it will prevent any backup from the --

MEMBER RAY: You are getting close to the microphone there, Brian.

MR. HUGHES: -- flooding of that.

This next slide is part of a boring. There was approximately 14 original borings for the concrete that they used for testing and other things. And there was additional borings and maybe John McConaghy, maybe you would know, was that four or three additional borings? Do remember?

MEMBER RAY: Come of the microphone, please. Identify yourself. Thank you.

MR. MCCONAGHY: John McConaghy with Duke Energy. When we relocated the plant, we performed seven additional borings.

MR. HUGHES: Okay, thank you. I knew there was additional borings but the number I didn't.

This is just another photo to give you a little comparison to scope. So, you can see there is a person there. So you can see a little more of the amount of concrete that we have.

Now, the next slide, I would like to go to some of them, we will talk about meteorology. The COL items, we looked at a bunch of site parameters, regional, local, on-site meteorology measuring program, short-term and long-term diffusions estimates.

We compared the AP1000 with the Lee site characteristics. WE compared wind speed, tornado, maximum roof loading in the winter precipitation, which included snow and ice and accumulation of such.

And there was zero exceedance. We had a 100-year return air period of temperatures, no exceedance.

We also looked at the cooling tower-induced effects: temperature, moisture, and salt deposition. Salt is not really an issue because it is fresh water. It is not on the ocean like Pilgrim and all those other sites.

And in conclusion on that, between the site, the dispersion limits -- we are up to slide 18, please -- the x/Q presented for the exclusion area bounding the low population zone, they were all within the AP1000 site parameters and the requirements.

In conclusion, the regulatory requirements for meteorology for Section 2.3 have been satisfied with no open items, no confirmatory items, no exemptions, nor departures.

And I would like to talk about geology, seismology, and geotechnical engineering. We spent a lot of time on this at the site and we had a fairly good staff. And we are going to have Mr. Gerry Stirewalt, Dr. Stirewalt, I will turn this over to you for your presentation.

MR. STIREWALT: I'm ready to go. Thank you, Brian.

Good afternoon. Even though I am the single speaker for 2.5, it does cover geology, seismology, geotechnical engineering. And I need to turn on my microphone. Should I repeat that?

I am Gerry Stirewalt. Good afternoon to you and even though I am the single speaker for this, I am covering geology, seismology, and geotechnical engineering and, conveniently, I have a geotech specialist and a seismology specialist in case anything else comes up, but both that Vlad and Weijun are back there. I double-checked to make sure.

Okay, let's wade quickly into the next slide because what I want to do, I want to cover 2.5.1

and 2.5.3 first. What I would like to stress the idea of the geologic characteristics of the foundation rock units. What I want to sort of show you, since you have heard about the geographic location, the geographic setting, that was defined by several speakers, I would like to talk about the geologic setting.

So, if you look at this particular image, this is a geologic map and you can see from it that both Units 1 and 2 are sitting atop a brown mass on the map. That brown mass happens to be deformed and metamorphosed igneous intrusive rock. It is a plutonic mass that is at least 300 million years old. So, it is deformed. It is metamorphosed. There are also some more mafic, as they say, iron- and magnesium-rich dykes it intruded. So, that is sort of the setting.

Now, I know that you know I am going to take you into the field. So, if we could look at the next slide, I want to take you to the outcrop. I mentioned the diorite dyke. I mentioned the granodiorite, the age of it. There are also some, for the last stage, juices, if you wish, of the pluton. You get various kinds of veining. And if you look at the lower part of the image -- I couldn't resist pointing, sorry -- you actually see that one of those veins is in fact offset by a minor fault. Aha! I just said fault. Well, okay. That is a potential concern. However, based on the field relationships that were observed and, in fact, the radiometric age dates that were taken on samples from shear zones, those minerals were un-deformed and we confirmed that the shearing was actually older than 145 million. So, nothing in there is quaternary. Quaternary is 2.6 million. So, the features that are there are very, very much older.

Okay, let's sort of split out Unit 1 and Unit 2 because you know Unit 1 is currently under Cherokee concrete. Well, staff audited information on the tectonic features and the lithologies at Unit 1. Well, how did we do that because it is under concrete? Well, we looked around the margins around that concrete because there are exposures there where we could look at the lithologies, the rock types, and the structures. We also examined the geologic maps that the Applicant prepared that were compiled from the original field maps that were prepared for the Cherokee sites. So, we, in fact, did confirm was at Unit 1.

And for Unit 2, we can walk on not

foundation grade level but above that, solid rock, hardrock level, and the Applicant will, when they open the excavations for safety-related engineering structures at Unit 1, they will do additional mapping and that will help ensure that there are no tectonic or non-tectonic features that could result in surface deformation at Unit 1 also. This is an absolute true hardrock site. You can see referenced in the slide 9200 feet per second for shear wave velocity. That is hardrock by anybody's definition. Again, these are igneous -- metamorphous igneous intrusive. So, it is really good solid rock.

If we can step into 2.5.2 quickly to address the two primary concerns that the staff raised, in fact the Applicant specified what those two were but let me reiterate because it is our view of it.

The original FSAR that was done in 2007 used the older EPRI-SOG seismic source models. The newer model, CEUS-SSC, again, that the Applicants already referenced published in 2012. So, there is a new source model. Well, okay. The staff asked an RAI on that and, in response, you have heard what the applicant did. In fact, they changed from the old seismic source models to the new. So, that is kind of covered.

The second concern also mentioned was the northwest corner of the original Unit 1, which is both Cherokee and Lee remember. In the northwest corner, there is a zone of softer material. Factually, it is actually saprolitic material rock that has weathered in place, chemical weathering. So, there is just a deeper weathering zone in that location. But the point is that it is softer and the properties were essentially non-uniform, compared to the hardrock locations for the rest of the footprint.

Well, the Applicant modified the footprint, again, as they have already explained to you, to move away from that northwest corner, which has issues related both to seismic and geotechnical engineering.

And now, again, as they said, the entire footprint for Unit 1 is atop hardrock with the kinds of shear wave values that I mentioned to you. And again, as the Applicant qualified, those changes resulted in a complete revision of the FSAR.

If we can take, just a brief moment to think about site response and what kind of confirmatory analyses that the staff did. Well okay, I am going to iterate one more time, this really is a hardrock site, 9,200 feet per second. Staff concluded that the GMPEs, the ground motion prediction equations that were applied by the Applicant for these analyses are absolutely appropriate for direct use and the UHRS reflects the hardrock conditions. So, everything that needed to be factored in was.

However, the staff did perform independent confirmatory analyses of the UHRS, did that at annual frequency of 10 to the minus 4 and 10 to the minus 5. And the results of that confirmatory analyses are in very, very good agreement with the result that the Applicant derived at the same frequencies of exceedance. And I will remind you that the UHRS, those are the spectra that are used to define the GMRS.

Now, staff also considered the presence of the legacy Cherokee concrete at Unit 1 in the FIRS site response analyses and that is going to be covered momentarily by Robert. So, I am not going to go into that one.

And let's step quickly, then, into 2.5.4 and 2.5.5 and let's talk about where the primary concerns were there. Well, staff evaluated the legacy concrete. As reminders, it lies atop continuous hardrock, shows no evidence of deterioration in the original, the earlier 14 holes plus the few that Brian and Mr. McConaghy mentioned. Averages about 15 feet thick, has a measured shear wave velocity around 7,500 feet per second. So, again, it is good stuff. Good stuff. It has not deteriorated based on those measurements.

The new concrete that will be placed will have similar properties and the placement will be guided by ACI 349. And the footprint relocation, to reiterate on that one more time because again, that was a concern for geotechnical engineering as well. If it is a soft zone, non-uniform properties, maybe there could be liquefaction. But the point is it was really different from the hardrock.

So, moving it, as has been described, totally solves that issue. We are now into sound rock. No more saprolitic material under the footprint for Unit 1.

Also, sensitivity analyses were done by the Applicant that showed the lateral earth pressures will not exceed standard design under seismic loading. And that sort of covers 2.5.4.

And for 2.5.5, rocks like these don't produce issues related to slope stability.

And if I may, in one more slide, let me

just sort of summarize our bottom line findings and conclusions then for the sections of 2.5.

2.5.1, no tectonic or non-tectonic features occur in the site region, the site vicinity, the site area, or at the site location that have the potential for adversely affecting either the suitability or safety of the site. It is a hardrock site.

2.5.3, no faults or shear zones younger than Middle Mesozoic. And again, that is older than 145 million years. That is what Ma stands for. None are observed so, in fact, negligible potential exists for tectonic surface deformation at the Lee site.

2.5.2, the GMRS adequately represents seismic hazard and, in fact, very well factored in are the effects of the site-specific subsurface material properties. That's good.

2.5.4, the Applicant properly characterized the subsurface material properties, including profiles directly underlying the Lee site. They used analytical methods that were -- yes, they put in conservative input values and basically, very conservatively evaluated both the stability of the foundation and the subsurface materials.

And that is what I had for 2.5.2, which is a lot quicker than I normally talk about geology. Do you have any questions?

MEMBER SKILLMAN: I do.

MR. STIREWALT: Yes.

MEMBER SKILLMAN: What does conservative mean under 2.5.4? Adequate and analytical methods with conservative input values. What does conservative mean in that context?

MR. STIREWALT: I am going to request that Dr. Wang step to the mike and handle that question with all of his details. Thank you for the question.

MR. WANG: My name is Weijun Wang. I am a geotechnical engineer in the NRC. And I reviewed the COLA 2.5.4 and the 2.5.5.

The conservative input here means when you use parameters as the input to the analysis, you have choice. You can either use so-called the mean value or you have another consideration, which will consider the variation of the soil properties in to consider to use so-called lower bound value.

So, if you use that in your consideration, you consider the variability of the soil property. And to choose proper value, which is a little bit lower than the average value, then we call that to the conservative side. If that not give you the quantify the number of what the value but here, the conservative input value means the value or the parameters used in the analysis is used to the lower bound.

MEMBER SKILLMAN: Thank you. I understand.

MR. STIREWALT: Thank you, Weijun. Are there other questions? If not, then I am going to pass the baton to Robert.

MR. ROCHE-RIVERA: Thank you, Gerry. Good afternoon, Mr. Chairman and members of the committee.

My name is Robert Roche-Rivera. I am a structural engineer in the Office of New Reactors, Division of Engineering and I am the lead reviewer for Section 3.7, seismic analysis.

The focus of my evaluation was structures but I also have staff in the audience that is able to support the discussions related to piping and equipment, as necessary.

This slides shows the team that comprised the review of Section 3.7 and 3.8, 3.8 dealing more with the structural aspects of the obligation and they are also here joining me in the audience. Next slide, please.

So my presentation will cover a little bit of background, which quite honestly was gone into very much detail already in the Applicant's presentation. This background is related to the AP1000.

This is the AP1000 hard rock high frequency evaluation criteria. Forgive me if I am going to be a little bit repetitive in that regard but I think it is important that we highlight that this process is already incorporated in the design certification.

And then I will get into the actual discussion of the certification for the departure, 2.0-1. And the departure is the exceedance of the site-specific hazard over the CSDRS and hard rock high frequency spectra included in the AP1000 standard design. Next slide.

So, here is the slide regarding the background. So, as was mentioned earlier, so the AP1000 standard design in relation to the CSDRS, or certified seismic design response spectra, it also provides what is called a hard rock high frequency spectra, which serves as an alternative parameter to compare against the site-specific case to determine the acceptability or applicability of the standard design to the site.

So, in the context of the hard rock high frequency site, if the site-specific ground motion response spectra is bounded by the hard rock high frequency spectra included in the AP1000 standard design, then no further evaluation is necessary.

However, if the contrary is the case, if there are exceedance of the hard rock high frequency --

MEMBER RAY: Stand by. That happens occasionally. I have forgotten what it signifies.

Okay, Robert, go ahead.

MR. ROCHE-RIVERA: Okay, thank you.

So, I would think if the site-specific ground motion response spectra, the site-specific hazard, is bounded by the hard rock high frequency spectra and there is no further evaluation required, the site is applicable -- the AP1000 standard design is applicable to the site. But if the contrary is the case, meaning the site-specific ground motion response spectra exceeds the hard rock high frequency spectra and, again, this is in the context of the hard rock high frequency site, then the city already provides a process totally for evaluating the implication of those exceedances and demonstrating whether or not the standard design is applicable to the site.

And that criteria or methodology, it is

indicated in DCD Section 2.5.2.1 and as it was explained earlier by the Applicant, it is comprised by two steps, essentially. The first step is after running site-specific history analysis and obtaining in-structure response spectra so there is a comparison of that in-structure response spectra.

If the in-structure response spectra of the site or for the site is bounded by the in-structure response spectra in the standard design, then you stop there. The AP1000 standard design is applicable to the site. However, if there is an exceedance at that level of the in-structure response spectra, then you go to the next step, which is the evaluations or methodology included in Appendix 3I and its supporting technical report, Technical Report 115. And with the purpose of, again, demonstrated that the high frequency input is non-damaging or, in other words, that the standard design, it is adequate for that specific site, which already has an exceedance of the hard rock high frequency spectra.

So, we move to the next one. So, that is about it for the background part of the presentation. So, Lee falls within that category of a hard rock high frequency site that has an exceedance of the hard rock high frequency spectra and CSDRS as demonstrated in this slide. To my left is the horizontal. To my right is the vertical. And it shows in both cases there is an exceedance. And that is the departure, again, 2.0-1.

So, in order to justify that departure or to demonstrate the acceptability of the standard design to the site, then the Applicant followed the process or methodology established in Appendix 3I or TR-115 to demonstrate the adequacy of the site -- of the standard design to the site.

I am highlighting here also in this slide our review of the Applicant's site-specific evaluations. It is a very comprehensive one, of course, and it included the audits. And the audit covered all aspects related to the seismic evaluation aspects, including structure, primary components, piping, equipment, everything.

And in addition to that, the staff, we also performed confirmatory analysis. Specifically here, when I am referring to confirmatory analysis, I am referring to an analysis of the development of, in essence, of what is the green curve or what would be the site-specific foundation input response spectra. What you are seeing here is the Applicant's foundation input response spectra. The staff independently developed an foundation input response spectra, compared that against the Applicant's foundation input response spectra and determined and concluded that they both compared really well and, therefore, based on that, determined that the Applicant's site-specific foundation input response spectra is acceptable.

Now, that still is not related to the actual Appendix 3I evaluation. That is just determining the adequacy of that curve. In essence, like I am saying, the green curve in those plots.

So, in the next few slides, in the following slides, then now we are going to get into the details of or a summary of the actual site-specific evaluation and how the adequacy is demonstrated for the Lee site.

MEMBER SCHULTZ: Robert, could you describe the conduct of the audit and the participants on the audit team?

MR. ROCHE-RIVERA: Yes, the conduct of the audit, it was mainly focused on the aspect related to Section 3.7 and 3.8. That is, again, the seismic analysis and structural evaluation. So, it included participants from the structural engineering branch and from the geotechnical engineering branch as well. The audit, itself, included discussions on aspects related to piping and equipment.

And in addition to that specific audit, as documented in Safety Evaluation Report Section 3.10, the staff also conducted separate additional evaluations of the supporting reports for the equipment portions of the evaluation. Okay?

MEMBER SCHULTZ: Yes, thank you.

MR. ROCHE-RIVERA: Thanks.

MEMBER RAY: Do you need a copy of that audit report?

MEMBER SCHULTZ: No, thank you.

MR. ROCHE-RIVERA: Any further questions? So, next slide.

So, then we go and get into a summary of the site-specific evaluation. So, the Applicant performed a site-specific time history frequency domain analysis. And based on that analysis, the Applicant developed in-structure response spectra. That is the first step.

Like I said earlier, when comparing that in-structure response spectra, the site-specific response spectra with the standard design response spectra, really the in-structure response spectra is largely envelope, as it was shown in the Applicant's slide but there are some exceedances. And therefore, because there are some exceedances, regardless of whether they are minor or their magnitude, they have to be justified and evaluated. And that is the next step.

The Applicant then looked deeper into what are the actual forces in the -- this is now regarding structures and primary components. What are the actual forces induced by the certified seismic design response spectra into the structure and what were or are the forces induced by the site-specific FIRS into the structure. The Applicant showed, a few minutes ago, such comparisons and the staff reviewed all those comparisons. And in all cases, the CSDRS governs over the site-specific forces. And again, this is the case for structures and primary components. We looked at that from the point of view of force assessing views.

It is similar for the piping evaluation. It is essentially the same. Instead of forces, we looked at stresses for piping. And I am already -- if we can go to the next slide.

MEMBER RICCARDELLA: Excuse me. Did the staff doing any confirmatory analyses if the in-structure response spectra?

MR. ROCHE-RIVERA: No. The answer is no. Not of the in-structure response spectra.

We evaluated the Applicant's analysis and results during the audit and we issued RAIs on that subject. And we determined, yes, it was a very similar review and, based on our audit over their calculations.

MEMBER RICCARDELLA: Okay.

MR. ROCHE-RIVERA: And their consistency also with the methodology provided by Appendix 3I, which we confirmed based on our review. The consistency of the Applicant's application of such methodology.

So, we are already in the following slide. And as I was saying just a moment ago, for the primary components part of the evaluation, the Applicant also looked at the forces induced by the CSDRS and those induced by the site-specific FIRS. And in all cases, we confirmed, the staff confirmed that in all cases, the CSDRS forces bound the site-specific forces.

The same is true for the piping evaluation. In this case, the Applicant looked at it from the point of view of stresses, which is typically done for piping packages. And again, in all cases, the AP1000 requirements bounded the site-specific requirements.

And as also was discussed a few minutes

ago in the case of equipment, the Applicant compared the AP1000 required response spectra and associated test response spectra. And for all the high frequency-sensitive equipment, in all cases, the test response spectra bounded both the required response spectra from the AP1000 and the required response spectra from the site. Based on that comparison, then we verified that information and based on that comparison, we determined that, indeed, the AP1000 requirements do govern over the site-specific requirements. In addition to that, like the Applicant also stated they also have a commitment that for future testing, and they provided an example in cases where there may need to be a replacement or the component may be a little bit different than what it was originally considered, then they will ensure that the test response spectra for those tests will bound the site-specific requirements, in addition to, of course, the AP1000 requirements.

MEMBER RICCARDELLA: And, again, I assume the same answer, you didn't do any independent analyses of these.

MR. ROCHE-RIVERA: No, for the -- no, exactly.

MEMBER RICCARDELLA: Okay. Did you review or your audit include confirmation of proper application of Appendix QA program?

MR. ROCHE-RIVERA: I think I am going to defer that question --

MEMBER RICCARDELLA: Appendix B, QA program.

MR. ROCHE-RIVERA: Appendix B, yes, quality assurance, of course. I mean definitely the documentation, in terms of the reports, it all followed the same criteria that has been followed consistent with the AP1000 standard design. So, I mean that is yes. And again, the methodology of analysis is consistent with the standard design, the Appendix 3I standard design, which incorporates already the important criteria from Appendix B.

MEMBER RICCARDELLA: My main concern is whether there was evidence of independent review of the calculations by the qualified analysts.

MR. ROCHE-RIVERA: Again, I just go back to saying in terms of how we determined the adequacy of these results, we performed a very detailed review of how they compare to what was done in the standard design.

MEMBER RICCARDELLA: Okay.

MR. ROCHE-RIVERA: And in all cases, they passed that evaluation.

MEMBER RICCARDELLA: Okay, thank you.

CHAIRMAN STETKAR: Robert, I will put you on the same spot I put the Applicant, who hasn't come back to us yet.

When I think of high frequency things and equipment that might be susceptible to high frequency damage, I immediately think of, I don't want to call it electrical equipment because people think of circuit breakers and stuff like that, I think of electronic equipment, light-weight stuff, cards, contacts, hard drives, stuff like that on computers. Do you recall whether they had test data for that particular equipment? Because as I said, I was trying to do this real-time here in the meeting and it is a 28 -- that table that they referred to, it is 3I6-2 is a 28-page table with a lot of line items on things and it is not immediately apparent that they had test data for the protection and monitoring system cabinets. They might. It is just hard for me to listen to the presentation and run through those line items.

I see things like switch gear. I see things like instruments, that kind of stuff. The example that they showed was a transfer switch panel but those are switches. Those are light switches.

MR. ROCHE-RIVERA: Well, what I can offer is that the example you are provided or you are asking about or specific equipment you are asking about, if it is equipment located in areas of the nuclear island where there is an expectation or it is confirmed by analysis that there are high frequency exceedances, if the equipment itself does have fundamental frequencies of vibration that coincide with that range of high frequency exceedance, it is included.

CHAIRMAN STETKAR: I didn't really want an easy one. I hear all of the qualifications that we did everything that is in the table and if it is in the table -- I am just trying to ask a simple question.

MEMBER RAY: Yes.

CHAIRMAN STETKAR: If I went to the plant and put my hands on a cabinet that is a PMS cabinet, which is in the nuclear island, which is near the control room, it is in a separate room, did they have test data on those cabinets, in particular, that equipment? They look like computers.

MR. ROCHE-RIVERA: I just am going to refer to the staff in the audience.

MR. PATEL: Hello. My name is Pravin Patel. I am in the Structural Engineering Group NRC.

The answer to this question is that what is in Westinghouse TR-115, that whole table which identify the sensitive equipment from the beginning of that design, those sensitive equipment are all very qualified and they also have a data base from their own other plant, operating plants and all this sort of equipment. Those equipments are already qualified for higher than required response spectra. Or if they use newer one, then also they were qualified to the required response spectra.

So, those are -- include inside the pipe, based on the locations and based on the test data with respect to in-structure response spectra. So, it meets the criteria for requirement of the equipment.

However, also, they used a damping value a little bit more conservative for the use of test requirements. So, that makes another conservative approach for the equipment qualification.

CHAIRMAN STETKAR: Thank you but nobody has yet answered my question. It is a simple question. I don't have a cabinet -- I wish I had a cabinet number. I don't have a cabinet number. I have been trying to search through the DCD. And of course, the DCD doesn't give you cabinet numbers.

If I had a cabinet number, I would say did they have test data for that cabinet.

MEMBER RAY: So, John, wait. Let the Applicant speak for a moment.

MR. THRASHER: This is John Thrasher with Duke Energy. And the question on cabinet qualification, I can try to qualify that from my earlier response.

CHAIRMAN STETKAR: That would help.

MR. THRASHER: So, following it up with Westinghouse and the cabinets are not considered high frequency and, therefore, you don't see the cabinets in the table. They would consider a cabinet, it typically has many bolted-type connections and high frequency input at the base of that cabinet would typically be dampened out before you get to items that were mounted in the cabinet.

The table in Appendix 3I lists all high frequency-sensitive equipment in the AP1000. Several cabinets, such as we presented on slide 24 of the transfer panel, several cabinets were tested --

CHAIRMAN STETKAR: I found those.

MR. THRASHER: -- as benchmark information to compare to cabinet qualification by analysis.

So, Westinghouse qualified the cabinets by analysis and tested several of the cabinets as benchmark information to ensure that that qualification by analysis was adequate.

CHAIRMAN STETKAR: Okay. And then try to be a little more careful because I am not -- I don't want to be too critical but I hear a lot of attorney-speak creeping in here.

When I talk about a cabinet, I tend to talk about the stuff that lives inside the cabinet. I hear you saying that the cabinet might be the thing houses the stuff that lives inside the cabinet.

So, I am talking about do I have confidence that at the high frequency exceedance accelerations at this site, will the solid state protection and monitoring system equipment perform its safety-related function. Yes or no, is it qualified and tested to do so or analyzed to do so at those frequencies? That is a simple answer, yes or no.

MEMBER RAY: Wait. Wait. Stop. Wait. Let the Applicant respond first and then you are welcome to.

MR. TUNON-SANJUR: Yes, this is Lee Tunon-Sanjur of Westinghouse.

The 28-page list is comprehensive as the industry-wide recognition of what is considered high frequency-sensitive equipment.

CHAIRMAN STETKAR: Okay. I will let you finish.

MR. TUNON-SANJUR: Okay.

CHAIRMAN STETKAR: But don't try to get so specific. I had a simple question and I want a yes or a no answer. That is, at the high frequency accelerations that exceed the spectrum from the design certification at the Lee site, will the safety-related protection and monitoring system equipment perform its safety-related function?

MR. TUNON-SANJUR: The answer is yes, the TRS tested to that equipment envelopes the AP1000 design DRS, and also the site-specific DRS. So yes, they are enveloped and tested.

CHAIRMAN STETKAR: Thank you.

MEMBER RAY: Okay. Now, before Brian, you speak, I also want to add, John, I heard them say that the cabinets, speaking generally, have been shown to insulate what is in the cabinet from what comes in at the base of the cabinet. That is what I heard stated.

CHAIRMAN STETKAR: Isolate, I think.

MEMBER RAY: Yes, isolate, insulate, isolate. And therefore, what I was going to add is maybe some of the stuff in the cabinets, because it is not exposed to the high frequency due to the bolted connections that he referred to, it doesn't have to be qualified to that spectrum. Now, that is not exactly what he just said.

CHAIRMAN STETKAR: He said something more definite.

MEMBER RAY: Yes, he did. And I also had him say something more definite, earlier, too.

So, it is clear what is being said, definitely. Brian, you wanted to speak.

MR. HUGHES: Yes, we had a couple of staff members go and look at the test methodology and how they would test and the documents. And they stated that it's within the Lee envelope and that it exceeds the envelope and that the individual components were not analyzed; they were physically tested. So, we are talking relays, circuit boards, that type of stuff.

So, they were pretty well satisfied that the components in the cabinets would, they stood the actual test. So, they were very confident of that.

CHAIRMAN STETKAR: Okay, thank you. That helps.

MEMBER RAY: Okay, let's return. Robert, are you --

MR. ROCHE-RIVERA: That is the end of my presentation.

MEMBER RAY: Okay. All right.

MR. KITCHEN: Mr. Chairman?

MEMBER RAY: Yes.

MR. KITCHEN: This is Bob Kitchen, Duke Energy. If I could follow-up on a question Dr. Riccardella asked on the QA program.

MEMBER RAY: Yes.

MR. KITCHEN: I can't say specifically for this analysis but the NRC did a very rigorous and thorough, it was about a week-long QA audit of Duke Energy in preparation of the call to make sure that Duke Energy had processes and practices in place to properly apply the 10 CFR 50 Appendix B QA requirements. And that was determined to be acceptable.

Now, as an ongoing practice, we do routine typically applied through the industry audit of the QA program for all of our vendors and specifically for Westinghouse and specifically for new plant.

We just did a full scope audit of Westinghouse in August of this year and we do a smaller audit in-between the biannual audits. The purpose of those audits is to make sure that Westinghouse, in this case, has the right program and practices and qualified personnel to apply QA programs as a vendor supporting the Duke Energy contract.

Separately, and as part of our process, we give a product, from the vendor in this case, a seismic analysis report. I can't tell you that we duplicate the analysis but we do review the validation that we accept that product.

So, that is how we apply the 10 CFR 50 program.

MEMBER RAY: Thank you. Okay, Brian, what more do you have?

MR. HUGHES: We are going to talk a little bit about the chlorine, just to highlight the chlorine.

This is one of the accidents that we looked at for a specific chlorine burst type accident. And we discussed that and concluded that the chlorine inside the main control room was less than the limit for the chlorine.

We did an independent analysis of that and as we discussed, they used ALOHA and the dictions were fairly consistent with the part of the HABIT. But we also had to use ALOHA and HABIT and that research is currently working on the HABIT, so that it would be available for use on a heavier gas such as chlorine.

And I don't have an update today on where they are on finishing that project but it looks promising.

That's all I have to say there. And what I would like to do is move on to emergency planning. We have Kenny Thomas from NSIR and he is going to address particularly the EOF and some other items as far as locations.

MR. THOMAS: Good afternoon, gentleman, ma'am. I am Kenny Thomas with NSIR, the Division of Fairness and Response to New Reactor Licensing Branch.

In the audience with me today is my Branch Chief, Alison Rivera and Dan Barss, the Team Lead. Mr. Barss has significant experience with the Reference COLA and the Subsequent COLAs and with the design certification.

Currently, I think Dr. Ray had a question just a little while ago about the Emergency Operating Facility. Okay, talking about location of the Emergency Operating Facility and it is a key idea for us, since Duke is requesting an exemption from the regulations in Appendix E for the location of the EOF.

Currently, what they are proposing is their Duke Energy Center in Charlotte, North Carolina, is approximately 40 air miles from the Lee nuclear site. Since the location is outside the 25-mile requirement in the regulation, the Commission has to make a ruling on the exemption request.

It currently serves as the EOF for a confined facility for McGuire, and Catawba, and for their Oconee stations. It has been the common EOF for Oconee -- I mean, I'm sorry, for McGuire and Catawba since 1987 and it has been for all three since 2005. It does have the required capabilities and the Appendix E requirements.

MEMBER RAY: Was a location exemption granted in any of those cases?

MR. THOMAS: I believe it was, sir, yes.

MR. HUGHES: They are mentioned in SECY paper.

MR. THOMAS: Yes, the SECY-1078 and the SRM.

Next slide. As part of the requirements in the Appendix E to 10 CFR Part 50, Duke Energy needs to have a near-site facility for the NRC. The Kings Mountain Generating Support Center or the Duke Energy In-Processing Facility is the same facility, two different names, is located approximately 15.5 miles straight line distance from the Lee facility and it does have the capability to provide the NRC its near-site location and communication capabilities.

Any questions?

MEMBER RAY: No, those are the facts as we understood them as well. Just the only thing to be added was that there was this exemption granted already for that facility. And I guess, secondly, what is the time? Does this occur coincident with the COLA approval before or after or what?

MR. THOMAS: Yes, sir. When we go to the hearing for Duke Energy's lead COLA, the Commission should make the ruling during that hearing.

MEMBER RAY: Is there any input -- this may be an awkward statement, John, so forgive me. Is there any input from us expected on that subject? Because we haven't devoted any focused attention to the subject.

MR. HUGHES: I would request that either you would recommend that that is a reasonable deal or not, if possible, if you can do that.

But Dan Barss is our expert in this area.

MR. BARSS: Yes, Dan Barss, the Team Leader, Emergency Preparedness in NSIR.

To answer your question is something required from you, I don't think anything is required from the ACRS on that matter. It really is a matter because of the way the regulations and the guidance is written, the Commission said they want to give the approval for where the EOF is located beyond that 25-mile distance.

The kind of Catch-22 that we are in is that the Commission can't act on something separate or individual for this application until they see the whole total sum, until the staff is done with their work.

So, that is why we wrote the SECY paper and you got the SRM and it is 100078, I think. And then basically what we proposed the Commission was that we, the staff, would do our review work. We would make our recommendation and that they, in the mandatory hearing process, would then do the approval as they normally do with the mandatory hearing process but they would also specifically be approving the location of the EOF, this combined EOF.

So, we kind of got that permission from them in the SRM saying that was an appropriate way to proceed on matters such as this and it affects any site that would propose to use a combined EOF that would fit that. It just happens that Lee is the only one, I think, now that still fits that.

MEMBER RAY: What have you done thus far?

MR. BARSS: What have we done this far?

MEMBER RAY: Thus far. Have you completed your analysis, made a recommendation?

MR. BARSS: Yes, we have completed our analysis. We have written our safety evaluation. It is in the process of being finalized and that will eventually go to the Commission.

MEMBER RAY: Well, okay. So, it is not then finalized yet would be another way to characterize it. It has been developed but not yet finalized.

MR. BARSS: We have no additional review that we intend to do at this point. It is administrative processing of the safety evaluation at this point.

MR. HUGHES: It's not final until the ACRS, we receive -- then we go to final. If you have some comments or suggestions for any of the changes or anything, we would certainly address that in the --

MEMBER RAY: Do any members wish to hear more on this subject at this meeting, given what we have heard said here? If not --

MEMBER SKILLMAN: I do not.

MEMBER RAY: -- we will assume we have heard enough then for us to do what we need to do.

MR. HUGHES: That concludes the staff's --

MEMBER RAY: I guess I have to ask one last question. Is this not yet finalized safety evaluation available?

MR. HUGHES: You have it.

MEMBER RAY: We have it?

MR. HUGHES: Yes, it is Chapter 13.3.

MEMBER RAY: Oh, okay. It is already in the final SER, you mean, the advanced final SER.

MR. HUGHES: Yes, it is. And I also would like to state that we have had multiple emergency drills utilizing this facility and they have all passed with flying colors.

MEMBER RAY: I took that for granted. I was just looking for some problem that might arise after we are done here.

All right. It sounds like everything is done that needs to be done, then.

MR. HUGHES: Yes.

MEMBER RAY: Okay. Anything more, Brian?

MR. HUGHES: That concludes the staff presentation. Is there any additional questions from members?

MEMBER RAY: Well, thank you very much. You will stand by for us if we need anything more from you, I trust.

We are wrapped up here and we are right on time. So, that is much appreciated.

MR. HUGHES: Thank you.

MEMBER RAY: Thank you. We have gone to open up the phone line now. It is the next step in our -- next to the last step in our process or it will be the last step, perhaps.

I should ask if there is anyone in the audience who wishes to make any comments to the committee at this time.

Hearing none, we will go through the usual exercise of trying to make sure we have the phone line open and available to speak to us.

Mr. Lewis, are you with us? Oh, there we are. We have got the line open, we now believe, if anyone is on the line. And certainly our participant, often, is Mr. Marvin Lewis. If you are there, please speak up and let us know you can hear us.

Hearing nothing, is there anyone else who can participate here by giving us comments? Yes, go ahead, please. Anyone?

Hearing no one seeking to make comments, we appreciate that and we will go ahead and close the line, then. And I will turn it back over to our full Committee Chairman, John Stetkar.

CHAIRMAN STETKAR: Thank you, Harold. And thanks again to both the Applicant and the staff for excellent presentations and excellent timing.

And with that, we will be off the record for the rest of the day.

(Whereupon, the above-entitled matter went off the record at 2:59 p.m.)

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# 50.46c ECCS Performance Requirements

ACRS Full Committee
December 2015

Paul M. Clifford
Division of Safety Systems
Nuclear Reactor Regulation

# Outline

1. 50.46c Flowchart
   – Provide background on research findings and past decisions
   – Discuss why rulemaking is the most effective and efficient approach

2. Summary of Major Changes
   – Relative to § 50.46

3. Summary of Public Comments
   – Changes incorporated relative to § 50.46c proposed rule

4. Conclusions

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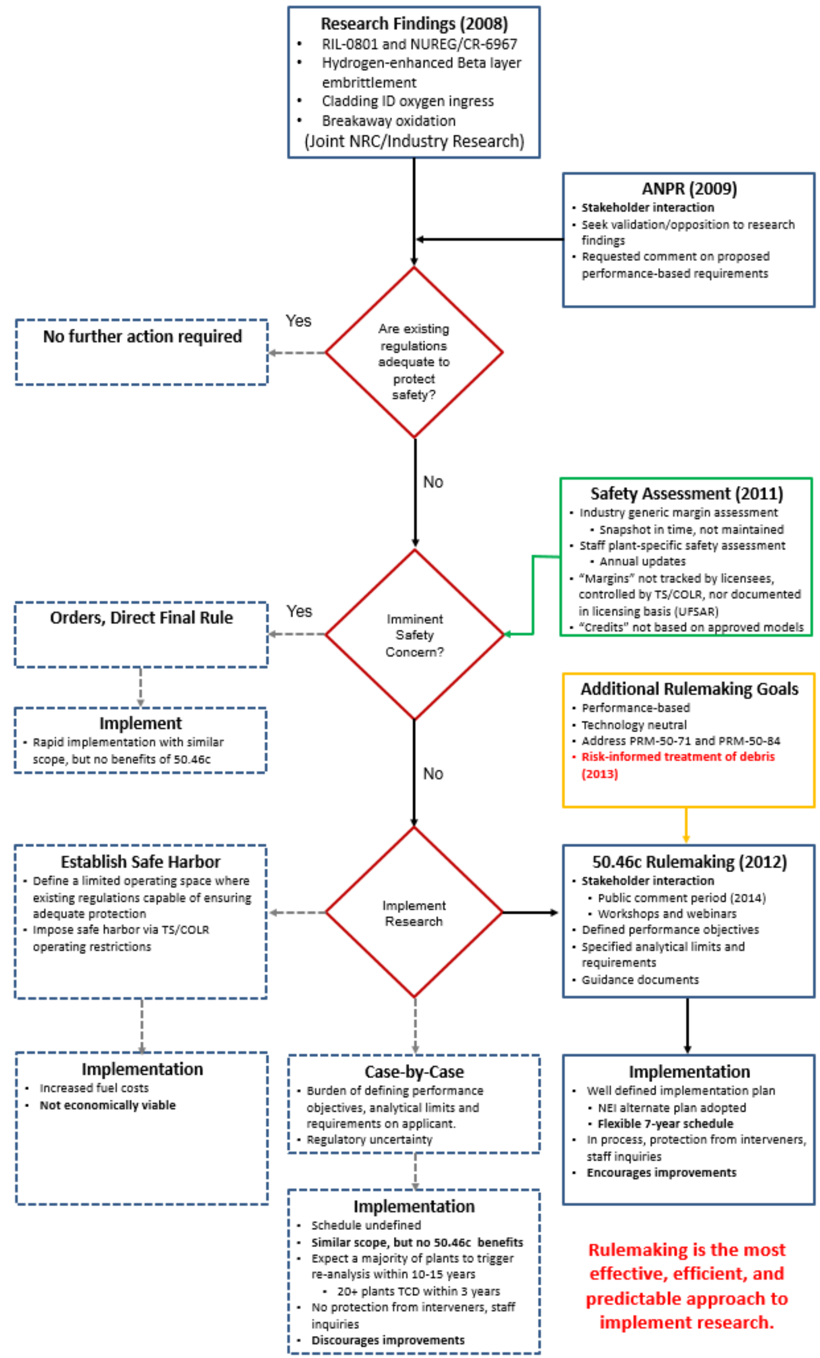
# 50.46c Flowchart



# ACRS Interactions on 50.46c

| Date | Meeting/Letter | ADAMS |
|---|---|---|
| October 9, 2002 | Subcommittee Meeting | ML023030246* |
| October 10, 2002 | Full Committee Meeting | ML022980190* |
| October 17, 2002 | Letter from ACRS to NRC staff | ML022960640 |
| December 9, 2002 | Response letter from NRC staff to ACRS | ML023260357 |
| September 29, 2003 | Subcommittee Meeting | ML032940296* |
| July 27, 2005 | Subcommittee Meeting | ML052230093* |
| September 8, 2005 | Full Committee Meeting | ML052710235* |
| September 8, 2005 | Letter from ACRS to NRC staff | ML052660300 |
| January 19, 2007 | Subcommittee Meeting | ML070390301* |
| February 2, 2007 | Full Committee Meeting | ML070430485 |
| May 23, 2007 | Letter from ACRS to NRC Staff | ML071430639 |
| July 11, 2007 | Response letter from NRC staff to ACRS | ML071640115 |
| December 2, 2008 | Subcommittee Meeting | ML083520501*<br>ML083530449* |
| December 4, 2008 | Full Committee Meeting | ML083540616* |
| December 18, 2008 | **Letter from ACRS to NRC staff** | ML083460310 |
| January 23, 2009 | Response letter from NRC staff to ACRS | ML083640532 |
| May 10, 2011 | Subcommittee Meeting | ML111450409 |
| June 8, 2011 | Full Committee Meeting | ML11166A181 |
| June 22, 2011 | **Letter from ACRS to NRC staff** | ML11164A048 |
| June 23, 2011 | Subcommittee Meeting | ML11193A035 |
| July 13, 2011 | Full Committee Meeting | ML11221A059 |
| July 21, 2011 | Response letter from NRC staff to ACRS | ML111861706 |
| December 15, 2011 | Subcommittee Meeting | ML120100268 |
| January 19, 2012 | Full Committee Meeting | ML12032A048 |
| January 26, 2012 | **Letter from ACRS to NRC Staff** | ML12023A089 |
| February 17, 2012 | Response Letter from NRC staff to ACRS | ML120260893 |
| December 2, 2014 | Subcommittee Meeting | ML14351A368 |
| November 3, 2015 | Subcommittee Meeting | MLXXXXX |
| December 3, 2015 | Full Committee Meeting | MLXXXXX |

*ADAMS file is a transcript of the ACRS meeting.

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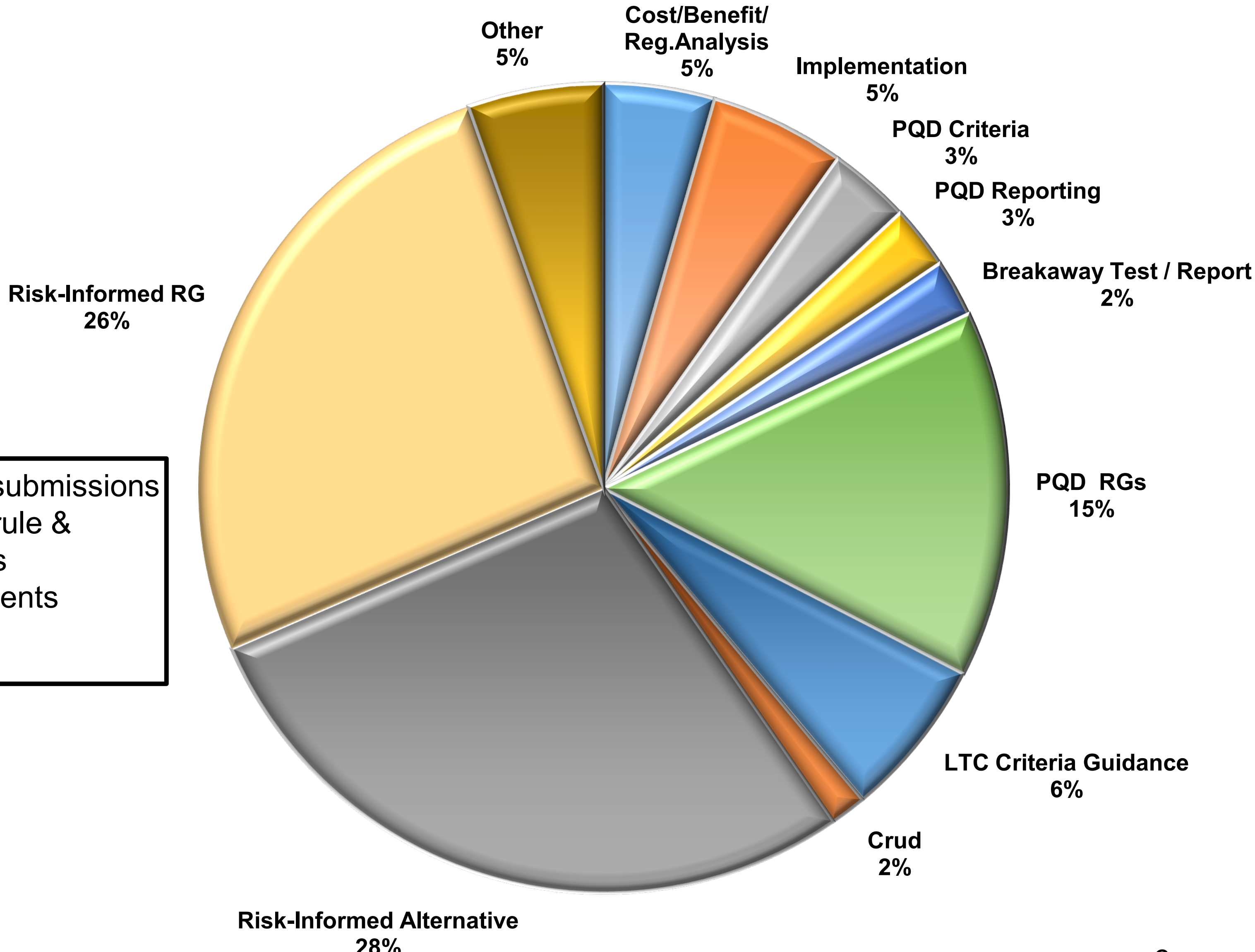
# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

# 50.46c Public Comments




43 comment submissions on proposed rule &
4 draft guides
= ~830 comments

# Major Comments

- Implementation
- Breakaway oxidation testing and reporting
- Guidance on testing protocols and analytical limits
- LTC performance requirement and testing
- Legacy fuel
- Reporting of changes and errors
- Appendix K

No industry comments challenging need for new requirements to address research findings

# Implementation

- Proposed rule codified a 3-track staged implementation
- Industry proposed an alternative plan whereby each licensee would submit a detailed plan and schedule for compliance within 6 months
- Public workshop and webinars conducted to develop effective and efficient implementation strategy
- Final rule adopts industry proposal
  - Each licensee submits an implementation plan within 6 months
  - Negotiated schedule to prioritize and balance workload
  - All 50.90 LARs submitted within 60 months
  - Fleet wide compliance within 84 months
  - Excludes debris consideration (deterministic and risk-informed)
- Approach avoids unnecessary exemptions, provides flexibility, and balances workload
- Established implementation requirements for COL's and DC's

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# Breakaway Testing

- Proposed rule required testing and reporting for each reload batch
- Industry opposed codified, repetitive testing and reporting
- Public workshop conducted to address testing protocols and testing frequency
- Final rule eliminates reporting requirement and defined frequency for confirmatory testing
  - Provides flexibility requested by industry
  - Each fuel vendor will establish breakaway oxidation testing program including frequency of confirmatory testing

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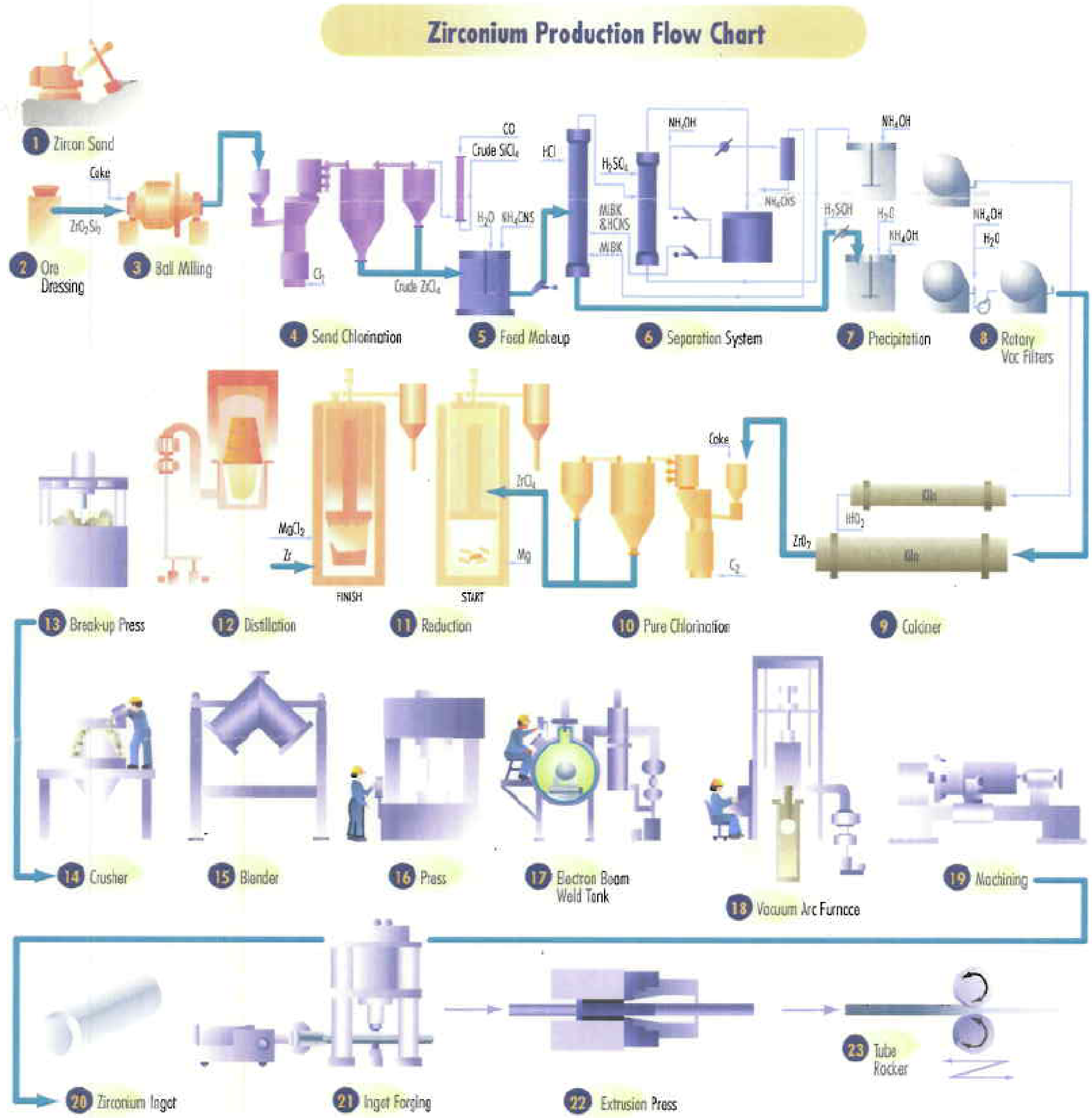
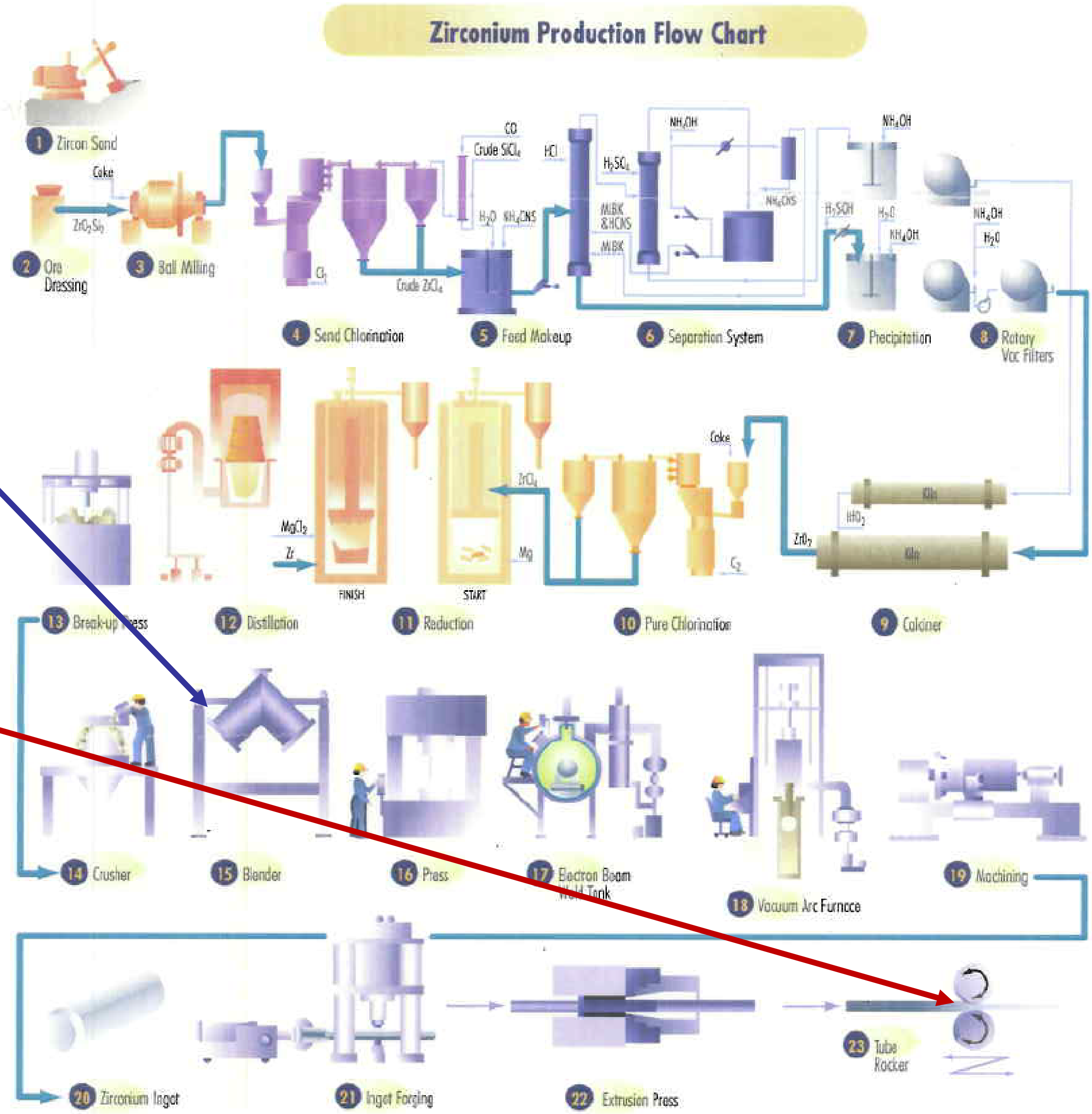



Source: ATI Wah Chang

- Major alloying elements




- Billet beta quench
- Tube reductions
- Intermediate heat treatments
- Final heat treatment
- Finishing

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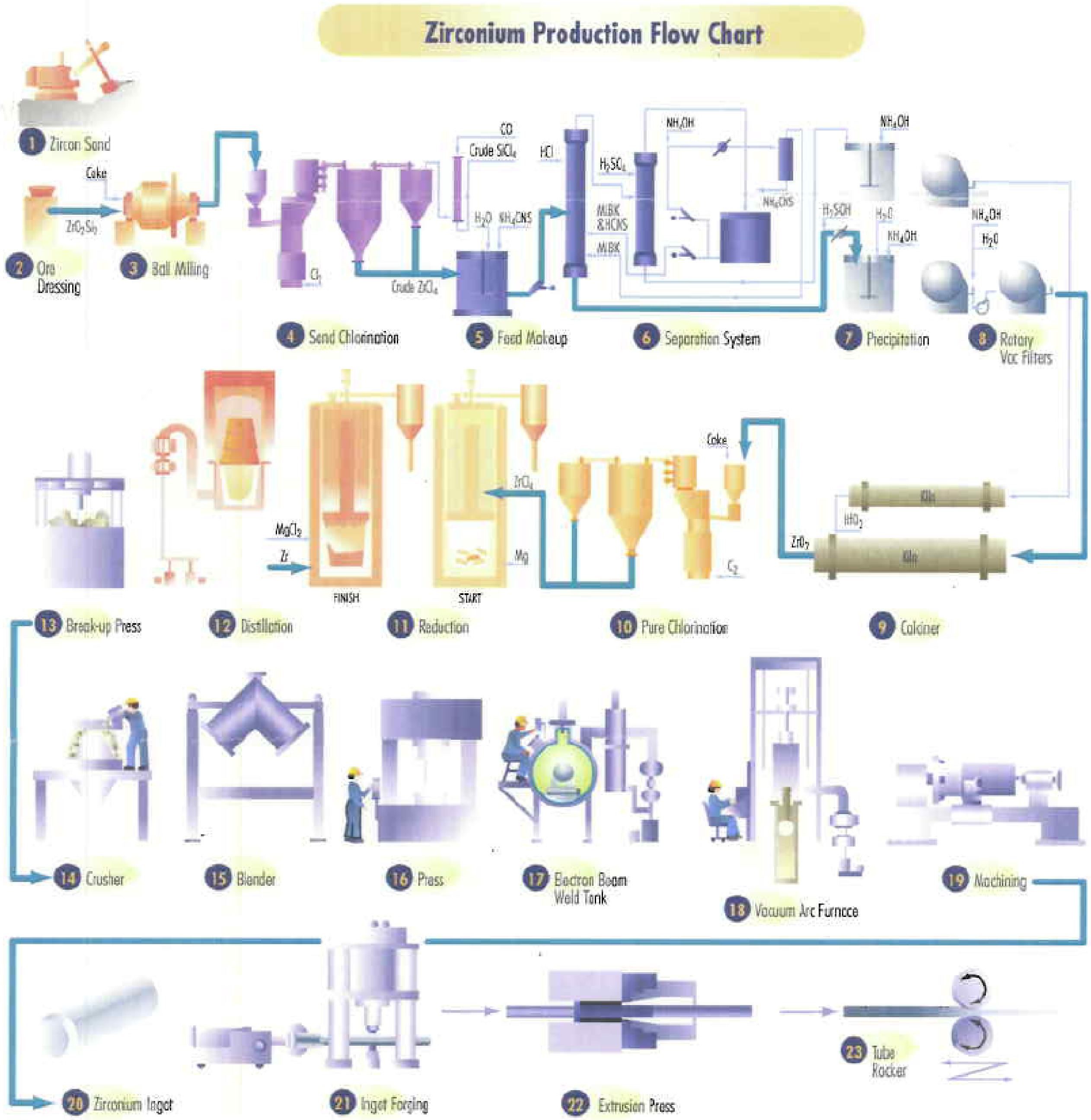
No existing barriers to prevent poor breakaway oxidation performance.

Conduct more research to identify sensitive parameters and then prescribe fabrication process?
- - or - -
Confirmatory testing?

Performance-based regulations rely on demonstrated performance.



# Guidance

- DG-1261, DG-1262, and DG-1263 provide guidance for conducting PQD and breakaway oxidation testing, interpreting data, and defining analytical limits.
- Industry comments
  - greater flexibility in the testing protocol and data evaluation
  - reduction or elimination of irradiated testing
  - compliance of legacy fuel
  - lack of hydrogen pick-up models
- Public workshop conducted to address testing protocols and applicability of analytical limits.
- Guidance updated to provide additional flexibility in testing protocol and data evaluation. In addition, added discussion of legacy fuel, provided default hydrogen pick up models, defined conditions where irradiated testing could be eliminated.

# LTC Fuel Performance

- Debris consideration introduce new concerns and necessitate an explicit fuel performance objective
  - Existing regulation requires continued effective core cooling
  - If debris impedes ECCS coolant delivery such that core temperatures increase, then LTC performance objective may no longer be satisfied
- Proposed rule required testing to establish an analytical limit (LTC-PCT) to maintain cladding ductility
  - LTC fuel performance outside scope of NRC research program
  - SOC requested input on LTC performance and available research data and testing procedures
- Industry opposed ductility performance metric, analytical limit, and required testing

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# LTC Fuel Performance

- Public workshop conducted to address LTC fuel performance
- Final rule eliminates cladding ductility as performance objective and does not mandate testing for clean plants with limited problematic debris
  - Risk-informed alternative likely to further reduce impact
- Final rule requires demonstration of no further cladding failure during long-term recirculation period
  - Testing only required if a debris-induced post-quench reheat is predicted and fuel temperatures reasonably challenge fuel integrity
  - No additional burden if debris source is limited

# Legacy Fuel

- Industry requested that legacy fuel be excluded from 50.46c compliance
- RG 1.224 updated to address legacy fuel

PQD Analytical Limit

- Fuel that is **manufactured prior** to the effective date of the rule and comprised of either **currently available** commercial cladding alloys (e.g., Zry-2, Zry-4) or **legacy zirconium alloys** no longer commercially available can be evaluated using Figure 2 of RG 1.224 to show compliance with 50.46c(g)(1)(ii)

Breakaway Oxidation

- Fuel that is **manufactured prior** to the effective date of the rule and comprised of **currently available** commercial cladding alloys (e.g., Zry-2, Zry-4) can be evaluated using the breakaway oxidation analytical time limit established for the current versions of those commercial alloys should be applied to show compliance with 50.46c(g)(1)(iii)
- Fuel that is **manufactured prior** to the effective date of the rule and comprised of **legacy zirconium alloys** no longer commercially available can be evaluated using an analytical time limit of 3,500 seconds to show compliance with 50.46c(g)(1)(iii)

# Reporting

- In the proposed rule, reporting and corrective actions paragraph rewritten to clearly state requirements
  - Fundamental approach for reporting and corrective action unchanged form current § 50.46
  - Clarification needed to address past industry and NRC staff misapplications
- NRC did not intend to restrict existing flexibility with respect to "estimating" effect, defining scope of reanalysis, or negotiating a schedule for reanalysis
- Public webinar conducted to address industry concerns
- Final rule language and SOC revised to clarify flexibility with respect to defining scope and schedule for reanalysis
- Industry encouraged to develop guidance

# Appendix K

- Appendix K provides a regulatory framework for LOCA EMs and is part of a majority of plant licensing bases
  - No changes to Appendix K included in proposed rule
- Industry requested that the “required and acceptable features of the evaluation models” be moved to a RG
  - Issue raised during several public workshops and webinars
  - Industry goal to provide flexibility for LTC evaluation models
- NRC concerned with selective implementation of acceptable features
- Regulation continues to allow use of a realistic plus uncertainty evaluation model for both long term and short term demonstration
- Industry encouraged to develop LTC guidance

# Conclusions

- With or without 50.46c, research findings must be incorporated into plant licensing bases to ensure adequate protection
- ECCS safety assessment supports NRC decision to pursue rulemaking, along with a flexible and efficient implementation plan
- Staff has conducted a series of public workshops and webinars to encourage stakeholder involvement
- Many changes incorporated into SOC, rule language, and guidance to improve clarity, expand flexibility, and reduce burden
- Staff requests that ACRS provide a written endorsement of the 50.46c rule package

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# Backup Slides

# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| **Rule Structure** | **Prescriptive** | **Performance-Based** |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

# Rule Structure

## 50.46c ECCS Performance During LOCA

(a) Applicability
(b) Definitions
(c) Relationship to Other NRC Regulations
(d) ECCS Performance
(e) Alternate Risk-Informed Approach
(f) [reserved]
(g) Fuel System Design – (current designs)
(h) [reserved]
(i) [reserved]
(j) [reserved]
(k) Use of NRC Approved Fuel
(l) Authority to Impose Restrictions on Operation
(m) Reporting, Corrective Actions, and Updates
(n) Significant Change or Error
(o) [reserved]
(p) Implementation

# Paragraph (d)

**(d) *Emergency core cooling system design.***

(1) *ECCS performance criteria.* Each LWR must be provided with an ECCS designed to satisfy the following performance requirements in the event of, and following, a postulated LOCA. The demonstration of ECCS performance must comply with paragraph (d)(2) of this section:

(i) Core temperature during and following the LOCA event does not exceed the analytical limits for the fuel design used for ensuring acceptable performance as defined in this section.

(ii) The ECCS provides sufficient coolant so that decay heat will be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

- Define **principal** performance objectives
  - Maintain acceptable core temperature during a LOCA
  - Remove decay heat following a LOCA
- Define **principal** analytical requirements for ECCS performance demonstration

# Rule Structure (cont.)

For <u>each</u> fuel design:

1. Define **specific** performance requirements and analytical limits which form the basis of "acceptable core temperature" based upon all established degradation mechanisms and unique features

2. Define **specific** analytical requirements which impact the predicted performance of the fuel under LOCA conditions

# Rule Structure (cont.)

Current Fuel Designs:

- Based upon extensive empirical database, including recent findings from High Burnup LOCA Research Program, 50.46c defines specific performance and analytical requirements for current fuel designs

New Fuel Designs:

- Additional research may be necessary to identify all degradation mechanisms and any unique features
- New performance objectives, analytical limits, and analytical requirements would need to be established based upon this research
- Several paragraphs reserved within 50.46c for future rulemaking on new fuel designs

# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| **Applicability** | **Zircaloy or ZIRLO Cladding** | **All LWR Cladding** |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

# Paragraph (a)

***(a) Applicability.*** The requirements of this section apply to the design of a light water nuclear power reactor and to the following entities who design, construct or operate a light water nuclear power reactor; each applicant for or holder of a construction permit under this part, each applicant for or holder of an operating license under this part, including a holder of a renewed operating license under 10 CFR part 54 (until the licensee has submitted the certification required under § 50.82(a)(1) to the NRC), each applicant for or holder of a combined license under part 52 of this chapter, including an applicant for an holder of a renewed combined license (until the licensee has submitted the certification required under § 50.82(a)(1) or § 52.11(a)(1) of this chapter to the NRC, as applicable), each applicant for a standard design certification, including an applicant for renewal of a standard design certification (including the applicant for that design certification after the NRC has adopted a final design certification rule), each applicant for a standard design approval under part 52 of this chapter, and each applicant for or holder of a manufacturing license, including an applicant for or holder of a renewed manufacturing license under part 52 of this chapter.

- Achieves rulemaking objective to expand applicability beyond “zircaloy or ZIRLO” to all LWRs
- Eliminates need for exemption requests for new zirconium alloys

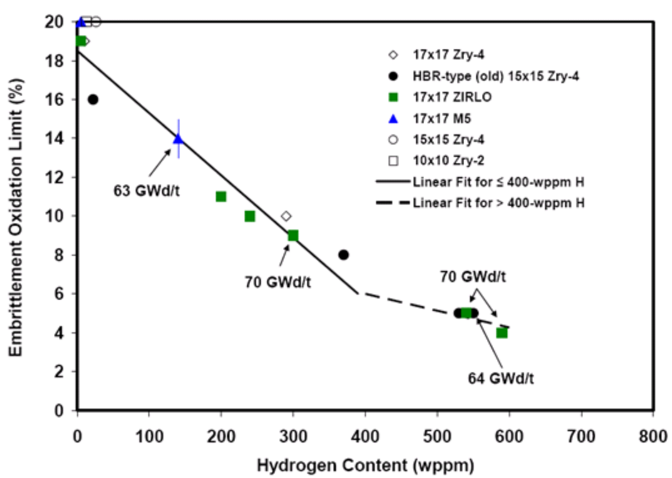
# Summary of Major Changes

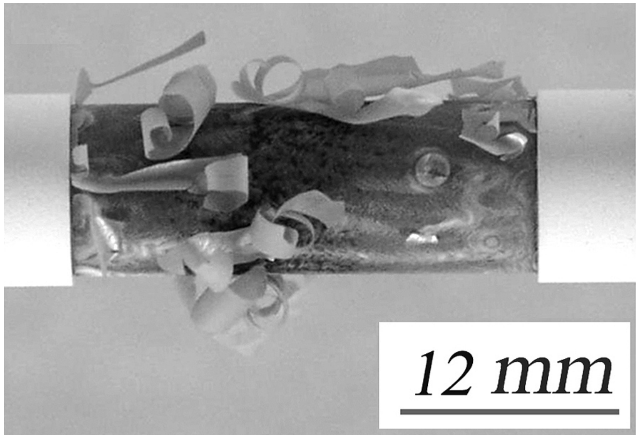
| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| **Burnup Related Phenomena** | **None** | **Cladding Inner Surface Oxygen Ingress** |
| **Corrosion Related Phenomena** | **None** | **Hydrogen-Enhanced Embrittlement** |
| **Fabrication Related Phenomena** | **None** | **Breakaway Oxidation** |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

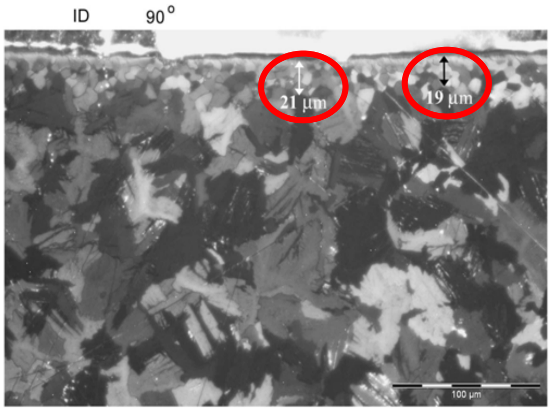
# Research Findings

New Embrittlement Mechanisms:

1. Hydrogen-enhanced beta layer embrittlement.
2. Cladding ID oxygen diffusion
3. Breakaway oxidation



# Paragraph (g)

**(g)** ***Fuel system designs: uranium oxide or mixed uranium-plutonium oxide pellets within cylindrical zirconium-alloy cladding.***

(1) *Fuel performance criteria.* Fuel consisting of uranium oxide or mixed uranium-plutonium oxide pellets within cylindrical zirconium-alloy cladding must be designed and manufactured to meet the following requirements:

> (i) *Peak cladding temperature*. Except as provided in paragraph (g)(1)(ii) of this section, the calculated maximum fuel element cladding temperature shall not exceed 2200 ° F.

- PCT is 1$^{st}$ of 5 fuel temperature analytical limits used to judge ECCS performance for current fuel designs
- Research confirmed embrittlement above 2200 ºF
- PCT limit also prevents runaway oxidation and high temperature failure
- SOC specific request for comment

# Paragraph (g)(1)(i)

- In response to SOC specific request for comment:
  - No new performance-based metrics for high-temperature cladding performance were identified
  - No new empirical data for defining a PCT other than 2200°F was provided
  - No testing procedures for identifying all high-temperature degradation mechanisms and defining acceptance criteria were provided
- No changes as a result of comments

# Paragraph (g)(1)(ii)

(ii) *Post-quench ductility*. Analytical limits on peak cladding temperature and integral time at temperature shall be established that correspond to the measured ductile-to-brittle transition for the zirconium-alloy cladding material based on an NRC-approved experimental technique. The calculated maximum fuel element temperature and time at elevated temperature shall not exceed the established analytical limits. The analytical limits must be approved by the NRC. If the peak cladding temperature, in conjunction with the integral time at temperature analytical limit, established to preserve cladding ductility is lower than the 2200 ºF limit specified in paragraph (g)(1)(i) of this section, then the lower temperature shall be the applicable analytical limit on peak cladding temperature.

- Maintains cladding ductility as performance objective
- Captures research finding
  - Hydrogen enhanced beta-layer embrittlement
- RG provides acceptable analytical limits for current alloys
- RG provides acceptable experimental technique

# Paragraph (g)(1)(ii)

Public Comments:

- Industry requested minor clarification
- Private individuals’ comment requesting prescriptive analytical limits
- Minor clarification as a result of comments

# Paragraph (g)(1)(iii)

(iii) *Breakaway oxidation.* An analytical time limit that has been shown to preclude breakaway oxidation using an NRC-approved experimental technique must be determined and specified for each zirconium-alloy cladding material. The analytical limits must be approved by the NRC. The total time that the cladding is predicted to remain above the temperature that the zirconium-alloy has been shown to be susceptible to breakaway oxidation must be less than the analytical limit. The breakaway oxidation behavior must be periodically confirmed using an NRC-approved experimental technique capable of determining the effect of composition changes or manufacturing changes on the breakaway oxidation behavior. The frequency of confirmatory testing must provide reasonable assurance that fuel is being manufactured consistent with the specified analytical limit.

- Maintains cladding ductility as performance objective
- Captures research finding
  - Breakaway oxidation (hydrogen uptake)
- RG provides acceptable experimental technique

# Paragraph (g)(1)(iii)

Public Comments:

- No industry comments challenging need to define an analytical limit for breakaway oxidation
- Many industry comments on testing frequency and reporting requirements

- Significant changes as a result of comments.
  - Deleted annual reporting requirement
  - Revised confirmatory periodic testing, no specified frequency
  - Granted flexibility requested by industry

# Paragraph (g)(2)

**(2)** ***Fuel system modeling requirements****.* The evaluation model required by paragraph (d)(2) of this section must model the fuel system in accordance with the following requirement:

(i) If an oxygen source is present on the inside surfaces of the cladding at the onset of the LOCA, then the effects of oxygen diffusion from the cladding inside surfaces must be considered in the evaluation model.

- Specifies analytical requirements for current fuel designs
- Captures research finding
  - Oxygen ingress from cladding inside surface reduces time-at-temperature to nil ductility

# Paragraph (g)(2)(i)

Public Comments:

- No industry comments challenging need to define an analytical requirement for cladding ID oxygen ingress

- No changes as a result of comments

# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| **Debris Consideration** | **Implicit** | **Explicit** |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

# Paragraph (d)(2)(iii)

(iii) *Core geometry and coolant flow*. The ECCS evaluation model must address calculated changes in core geometry and must consider those factors, including debris, that may alter localized coolant flow in the core or inhibit delivery of coolant to the core. However, a licensee may evaluate effects of debris on long-term cooling using a risk-informed approach as specified in paragraph (e) of this section, in which case the ECCS evaluation model specified in paragraph (d)(2)(i) or d(2)(ii) of this section need not include the effects of debris on long-term cooling.

- Added debris effects to analytical requirements
- Consistent with existing requirements

# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| **LTC Performance Requirement** | **General** | **Explicit** |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

# Paragraph (g)(1)(v)

(v) *Long-term cooling*. After any calculated successful initial operation of the ECCS, the calculated core temperature must be maintained to prevent further cladding failure, and the ECCS shall provide sufficient coolant to remove decay heat, for the extended period of time required by the long-lived radioactivity remaining in the core.

- Existing regulation requires **continued effective core cooling**
  - If debris impedes ECCS coolant delivery such that core temperatures increase, then LTC performance objective no longer satisfied
  - Debris resolution strategy may necessitate exemption requests
  - New, more explicit performance requirement needed to judge acceptability of any debris-induced post-quench reheat
- Applicants must demonstrate no further cladding failure during long-term recirculation period
  - No addition burden if debris source is limited

# Summary of Major Changes

| | **§ 50.46** | **§ 50.46c** |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| **Crud Treatment** | **None** | **Explicit** |
| Risk-informed Debris Treatment | N/A | Allowed |

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# Paragraph (d)(2)(iii)

(ii) The thermal effects of crud and oxide layers that accumulate on the fuel cladding during plant operation must be evaluated.

- Achieves rulemaking objective to address petition for rulemaking
- Oxide growth and crud deposition models will be reviewed and approved

# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| **Risk-informed Debris Treatment** | **N/A** | **Allowed** |

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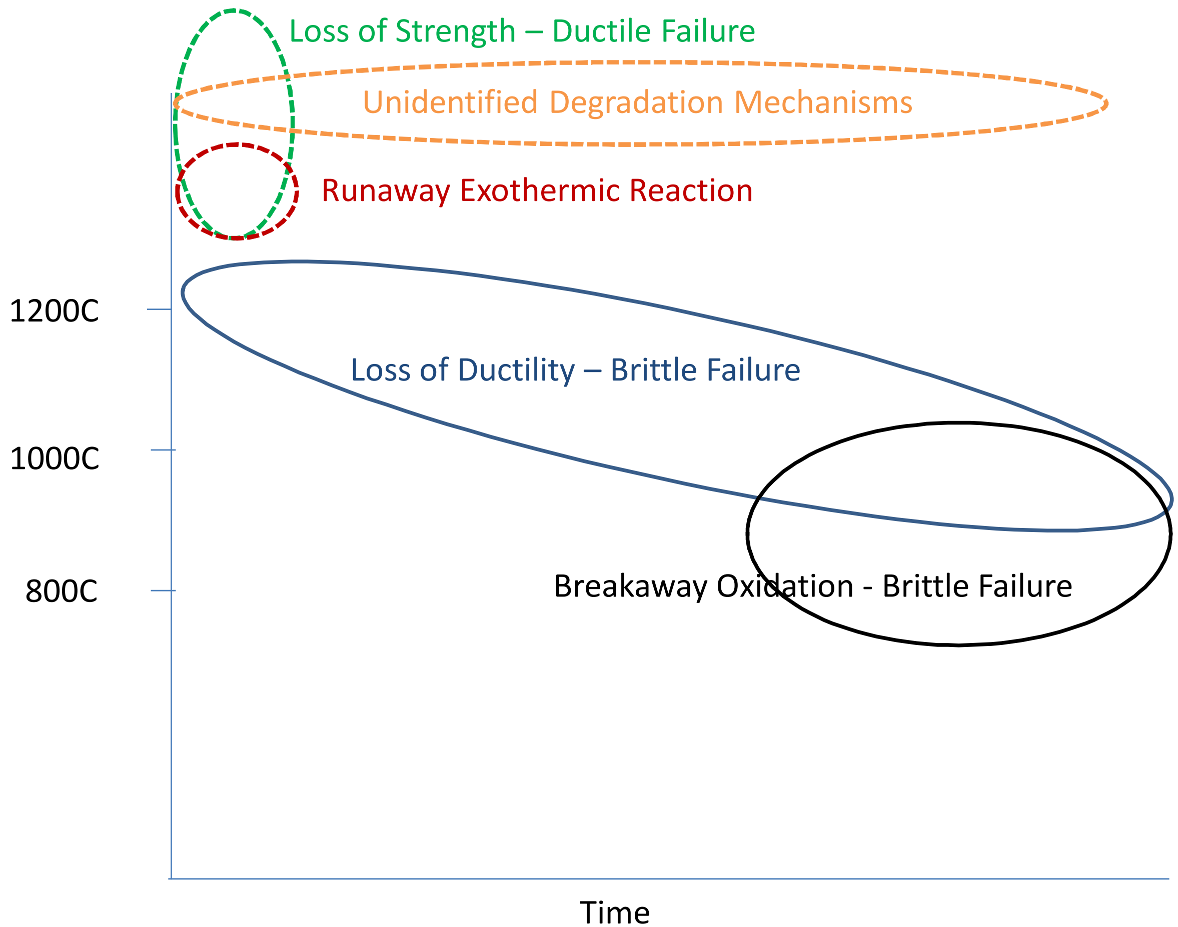
# Major Revisions in Final Rule

- Breakaway oxidation testing and reporting
  - Deleted annual reporting requirement
  - Revised confirmatory periodic testing, no specified frequency
- Long-term cooling fuel performance requirement
  - Deleted PCT analytical limit and ductility performance metric
  - If debris prompts a post-quench reheat transient, then research must be conducted to demonstrate no further cladding failure
- Implementation plan
  - Deleted Table 1 plant assignments
  - Adopted NEI proposal. Within 6 months each licensee must submit an implementation plan and schedule
    - LAR must be submitted within 60 months of final rule
    - Compliance must be achieved within 84 months of final rule
- Significant changes to DG-1261, DG1262, and DG-1263

# Summary of Major Changes

| | § 50.46c | Benefit |
|---|---|---|
| Rule Structure | Performance-Based | More flexibility |
| Applicability | All LWR Cladding | Eliminates exemption requests for modern alloys |
| Burnup Related Phenomena | Cladding Inner Surface Oxygen Ingress | Supports current, high efficiency, high burnup core loading patterns |
| Corrosion Related Phenomena | Hydrogen-Enhanced Embrittlement | Supports current, high efficiency, extended operating cycles |
| Fabrication Related Phenomena | Breakaway Oxidation | Improves cladding performance without interfering with manufacturing flexibility |
| Debris Consideration | Explicit | Regulatory stability |
| LTC Performance Requirement | Explicit | Supports closure of GSI-191 and reduces need for costly fiber removal |
| Crud Treatment | Explicit | Regulatory stability |
| Risk-informed Debris Treatment | Allowed | Supports closure of GSI-191 and reduces need for costly fiber removal |



Loss of Strength – Ductile Failure
Unidentified Degradation Mechanisms
Runaway Exothermic Reaction
1200C
Loss of Ductility – Brittle Failure
1000C
800C
Breakaway Oxidation - Brittle Failure
Time

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# ASTM Composition

**TABLE 1 Chemical Requirements**

| Element | Composition, Weight % | | | |
|---|---|---|---|---|
| | UNS R60001 | UNS R60802 | UNS R60804 | UNS R60901 |
| Tin | . . . | 1.20–1.70 | 1.20–1.70 | . . . |
| Iron | . . . | 0.07–0.20 | 0.18–0.24 | . . . |
| Chromium | . . . | 0.05–0.15 | 0.07–0.13 | . . . |
| Nickel | . . . | 0.03–0.08 | . . . | . . . |
| Niobium (columbium) | . . . | . . . | . . . | 2.40–2.80 |
| Oxygen | [A] | [A] | [A] | 0.09–0.15 |
| Iron + chromium + nickel | . . . | 0.18–0.38 | . . . | . . . |
| Iron + chromium | . . . | . . . | 0.28–0.37 | . . . |
| **Maximum Impurities, Weight %** | | | | |
| Aluminum | 0.0075 | 0.0075 | 0.0075 | 0.0075 |
| Boron | 0.00005 | 0.00005 | 0.00005 | 0.00005 |
| Cadmium | 0.00005 | 0.00005 | 0.00005 | 0.00005 |
| Calcium | ... | 0.0030 | 0.0030 | ... |
| Carbon | 0.027 | 0.027 | 0.027 | 0.027 |
| Chromium | 0.020 | . . . | . . . | 0.020 |
| Cobalt | 0.0020 | 0.0020 | 0.0020 | 0.0020 |
| Copper | 0.0050 | 0.0050 | 0.0050 | 0.0050 |
| Hafnium | 0.010 | 0.010 | 0.010 | 0.010 |
| Hydrogen | 0.0025 | 0.0025 | 0.0025 | 0.0025 |
| Iron | 0.150 | . . . | . . . | 0.150 |
| Magnesium | 0.0020 | 0.0020 | 0.0020 | 0.0020 |
| Manganese | 0.0050 | 0.0050 | 0.0050 | 0.0050 |
| Molybdenum | 0.0050 | 0.0050 | 0.0050 | 0.0050 |
| Nickel | 0.0070 | . . . | 0.0070 | 0.0070 |
| Niobium | ... | 0.0100 | 0.0100 | ... |
| Nitrogen | 0.0080 | 0.0080 | 0.0080 | 0.0080 |
| Phosphorus | . . . | . . . | . . . | 0.0020 |
| Silicon | 0.0120 | 0.0120 | 0.0120 | 0.0120 |
| Tin | 0.0050 | . . . | . . . | 0.010 |
| Tungsten | 0.010 | 0.010 | 0.010 | 0.010 |
| Titanium | 0.0050 | 0.0050 | 0.0050 | 0.0050 |
| Uranium (total) | 0.00035 | 0.00035 | 0.00035 | 0.00035 |

[A] When so specified in the purchase order, oxygen shall be determined and reported. Maximum, minimum, or both, permissible values should be specified in the purchase order.

# ASTM Testing

- ASTM nuclear grade zirconium standard (B350/351) require periodic testing
  - Chemical composition and microstructure
  - Corrosion
  - Mechanical properties

**9. Special Requirements**

9.1 *Corrosion Properties:*

9.1.1 The product shall be corrosion resistant when tested in accordance with 15.2.4 and shall meet the criterion in 9.1.2.

9.1.2 *Acceptance Criterion:*

9.1.2.1 *Grades R60802 and R60804*—All coupons thus tested shall exhibit a continuous, black, lustrous oxide film and be free of white or brown corrosion product in excess of standards previously agreed upon between manufacturer and purchaser. Coupons shall exhibit a weight gain of not more than 22 $mg/dm^2$ in a 72-h test or 38 $mg/dm^2$ in a 336-h test.

9.1.2.2 *Grade R60901*—All coupons shall exhibit a continuous, uniform, dark gray oxide film. Coupons shall exhibit a weight gain of not more than 35 $mg/dm^2$ in a 72-h test or 60 $mg/dm^2$ in a 336-h test.

**14. Number of Tests, Retesting, and Reworking**

14.1 *Number of Tests:*

14.1.1 *Chemical Composition*—Sampling shall be in accordance with Specification B350/B350M, except for hydrogen, nitrogen, and oxygen.

14.1.1.1 *Hydrogen, Nitrogen, and Oxygen*—For final product, two random samples for each 4000 lb [1800 kg] or fraction thereof shall be analyzed for hydrogen, nitrogen, and oxygen.

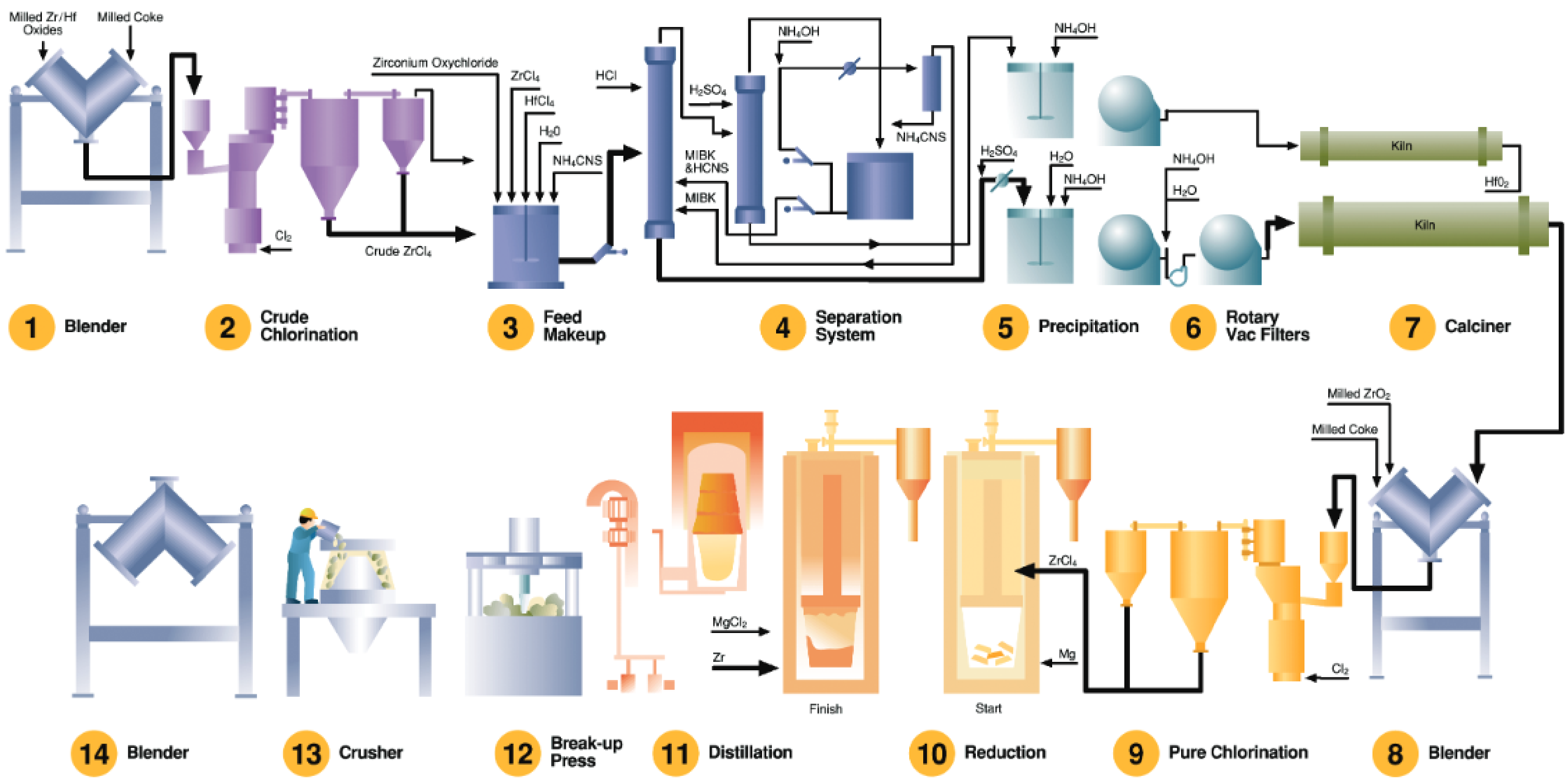
14.1.2 *Mechanical Properties*—Two random samples for each 4000 lb [1800 kg] or fraction thereof shall be tested for mechanical properties in the longitudinal direction.

14.1.3 *Microstructure*—Two longitudinal samples taken at random shall be examined for recrystallization.

14.1.4 *Corrosion Properties*—Two samples chosen at random from each 4000 lb [1800 kg] or fraction thereof shall be corrosion tested.

# Zirconium Sponge

**Figure 4.** *Flow diagram of traditional zirconium production process.*




Source: Advances in Zirconium Sponge Supply, Randall Scheel, ATI Wah Chang, Corrosion Solutions Conference 2011 Proceedings

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# 50.46c Risk-Informed Alternative for Long-Term Core Cooling

Advisory Committee on Reactor Safeguards
December 3, 2015

Steve Laur, CJ Fong
Division of Risk Assessment
Office of Nuclear Reactor Regulation

# Summary of Major Changes

| | § 50.46 | § 50.46c |
|---|---|---|
| Rule Structure | Prescriptive | Performance-Based |
| Applicability | Zircaloy or ZIRLO Cladding | All LWR Cladding |
| Burnup Related Phenomena | None | Cladding Inner Surface Oxygen Ingress |
| Corrosion Related Phenomena | None | Hydrogen-Enhanced Embrittlement |
| Fabrication Related Phenomena | None | Breakaway Oxidation |
| Debris Consideration | Implicit | Explicit |
| LTC Performance Requirement | General | Explicit |
| Crud Treatment | None | Explicit |
| Risk-informed Debris Treatment | N/A | Allowed |

# Paragraph (e)(1)

(e)(1) *Attributes of an acceptable risk-informed approach.* An entity may request that the NRC approve a risk-informed approach for addressing the effects of debris on long-term core cooling to demonstrate compliance with the requirements in paragraph (d)(2)(iii) of this section. If the alternate risk-informed approach is used, then the ECCS evaluation model specified in paragraph (d)(2)(i) or (d)(2)(ii) of this section need not include the effects of debris on long-term cooling. If an entity desires to change the methods employed in the systematic processes in paragraph (e)(1)(iii) of this section, as approved by the NRC, then the entity shall obtain NRC review and approval before the change is implemented.

- Risk-informed approach allows the ECCS evaluation model to ignore debris effects on long-term cooling (LTC)
- Requires NRC review and approval via a license amendment request (LAR)
- Uses RG 1.174 guidance as requirements for LAR contents and risk acceptance criteria
- Requires periodic monitoring and reporting (see later slides)
- RG 1.229 will provide guidance on acceptable methods

# Paragraph (m)(6)

- (m)(6) *Risk-informed consideration of debris: reporting*. If an entity implementing the risk-informed approach to address debris effects determines that either the acceptance criteria of paragraph (e)(1)(i) of this section have been exceeded or the requirements of paragraph (e)(1)(ii) of this section are no longer met, then the following reporting actions must be taken.

  -Various requirements for different entities (e.g., Part 52 plants)

  -Make a timely report describing issue and how resolved

- Requires report if risk has increased beyond the acceptance criteria
- Requires report if safety margins or defense-in-depth decrease

# Paragraph (m)(7)

(m)(7) *Risk-informed consideration of debris: corrective action.* If an entity implementing the risk-informed approach to address debris effects determines that either the acceptance criteria of paragraph (e)(1)(i) of this section have been exceeded or the requirements of paragraph (e)(1)(ii) of this section are no longer met, then the following corrective actions must be taken;

- Requires corrective action if risk acceptance criteria exceeded
- Requires corrective action if defense in depth or safety margins are decreased
- A licensee must take timely corrective action such that the acceptance criteria are met

# Paragraph (m)(8)

(m)(8) Risk-informed consideration of debris: updates.

(i) Each licensee shall update its risk informed evaluations under paragraph (e)(1) of this section no later than 48 months after initial NRC approval or the latest update. … Each licensee that desires to change the methods or approaches employed in the NRC approved risk-informed evaluation of debris shall submit an amendment to its operating license under …

- Requires update of risk-informed evaluation at least every 48 months (risk, defense-in-depth, safety margins)
- COLs update after initial fuel loading
- Update must:
  - correct any identified errors
  - incorporate changes to the plant design or operation
  - account for industry operating experience
- License amendment required to use different methods

# Conclusions

- Many changes were made to proposed rule to clarify the requirements to implement a risk-informed approach to address the effects of debris on long-term cooling.
- The rule limits the use of risk-informed evaluations to the effects of debris on LTC
- The rule allows the use of the risk-informed alternative only for emergent conditions, not to allow problematic material to be designed into a plant.
- NRC is finalizing the guidance that will assist in implementing the risk-informed alternative. (RG 1.229)

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# Backup Slides

# Paragraph (e)(1)

Public Comments:

- Risk-informed (RI) evaluations should be allowed for all portions of the post-LOCA period, not just LTC and should cover aspects of the evaluation other than debris
- The requirements for risk-informed submittal contents are unclear
- The requirements for LTC analyses for entities implementing a risk-informed evaluation are unclear (RI vs deterministic)
- LTC and STC are not defined
- Acceptance criteria should be in a regulatory guide, not the rule
- RI evaluations allowed only for the effects of debris on LTC
- Clarified requirements for RI submittals by rewriting rule sections
- Clarified requirements for LTC analyses to be submitted by plants using a RI evaluation for the effects of debris on LTC
- Require the applicant to define LTC and STC periods
- Maintained high level acceptance criteria within the rule

# Paragraph (m)(6)

Public Comments:

- Reporting should not be required unless a significant increase in risk occurs or is discovered
- Reporting requirements should be in a regulatory guide
- Existing reporting requirements should be used to determine if reporting is required for findings associated with the RI evaluation

- Reporting, corrective action, and the requirements for updates were clarified by splitting a single sub-paragraph into 3 sub-paragraphs
- Maintained reporting requirement for increases in risk and reductions in defense-in-depth or safety margins that exceed the acceptance criteria
- Maintain high level reporting requirements in the rule

# Paragraph (m)(7)

Public Comments:

- Corrective actions should be the same as those for existing risk-informed evaluations

- Clarified corrective action requirements in separate sub-paragraph
- Maintained corrective action requirements

# Paragraph (m)(8)

Public Comments:

- Updates should be required only for facility or procedure changes

- Clarified reporting requirements in separate sub-paragraph
- Maintained 48 month requirement for periodic updates

# Additional Comments

Public Comments:

- The public commented that other regulations may require exemptions to implement the RI approach, specifically GDC-19 and 10 CFR 50.67

- Rule is being changed to cover these two regulations (in progress)

# 10 CFR 50.46c Rule Making

**Gordon Clefton**
Sr. Project Manager, NEI

**Tom Eichenberg**
Sr. Specialist, Reactor Safety Analysis, TVA
Chair, Regulatory Technical Advisory Committee, EPRI Fuel Reliability Program

Full ACRS Committee Meeting
Rockville, Md., USA: 3 December 2015

# NEI Perspective

## 10CFR50.46c is a substantial consideration

- NEI Cumulative Effects of Regulation Project On-going
    - Some Plants May Find it Difficult to Amortize Cost Over the Remaining Life of Plant
    - Plants are Investigating Alternative Means to Achieve Compliance and Maintain an Adequate Level of Safety
- NRC 'Project AIM 2020' On-going
    - Right-sizing the NRC Budget and Staff
    - Aggressively Pursuing an Effort to Baseline and Prioritize Workload to Improve Productivity
- NEI Petition for RuleMaking in 2000; Projected to be Complete 2022-2023

# Public Health and Safety Aspect

U.S. Fleet Currently Provides Robust Protection of Public Health and Safety

## Potential Concern:

- Proposed § 50.46c is Considered “Adequate Protection” Rulemaking

## Discussion:

- Fleet Operability Assessment Show Margin to Phenomenon
- Non-trivial Retained Margin Exists in Analytical Limits
  - Brittle Failure Protected by Ductility Standard / Testing Methodology
- Early Breakaway Oxidation Only Observed for Older Russian Material
  - Russian Vendors No Longer Utilize Process Associated with the Phenomenon
  - U.S. Licensees/ Western Fuel Vendors Have Not Experienced Early Breakaway Oxidation

# Other Aspects

## Potential Concern:

- Guidance Gaps
  - Long Term Core Cooling
    - Risk Informed
  - Reporting
  - Review Standard

## Discussion:

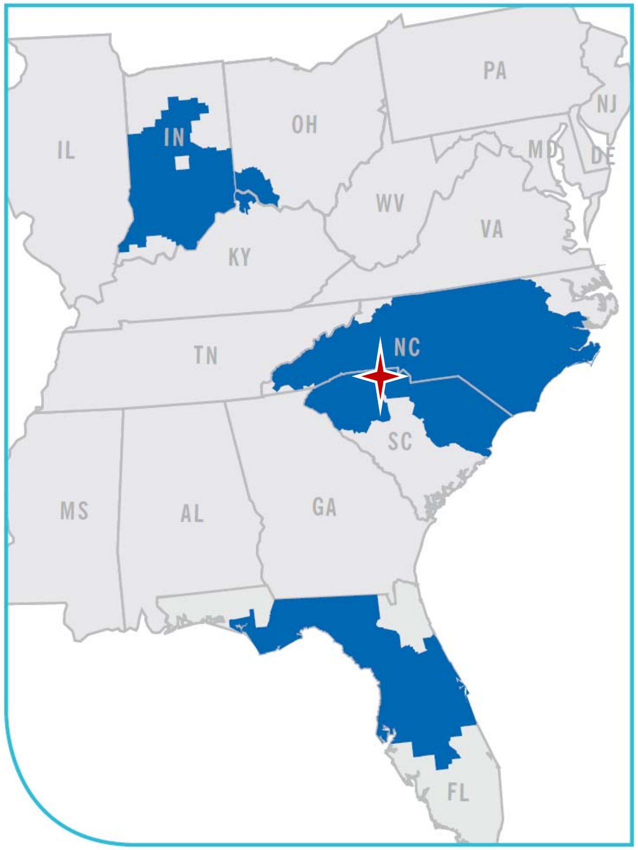
- Industry will Work to Bridge Guidance Gaps
  - Propose Detailed Guidance for Staff Review and Endorsement

# NEI Perspective

## §50.46c Implementation Proposal

- Suggest a Conditional Compliance; Switch to § 50.46c
  - If a Plant Makes a Change Requiring a New Evaluation Model (EM)
  - If Thermal Conductivity Degradation or Other Changes/Errors Affect PCT Require a New EM
- Allows Maintaining Compliance with Existing § 50.46
- Allows Maintaining Significant Margins of Safety Under Current Acceptance Criteria
- No Fixed Date for § 50.46c Compliance is Required
- 50.46c(p)(2)(iii)
  - Recommend deleting: "Licensees must be in compliance with the requirements of this section no later than 84 months after [INSERT DATE THAT IS 30 DAYS AFTER THE DATE OF PUBLICATION IN THE FEDERAL REGISTER]. "
  - Recommend keeping: "Until such compliance is achieved, the requirements of § 50.46 continue to apply for purposes of ECCS design and fuel design."

# LEE NUCLEAR STATION Introduction/Overview




Bob Kitchen
*Director Licensing*
*Nuclear Development*

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# RG 1.229 "Risk-informed Approach for Addressing the Effects of Debris on Post-accident Long-term Core Cooling"

Advisory Committee on Reactor Safeguards
December 3, 2015

CJ Fong, Steven Laur, Division of Risk Assessment
Stephen Smith, Division of Safety Systems
Office of Nuclear Reactor Regulation

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# Purpose and Scope of RG

- RG has acceptable methods/approaches for addressing 10 CFR 50.46c(e)
- RG leans heavily on existing, staff-approved methods
  - WCAP-16530-NP-A for chemical effects
  - 15 grams per fuel assembly for hot leg break
- Scope may be expanded in future Revs
  - Current focus is PWRs
  - Other entities should justify that each approach or method meets the intent

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# Background

- Separate path from other 50.46c RGs
  - Incorporate lessons from STP pilot review
- DG for public comment (80 FR 21658)
  - Published April 20, 2015
  - Comments due July 6, 2015
  - Over 200 comments received
- RG substantially revised
- RES raised substantive issues during concurrence on final RG

# Outline of Section C

- Systematic risk assessment of debris
- Initiating Event Frequencies
- Defense-in-Depth and Safety Margins
- Uncertainty
- Monitoring Program
- Quality Assurance
- Periodic Update
- Reporting and Corrective Actions
- License Application

# Outline of Appendix A ("detailed")

A-1 Scope
A-2 Failure mode identification
A-3 PRA model changes
A-4 Submodel development
A-5 Scenario development
A-6 Debris source term
A-7 Debris transport
A-8 Strainer evaluation
A-9 Impact of debris
A-10 Chemical effects
A-11 Debris penetration evaluation
A-12 Debris penetration effects
A-13 Submodel integration
A-14 Systematic risk assessment (solve PRA)

# Outline of Appendix B (“simplified”)

B-1 – Perform the following from Appendix A:

- A-1 Scope
- A-2 Failure mode identification
- A-5 Scenario development
- A-6 Debris source term
- A-7 Debris transport

B-2 – Impact of debris

B-3 – Systematic risk assessment (bounding)

# Resolving Comments

- Due to complexities in break frequency allocation we have reverted to a very conservative approach while allowing analysts to justify other approaches
- Consolidated and improved guidance on uncertainty
  - Comment from external stakeholders
  - Major comment area from RES

# Conclusion

- Informed by STP Pilot
- Updated to incorporate public comments
- Leverages existing approved deterministic guidance
- Future revisions may provide less conservative approaches compared to the bounding approach

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# Questions?

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# Backup Slides

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# Resolving RES Comments (cont'd)

- Guidance: how to treat partial breaks (e.g., 5" equivalent on 31" pipe)
- Guidance: site-specific applicability of the generic NUREG-1829 data, including
  - Water hammer
  - Seismically-induced LOCA

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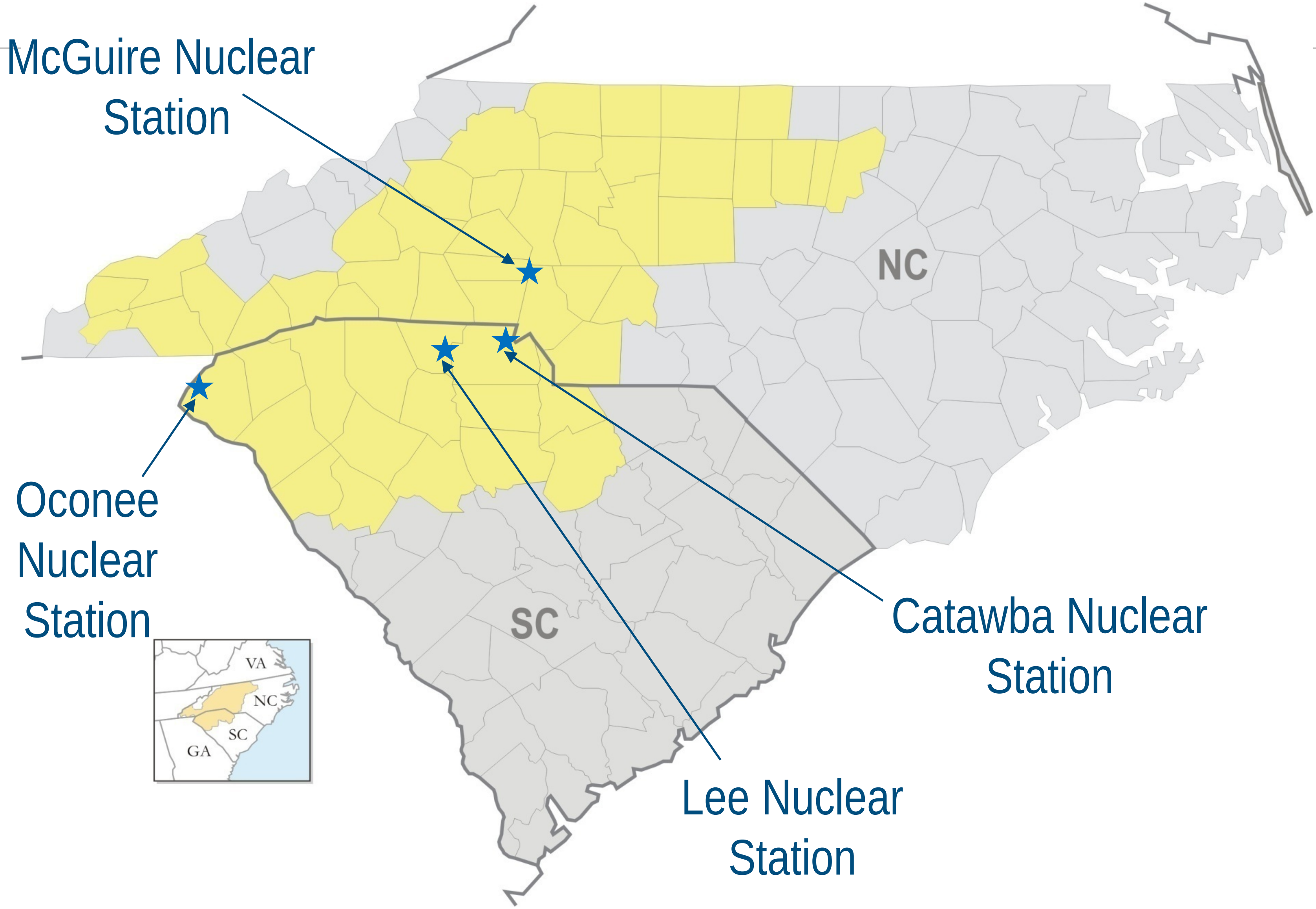
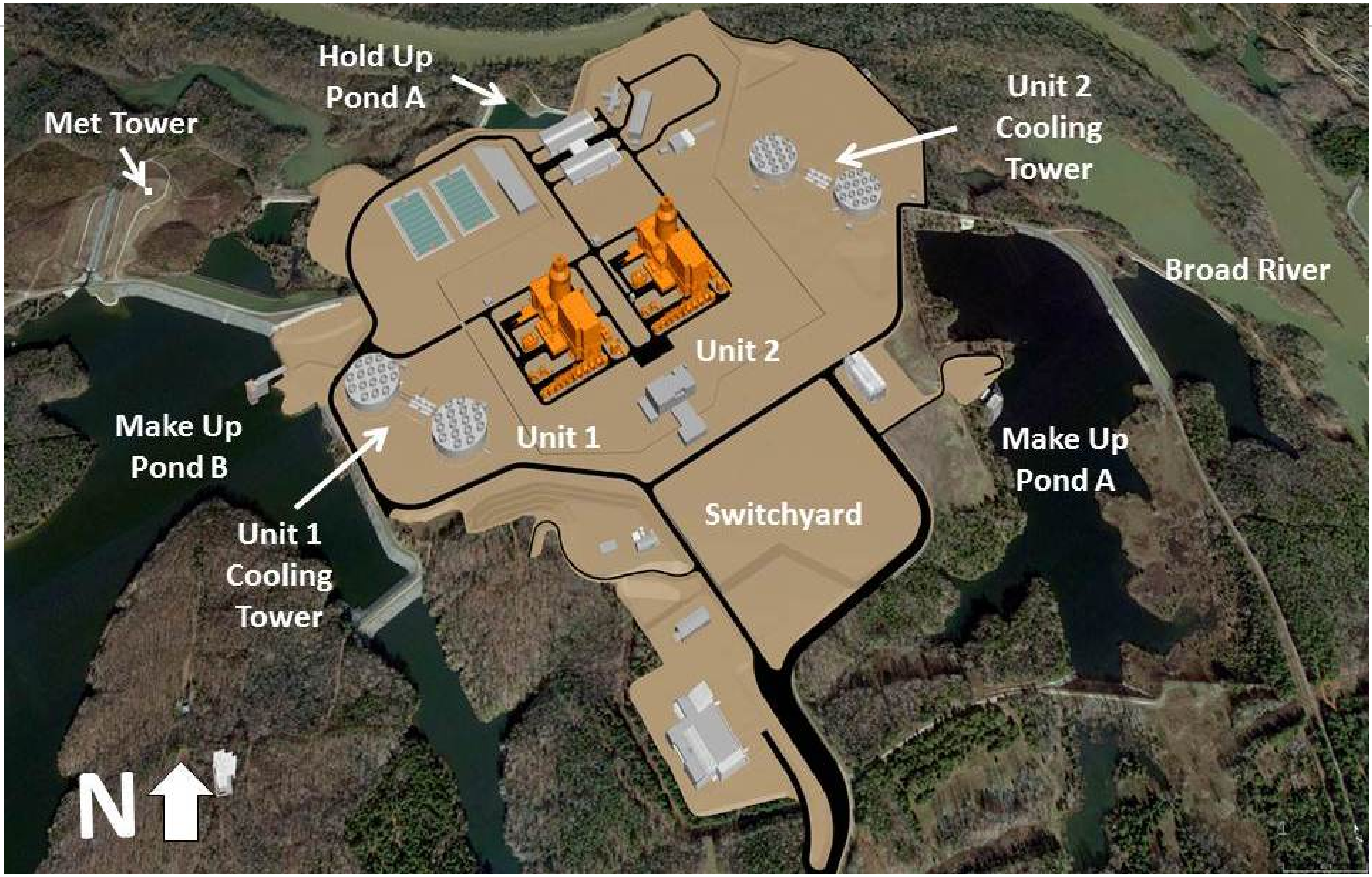
# RES Comments (continued)

- Clarify: break locations that produce and transport debris may not be screened from the analysis based strictly on low frequency
- Guidance: periodic update of risk-informed analysis must consider that the NUREG-1829 LOCA frequencies were originally published with an "expiration date" of 15 years

# Duke Energy Carolinas Nuclear Fleet



# Lee Site Layout



# Lee COLA Changes Since R-COL

- Post-Fukushima actions
  - Central Eastern US (CEUS) Seismic Source Characterization Model
- Emergency Plan Rule Implementation
- Electrical Bulletin 2012-01 Response
- AP1000 Generic Design Changes
  - Condensate Return & Passive RHR Cooling
  - Main Control Room Operator Dose
  - Main Control Room Heat Load
  - Hydrogen Vent In Containment
  - Plant Monitoring System (PMS) Flux Doubling

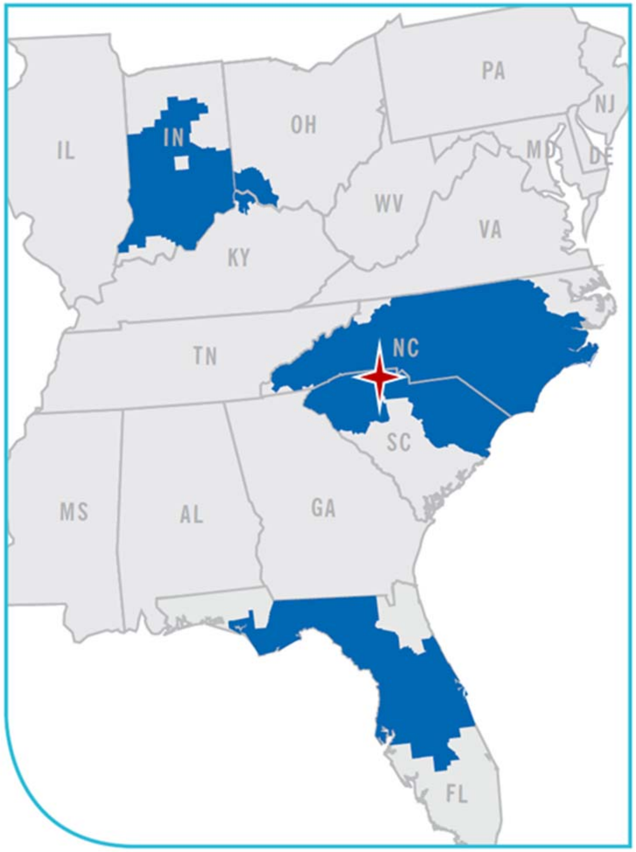
# Focus Areas for Discussion

- Non-seismic site characteristics are bounded by AP1000 site parameters
- Plant relocation
  - Unit 1 foundation over Cherokee foundation
  - Unit 2 foundation on rock
  - Ensures uniform foundation support conditions
- Seismic evaluation
  - Incorporates latest CEUS-SSC model
  - Incorporates updated EPRI ground motion model
  - Site-specific spectra exceed CSDRS and HRHF
  - DCD-specified methodology followed to address

# Plant Relocation


- Relocated Unit 1 is entirely underlain by former Cherokee foundation over previously-mapped continuous rock
- Unit 2 is founded on continuous rock
- Site-specific configuration aligns with DCD

# LEE NUCLEAR STATION
# Seismic Evaluation




John Thrasher
*Director Engineering*
*Nuclear Development*

# Lee Site Vibratory Ground Motion

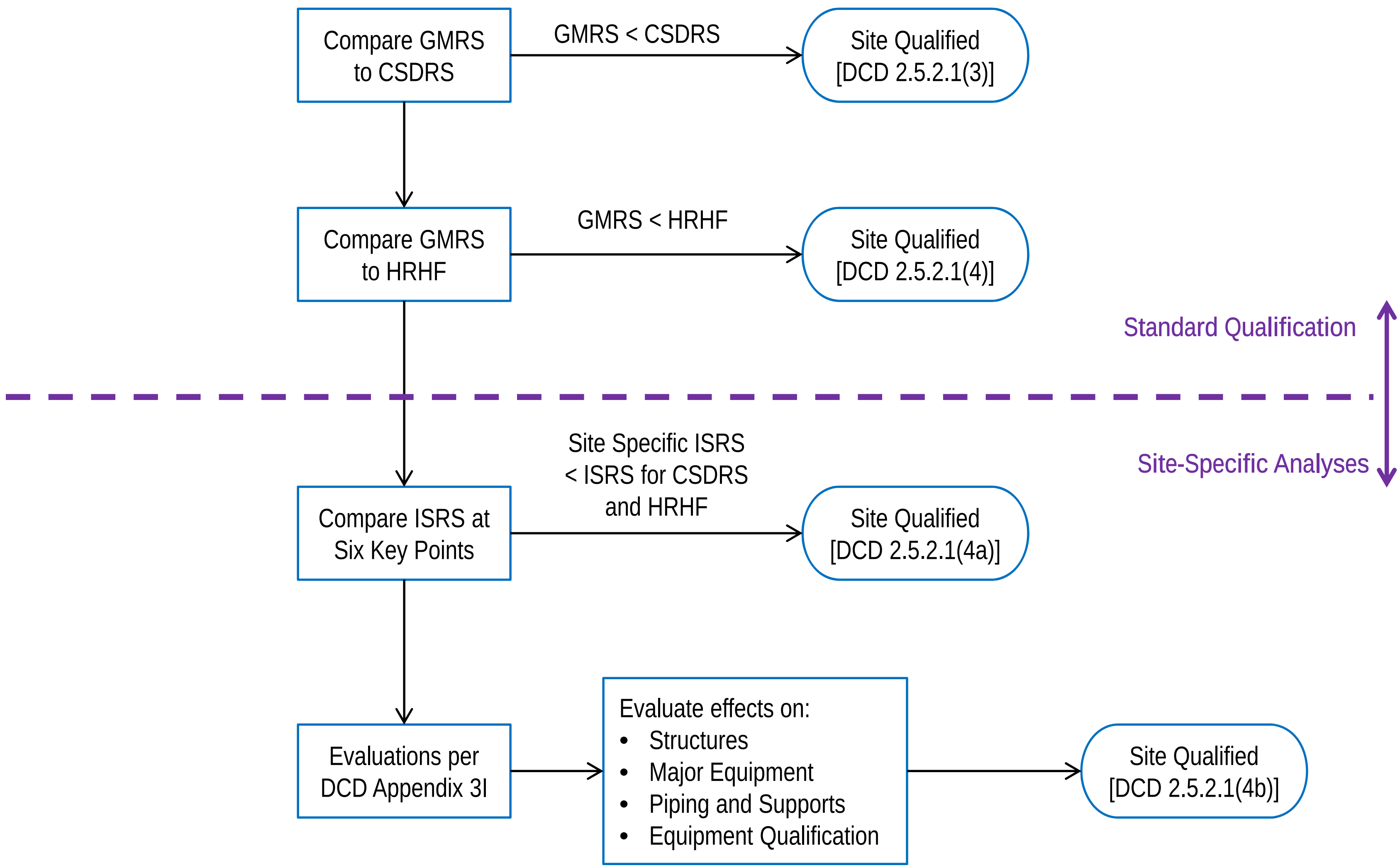
- CEUS (NUREG-2115) seismic source characterization model implemented directly, using updated EPRI 2013 ground motion model
- Newer information evaluated per NUREG-2117
  - East Tennessee Seismic Zone (ETSZ)
  - M5.8 Mineral Virginia earthquake (2011)
  - No change to NUREG-2115 models
- PSHA shows low-frequency hazard has contributions from Charleston and New Madrid RLMEs, and from local background; high-frequency contribution is almost completely from local background sources
- NI FIRS (envelope of GMRS and Unit 1 FIRS) is considered applicable to both units, and is used in site-specific evaluations

# AP1000 Certified Design

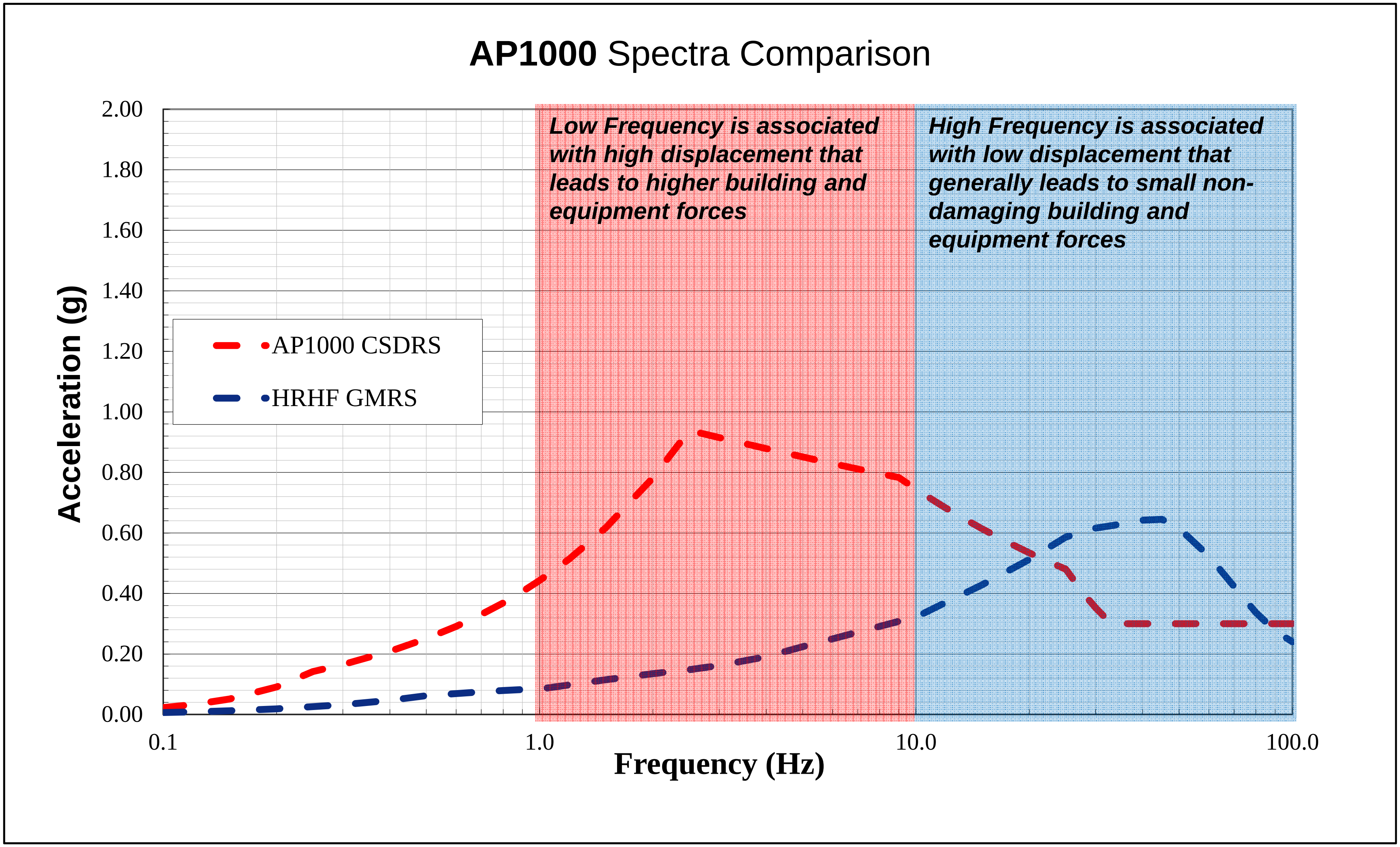
- AP1000 seismic design basis is CSDRS; a site whose GMRS is below the CSDRS is acceptable [DCD 2.5.2]
- To address high frequency spectra exceedances for hard rock sites, an <u>alternate acceptance criterion</u>, the HRHF spectra, was developed; the supporting evaluation (APP-GW-GLR-115), demonstrated that a site whose GMRS is below the HRHF spectra is also acceptable [DCD 2.5.2]
- DCD provides a two-step alternate methodology to qualify a site where the CSDRS or the HRHF do not bound the site-specific GMRS [DCD 2.5.2.1]

# AP1000 DCD – Approved Methodology to Address Site-Specific Seismic Characteristics (Rock Site)

DUKE ENERGY



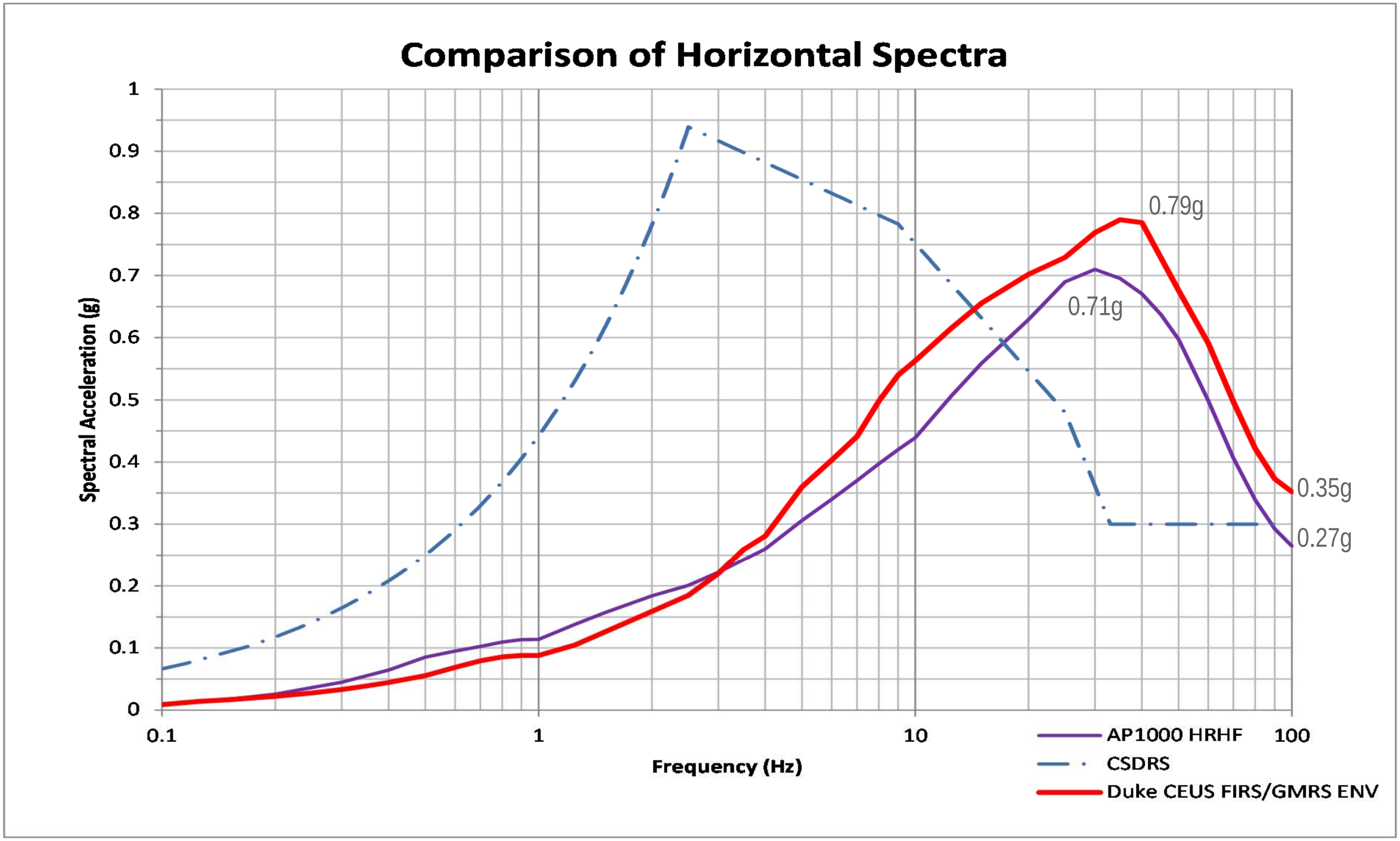
# DCD Spectra for Comparison



# Lee Site NI FIRS Exceed CSDRS and HRHF in High Frequency Range

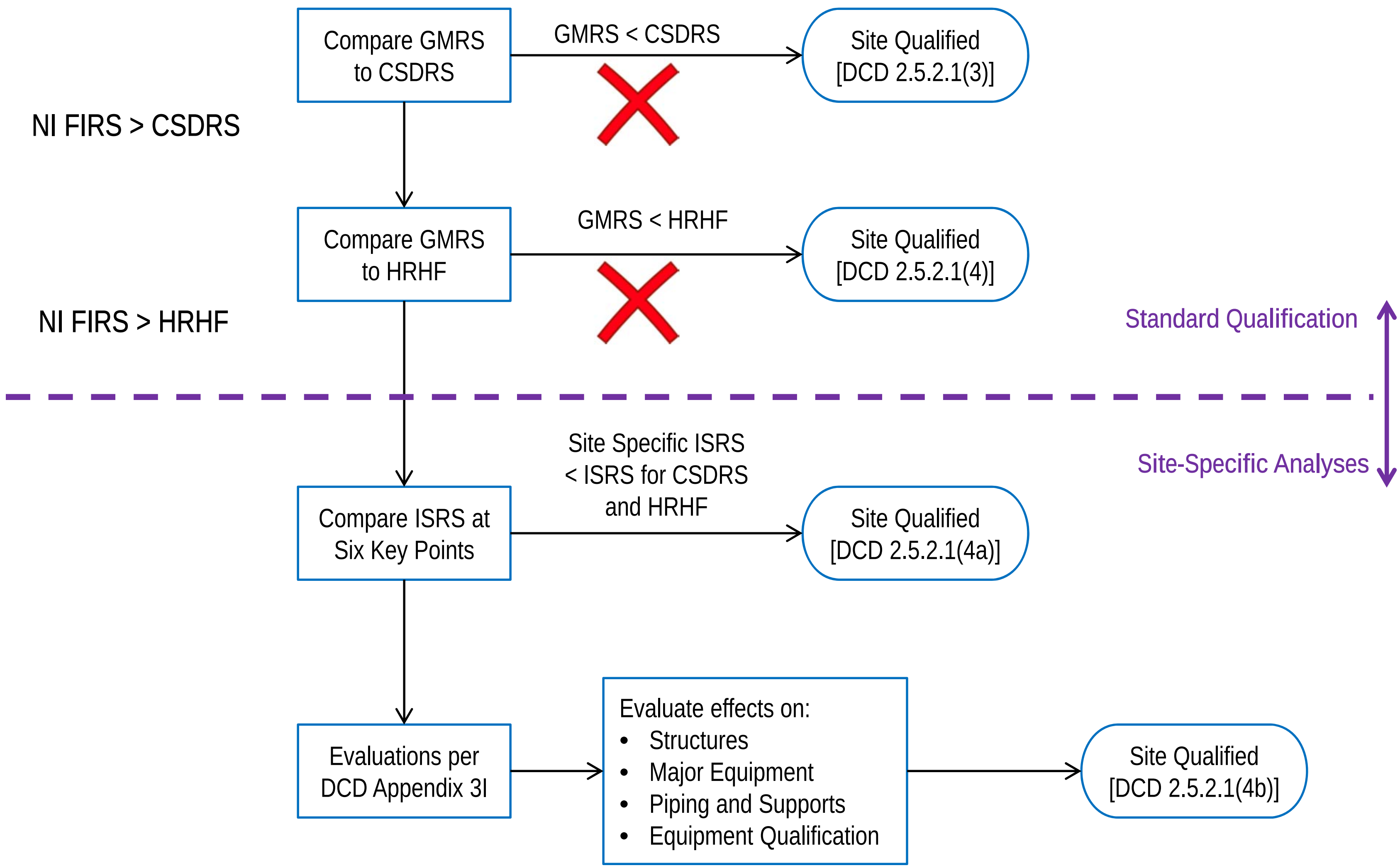
- After plant relocation, Lee Nuclear Station is a uniform hard-rock site with configuration just as described in AP1000 DCD
- Site characteristic NI FIRS (envelope of GMRS and Unit 1 FIRS) are higher than CSDRS in high frequency range; therefore, the certified design CSDRS cannot be directly used to qualify AP1000 at Lee [DCD 2.5.2.1(3)] (WLS DEP 2.0-1)
- Site characteristic NI FIRS are also higher than the alternate acceptance criterion (HRHF spectra), so HRHF spectra also cannot be directly used to qualify AP1000 at Lee [DCD 2.5.2.1(4)]

# Lee Site NI FIRS




Lee Vertical Spectra Comparison is Similar to Horizontal in Both Spectral Shape and Acceleration Magnitude

# AP1000 DCD – Approved Methodology to Address Site-Specific Seismic Characteristics (Rock Site)

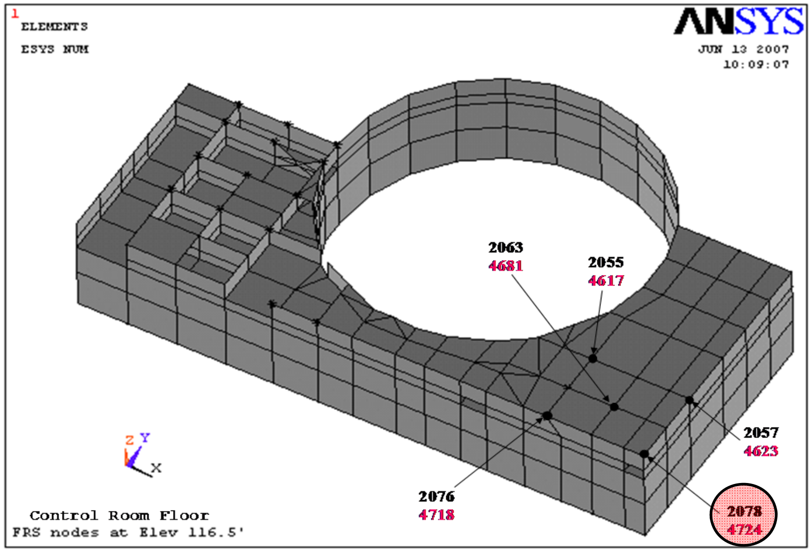


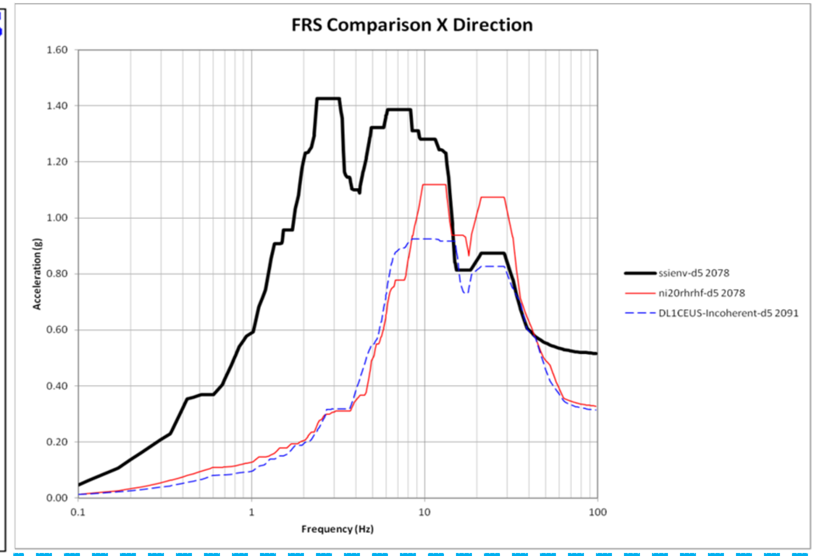
# AP1000 DCD Provides Alternate Methodology for Site-Specific Seismic Qualification

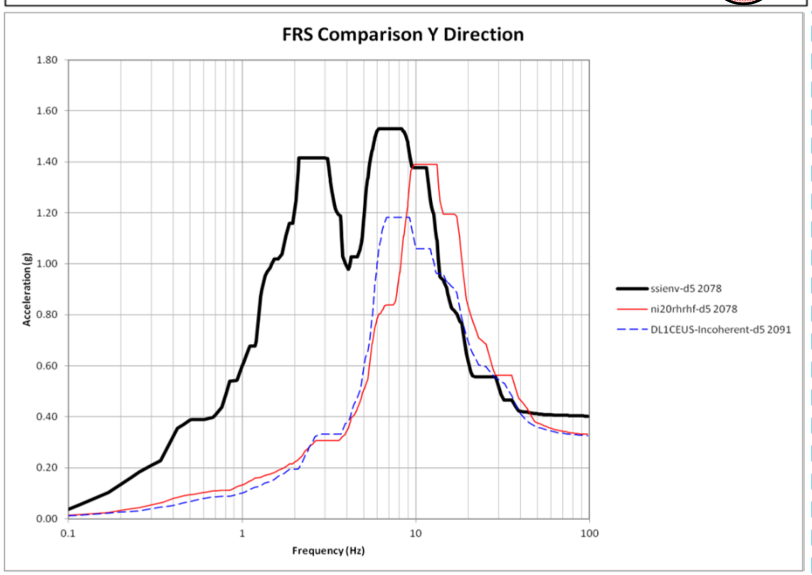
- Provisions of DCD 2.5.2.1 further outline a two-step alternate methodology by which such a site can be qualified
- First step is to compare site-specific in-structure response spectra at six key locations to the corresponding in-structure spectra resulting from CSDRS and/or HRHF; if site-specific in-structure spectra are below corresponding AP1000 spectra, the site is acceptable [DCD 2.5.2.1(4a)]

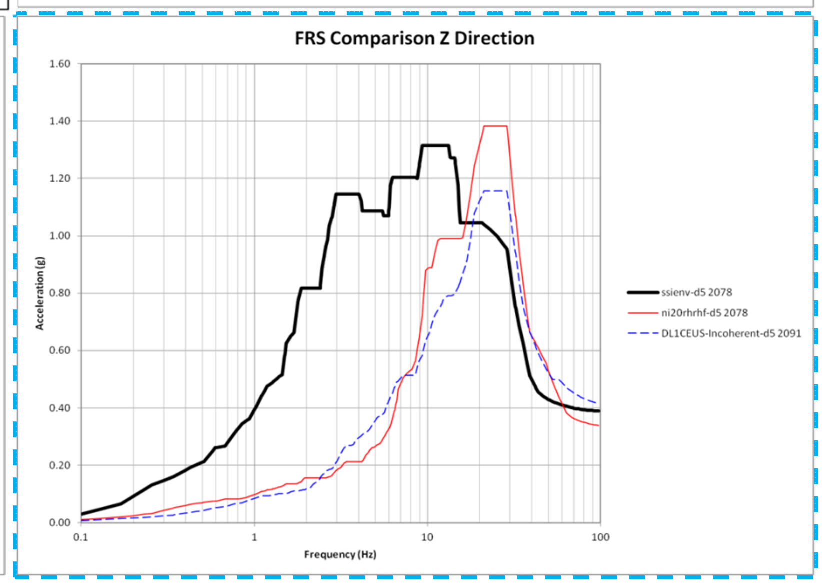
# Comparison of Key Location ISRS: CSDRS, HRHF vs Lee

## Key Location - Aux Bldg. NE Corner at Elevation 116'-6" – Control Room Floor



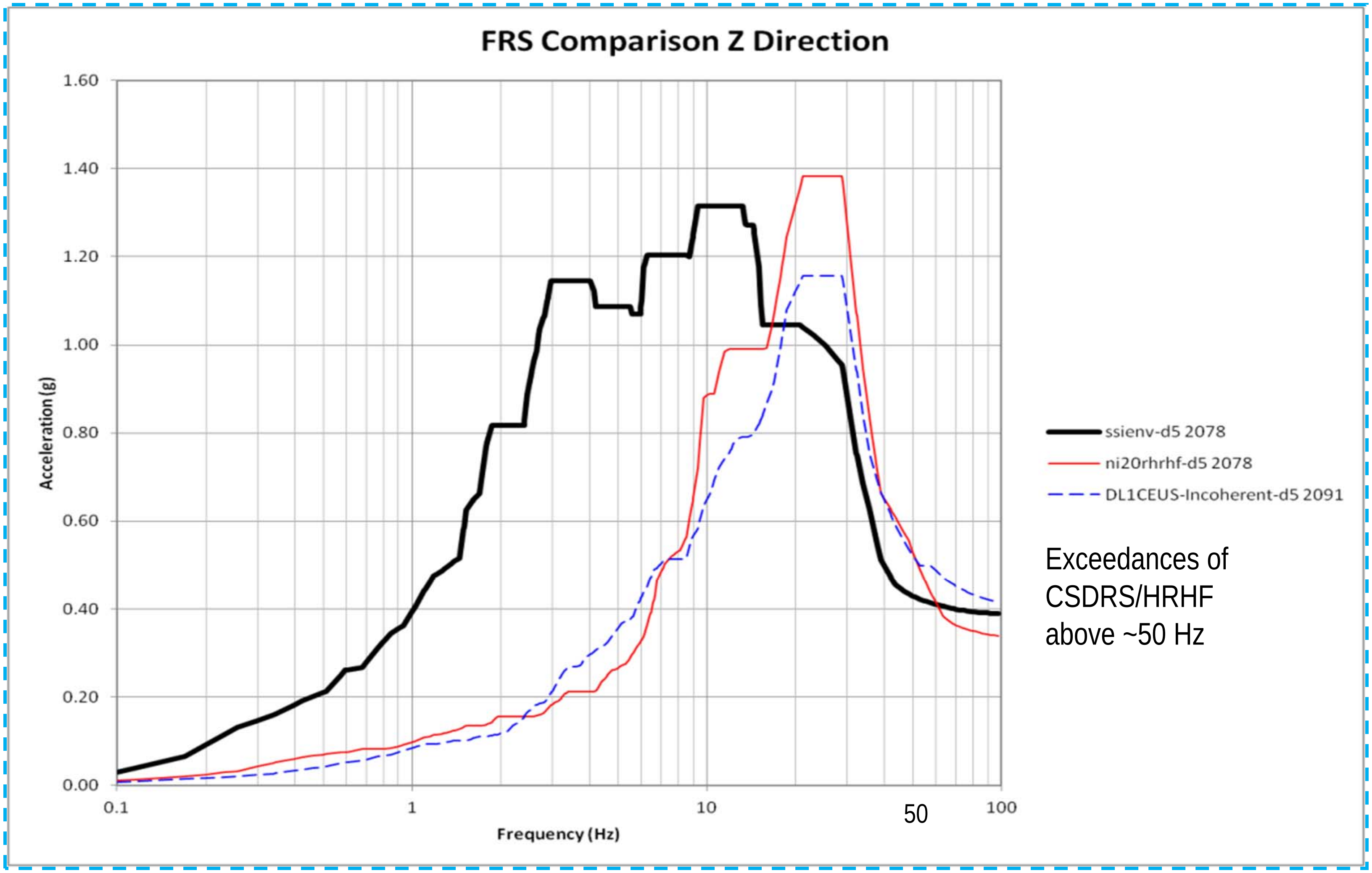



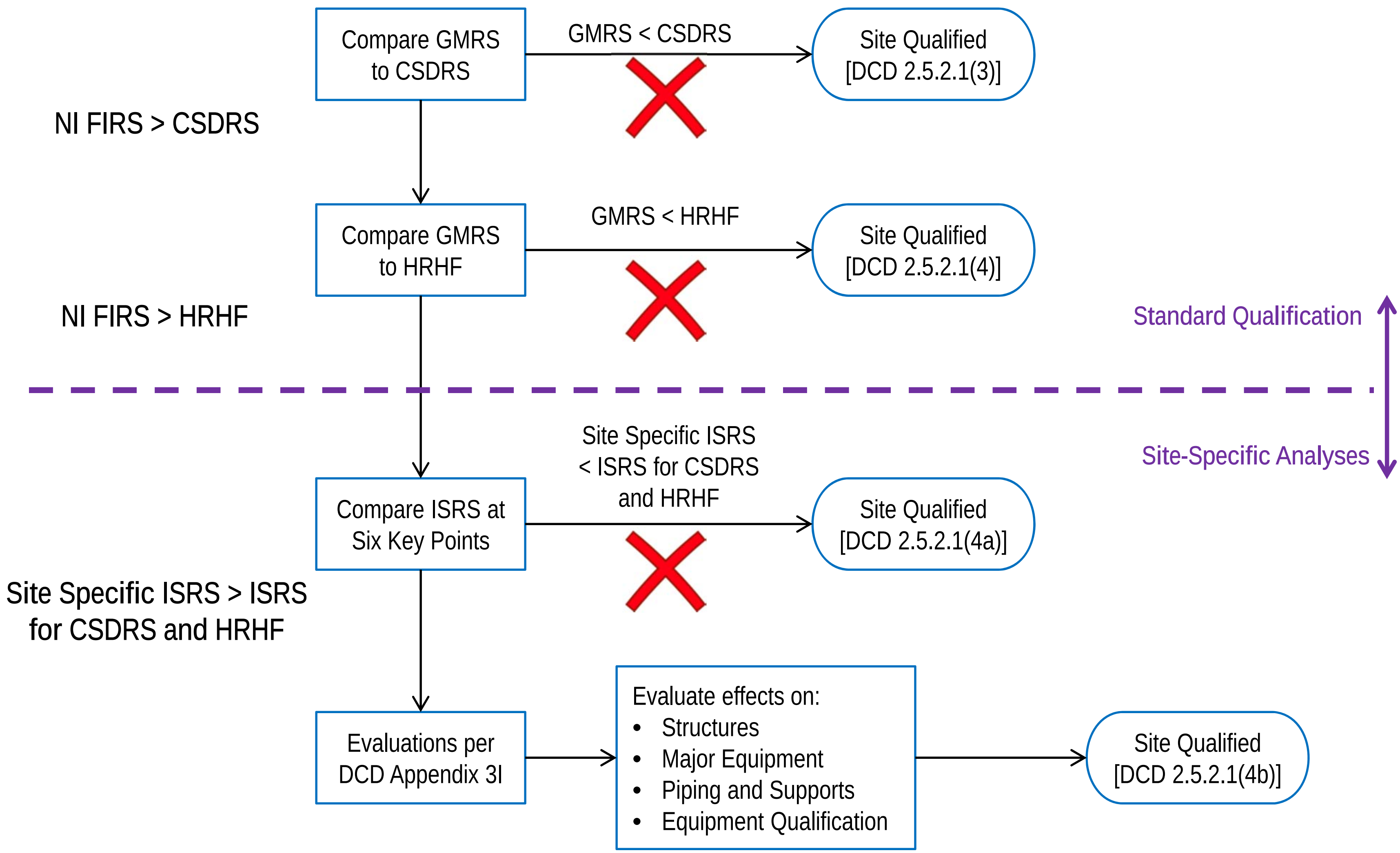



# Comparison of Key Location ISRS: CSDRS, HRHF vs Lee

## Key Location - Aux Bldg. NE Corner at Elevation 116'-6" – Control Room Floor



# AP1000 DCD – Approved Methodology to Address Site-Specific Seismic Characteristics (Rock Site)



# AP1000 DCD Provides Alternate Methodology for Site-Specific Seismic Qualification (Second Step)

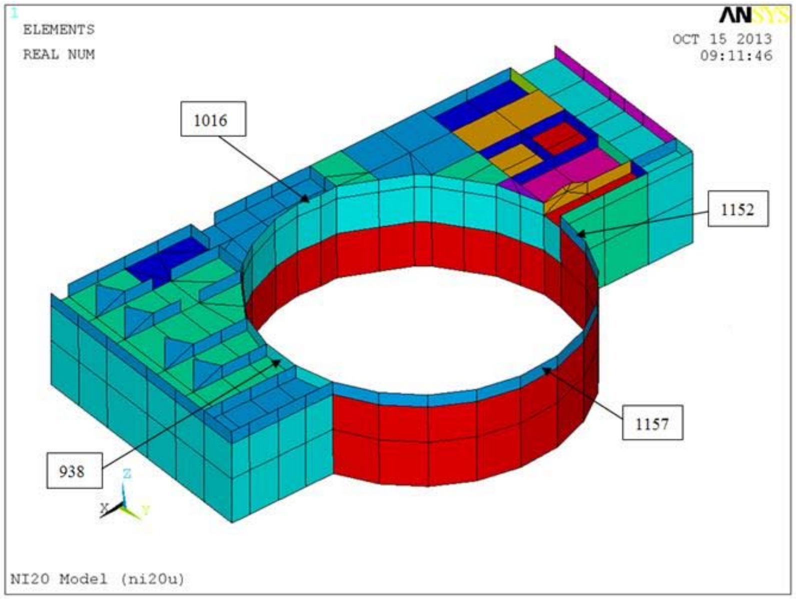
- If spectra test at the six key locations is not successful, an Applicant may use high-frequency evaluation methodology used in APP-GW-GLR-115 (TR-115) for the certified design to demonstrate design compliance for the site-specific seismic inputs [DCD 2.5.2.1(4b)]

# Site-Specific Analysis Shows That High-Frequency Exceedances Do Not Control Design and Qualification

- Review of representative sample of structures, major equipment and piping shows that CSDRS controls design forces and moments
- Standard AP1000 piping design practices using CSDRS and HRHF have already considered cases enveloping Lee site-specific requirements
- Review of high-frequency equipment qualification practices shows that exceedances will not affect equipment qualification
  - In all completed tests, the Test Response Spectra (TRS) are higher than site-specific Required Response Spectra (RRS)
  - Duke Energy will ensure that all future TRS are also higher than site-specific RRS

# Comparison of Forces: CSDRS vs Lee

## *Shield Building RC/SC Connection Region*




**CSDRS forces bound the site-specific forces.**

| Table 6.1-2 | Shield Building Time History Member Force Comparison | | | | | |
|---|---|---|---|---|---|---|
| | William S. Lee Site-Spectra (kips/ft) | | | CSDRS (kips/ft) | | |
| **Element #** | **TX** | **TY** | **TXY** | **TX** | **TY** | **TXY** |
| **938** | 8.3 | 59.0 | 54.6 | 22.3 | 156.5 | 125.1 |
| **1152** | 18.8 | 80.2 | 55.1 | 73.2 | 236.6 | 117.1 |
| **1157** | 18.6 | 133.6 | 55.0 | 72.6 | 456.1 | 196.9 |
| **1016** | 10.8 | 70.5 | 25.0 | 42.4 | 252.3 | 59.4 |

# Comparison of Forces: CSDRS vs Lee

## *Reactor Coolant Loop Primary Equipment Nozzles*

| Table 6.2.2-5 Reactor Coolant Loop Primary Equipment Nozzle Load Comparison | | |
|---|---|---|
| **RCL Nozzle** | **William S. Lee Site-Spectra** | **CSDRS** |
| | **Bending Moment (kip-ft)** | |
| RCP_SG | 234 | 3710 |
| RCP_CL | 3081 | 3809 |
| CL_RPV | 514 | 1013 |
| HL_RPV | 292 | 1374 |
| HL_SG | 990 | 3863 |

**CSDRS forces bound the site-specific forces.**

# Class 2:Ten Highest Pipe Stress Points:
## *HRHF vs Lee and CSDRS vs Lee*

| Pipestress Loading Combination: Comparison of HRHF (402) and Duke Lee CEUS (403) | | | | |
|---|---|---|---|---|
| HRHF | | Duke Lee CEUS | | % Difference |
| Node | Stress (ksi) | Node | Stress (ksi) | |
| 1250 | 27.733 | 1250 | 21.719 | -21.69 |
| Z010 | 26.409 | Z010 | 20.654 | -21.79 |
| 1245 | 25.087 | 1245 | 19.69 | -21.51 |
| 1240 | 24.286 | 1240 | 19.152 | -21.14 |
| Z009 | 23.243 | 1251 | 19.789 | -14.86 |
| 1095 | 22.73 | Z009 | 18.429 | -18.92 |
| 1251 | 23.968 | 1235 | 17.634 | -26.43 |
| 1235 | 22.199 | 1095 | 16.891 | -23.91 |
| Z005 | 21.632 | 1250 | 17.927 | -17.13 |
| 1250 | 21.746 | 1245 | 16.641 | -23.48 |

HRHF vs Lee

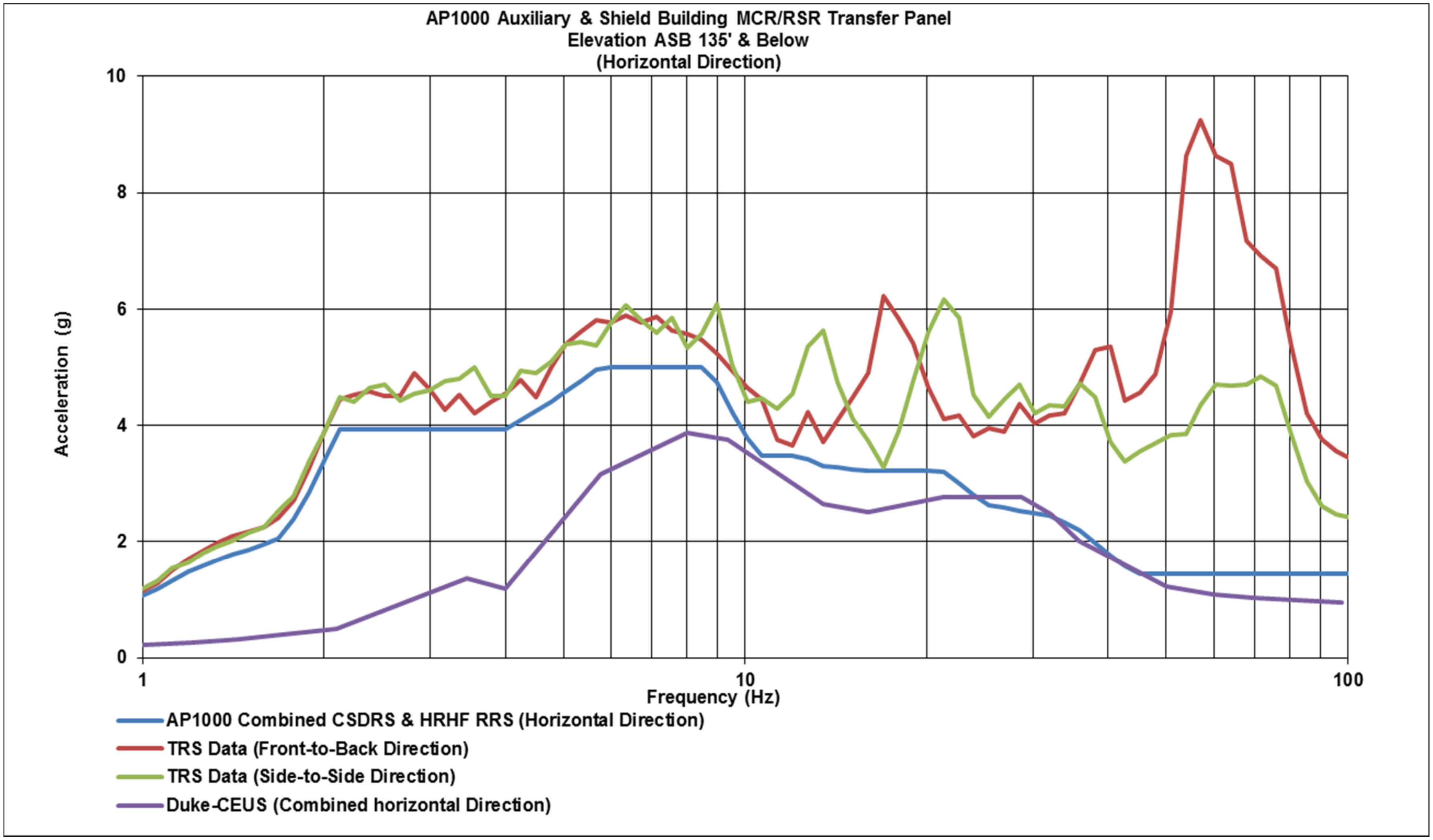
| Pipestress Loading Combination: Comparison of CSDRS (401) and Duke Lee CEUS (403) | | | | |
|---|---|---|---|---|
| CSDRS | | Duke Lee CEUS | | % Difference |
| Node | Stress (ksi) | Node | Stress (ksi) | |
| A005 | 19.887 | A026 | 11.894 | -40.192 |
| A026 | 13.200 | B410 | 11.075 | -16.098 |
| A002 | 13.569 | A005 | 10.228 | -24.622 |
| B410 | 10.653 | A090 | 9.938 | -6.712 |
| A090 | 10.798 | A092 | 8.521 | -21.087 |
| A006 | 9.827 | BC40 | 7.770 | -20.932 |
| A092 | 9.196 | A002 | 7.024 | -23.619 |
| A011 | 9.145 | A093 | 6.553 | -28.343 |
| A012 | 9.084 | BC50 | 6.259 | -31.099 |
| A340 | 9.002 | 1348 | 7.606 | -15.508 |

CSDRS vs Lee

Note: Results are shown for Spent Fuel Cooling System, identified as potentially sensitive to high-frequency input motion.

**CSDRS forces bound the site-specific forces.**

# Equipment Qualification by Testing
## *MCR/RSR Transfer Panel (Horizontal Direction)*



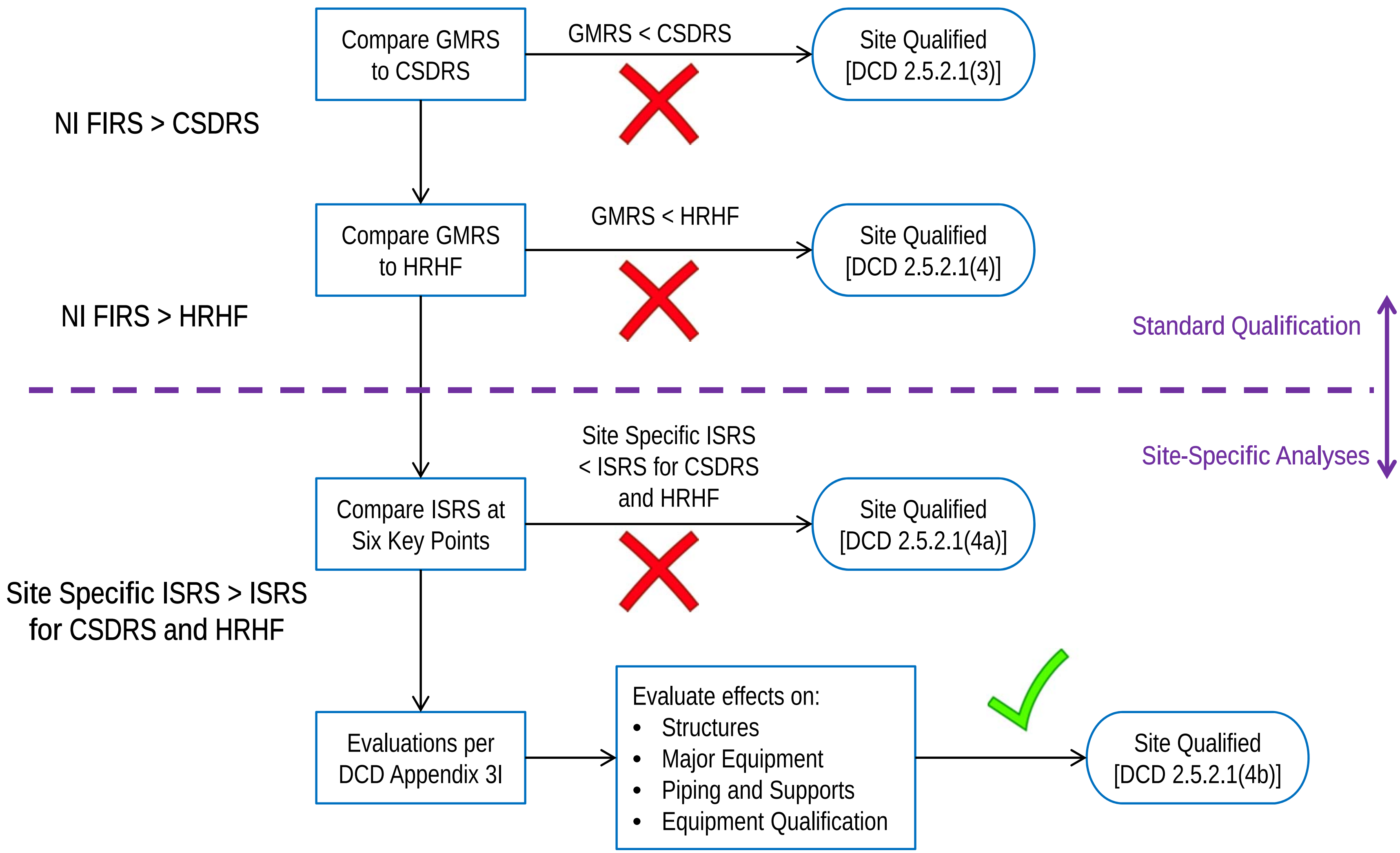

**TRS based on CSDRS and HRHF bound the site-specific RRS.**

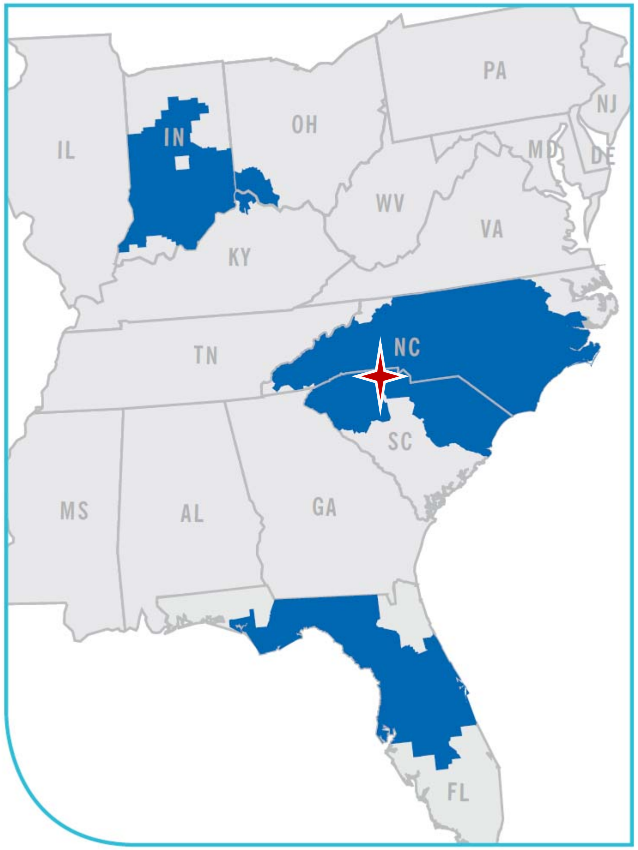
# Site-Specific Analysis Summary

DUKE ENERGY.

- Site-specific in-structure spectra at six key locations show exceedances over corresponding spectra for CSDRS and HRHF
- Review of representative sample of structures, major equipment and piping shows that CSDRS controls design forces and moments
- Standard AP1000 piping design practices using CSDRS and HRHF have already considered cases enveloping Lee site-specific requirements
- Review of equipment qualification practices shows that exceedances do not affect equipment qualification
  - In all completed tests the Test Response Spectra (TRS) are higher than site-specific Required Response Spectra (RRS)
  - Duke Energy will ensure that all future TRS are also higher than site-specific RRS

# AP1000 DCD – Approved Methodology to Address Site-Specific Seismic Characteristics (Rock Site)

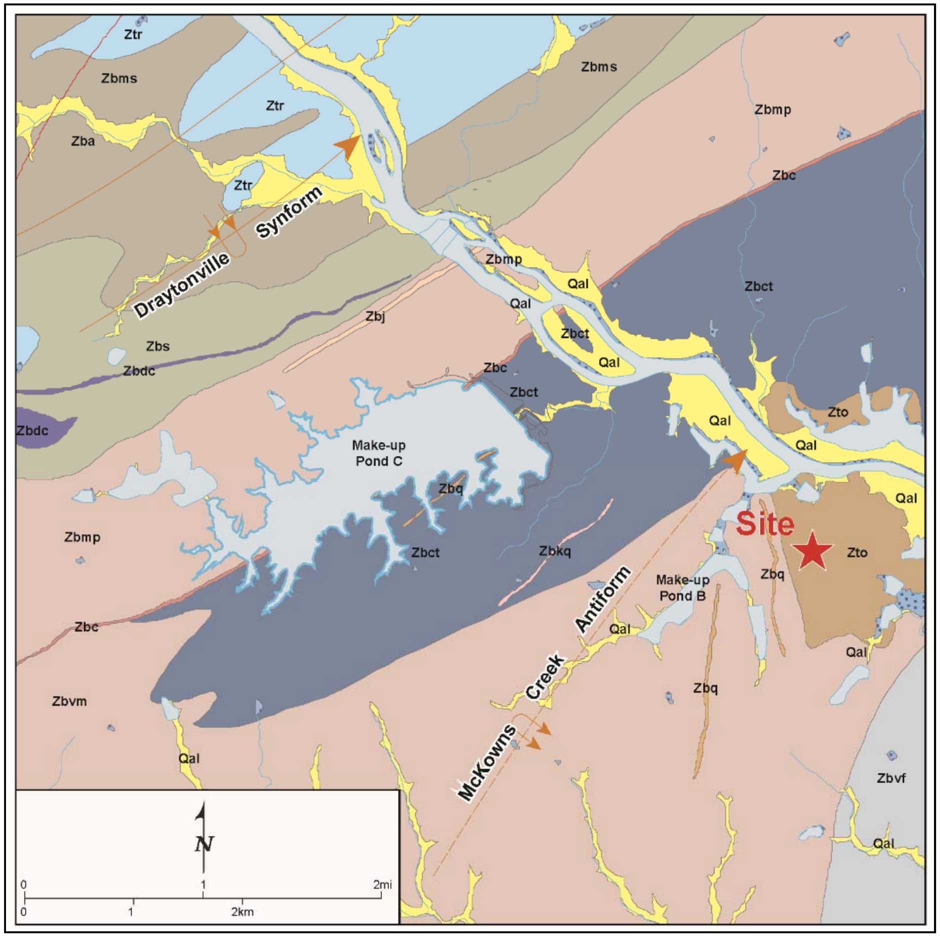





# LEE NUCLEAR STATION

# ACRS Full Committee Backup Slides

# Site Area Geologic Mapping in the Area of Planned Make-Up Pond C




Modified from FSAR Figure 2.5.1-219a

Geology underlying MUPC extensively studied and mapped:

- CNS PSAR (1974)
- South Carolina Geologic Survey (2004)
- Lee COLA (2006-2007)

# Topography Near Lee Site

# FSAR 2.3 Meteorology – Air Temperature

| | AP 1000 DCD Site Parameters | Lee Site Characteristic |
|---|---|---|
| Maximum Safety | 115°F dry bulb/86.1°F coincident wet bulb | 107°F dry bulb/84°F coincident wet bulb (100-year max) |
| | 86.1°F wet bulb (noncoincident) | 85°F (100-year max) |
| Minimum Safety | -40°F | -5°F (100-year min) |
| Maximum Normal | 101°F dry bulb/80.1°F coincident wet bulb | 94°F dry bulb/77°F coincident wet bulb (0.4% annual exceedance) |
| | 80.1°F wet bulb (noncoincident) | 77°F wet bulb (0.4% annual exceedance) |
| Minimum Normal | -10°F | 20°F (99.6% annual exceedance) |

# FSAR 2.3 Meteorology – Wind Speed

| | AP 1000 DCD Site Parameters | Lee Site Characteristic |
|---|---|---|
| Operating Basis | 145 mph (3 second gust) | 96 mph (3 second gust) |
| Tornado | 300 mph | 230 mph |
| Maximum Pressure Differential | 2.0 psi | 1.2 psi |

# FSAR 2.3 Meteorology – Precipitation

| | AP 1000 DCD Site Parameters | Lee Site Characteristic |
|---|---|---|
| Rain | 20.7 in/hr | 18.9 in/hr |
| Snow/Ice | 75 psf | 17.7 psf |

# Flooding Evaluation Results

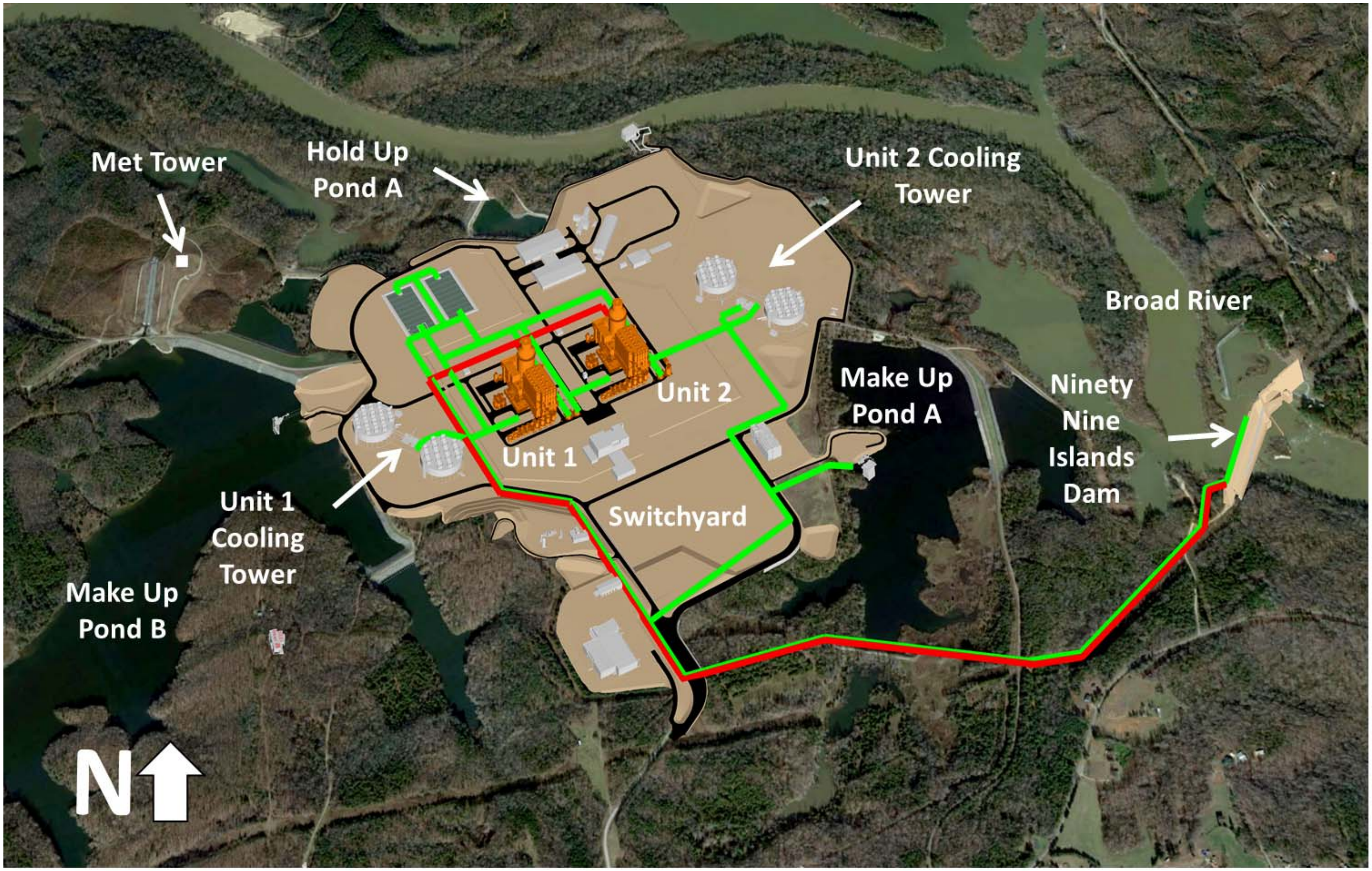
- WLS designed as a dry site (finished floor elevation = 593 ft.)
- **Maximum flood level = 592.56 ft.** (Local Intense Precipitation)
- Adjacent surface water bodies, resulted in lower water surface elevations

| Adjacent Water Body | PMF Elevation (ft.) | Dam Failure Elevation (ft.) | Wind Wave Elevation (ft.) | Margin (ft.) |
|---|---|---|---|---|
| Broad River | 551.49 | 576.50 | 585.36 | 7.64 |
| MUPA | 558.15 | 576.50* | 585.36 | 7.64 |
| MUPB | 584.40 | 585.06 | 589.10 | 3.90 |

*MUPA inundated by Broad River PMF/dam failure result

- Other phenomena bounded by PMF/dam failure results
- No flood protection required

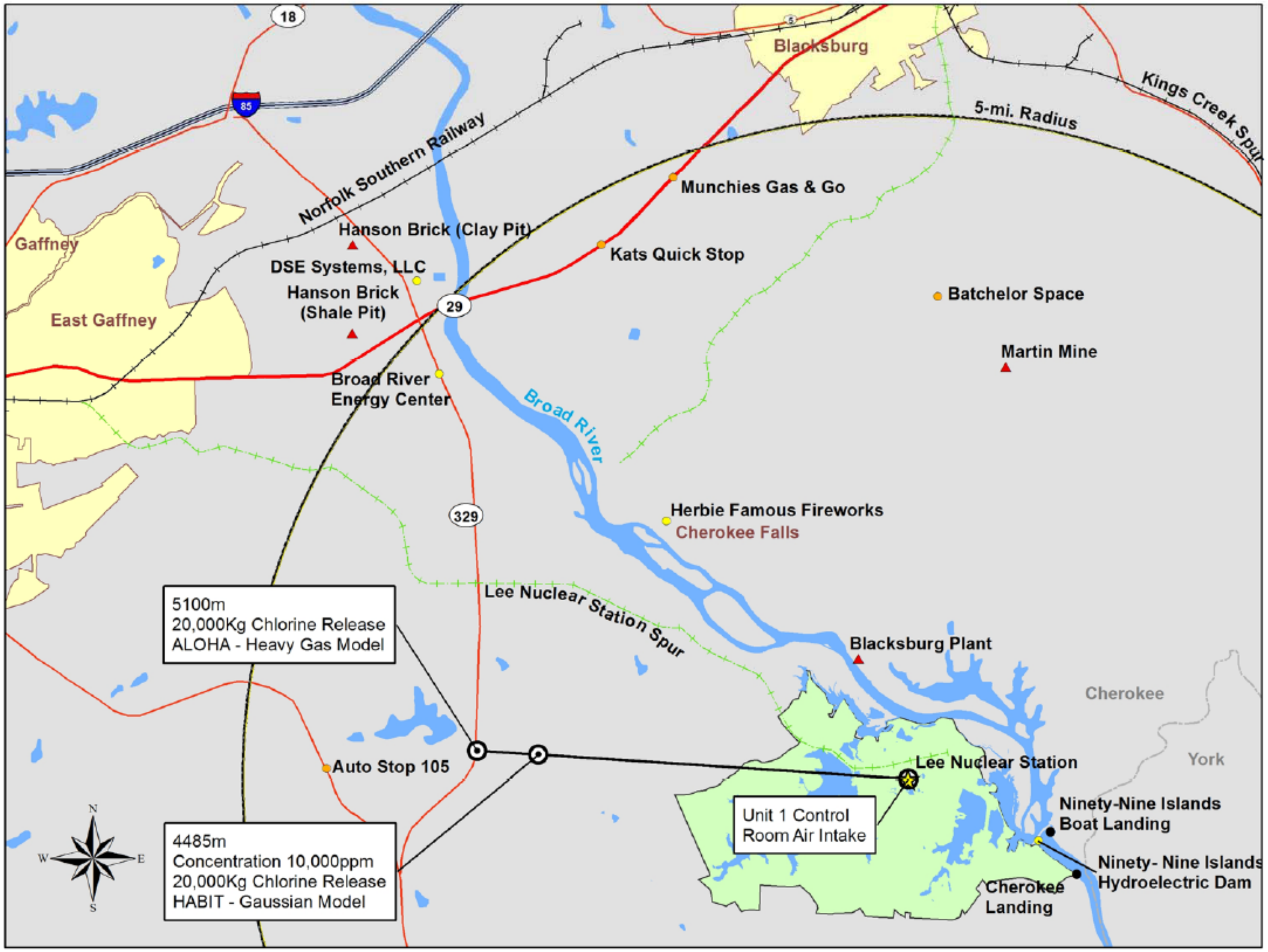
# Waste Water and Liquid Radwaste Systems



# FSAR 6 Offsite Chemical Spill Effects on MCR

- Postulated chlorine tanker spill/release on major roadway at closest approach to the plant site
- A hybrid analysis performed to address heavier-than-air dispersion characteristic of chlorine
  - ALOHA code applied to evaluate chlorine dispersion from spill location to heavier-than-air transition location
  - HABIT code applied to evaluate chlorine dispersion from transition location to MCR intake and evaluate chlorine buildup in MCR

# FSAR 6 Offsite Chemical Spill Effects on MCR



# FSAR 6 Offsite Chemical Spill Results

- The concentration of chlorine in the MCR remains below the Regulatory Guide 1.78  toxicity limit of 10 ppm for chlorine
  - No ventilation system alarm or protective actions required to maintain MCR below toxicity limit

# FSAR 6 Onsite Site Specific Chemicals

- FSAR Table 6.4-202 summarizes on-site chemicals
- Two site specific (pH control) chemicals screened for further evaluation
  - Methoxypropylamine (MPA)
  - Dimethylamine (DMA)
- Limiting concentrations at MCR elevated air intake location analyzed using SLAB code
- The evaluation confirmed that concentrations at the control room intake do not exceed toxicity limits

# Emergency Response Facilities

- Emergency Operations Facility
  - EOF location exception requested;  EOF is greater than 25 miles from the TSC (NUREG-0696 Guidance).
    - TSC is ~40 air miles from the EOF in Charlotte, NC
    - Common EOF currently supporting Catawba, McGuire and Oconee Nuclear Stations
  - Plan to include Lee Nuclear Station also
  - Includes Joint Information Center
  - Common EOF has supported multi-site exercises
  - A Near Site Assembly Area is provided at Kings Mountain Generation Support Facility if needed by NRC or other Emergency Responders, 15.5 miles from the Lee Site

# Post-Fukushima Non-Seismic Actions

- Lee Post-Fukushima RAI based on AP1000 Licensee Orders and 50.54(f) letter requirements
  - NTTF Recommendation 9.3, EP Staffing and Communications
  - NTTF Recommendation 4.2, Mitigating Strategies
  - NTTF Recommendation 7.1, SFP Instrumentation

# Recommendation 9.3 (EP)

- NRC Fukushima Near-term Task Force (NTTF) Recommendation 9.3 on EP staffing and communications resulted in 50.54(f) letter issuance to current licensees at the time.
  - Lee responded to this item via RAI based on Recommendation 9.3 requirements outlined in Enclosure 5 of the March 12, 2012 50.54(f) letter.
  - Lee has a proposed license condition to address the staffing and communications assessments required by this letter.

# Recommendation 4.2 (Mitigating Strategies)

- Fukushima NTTF Recommendation 4.2 on mitigating strategies resulted in order issuance to current licensees at the time.
  - Lee responded to an RAI referencing Attachment 3 to Order EA-12-049.
  - Lee will have a license condition to address the actions required for this recommendation similar to the requirements in the Mitigation of Beyond-Design-Basis Events (MBDBE) proposed rule (10 CFR 50.155).

# Recommendation 7.1 (SFP Instrumentation)

- Fukushima NTTF Recommendation 7.1 on spent fuel pool (SFP) instrumentation resulted in order issuance to current licensees at the time.
  - Lee responded to an RAI referencing Attachment 3 to Order EA-12-049.
  - Lee has a proposed license condition to address the training portion of the actions required for this recommendation. All other portions of the recommendation are satisfied by the AP1000 plant design.
    - DCD Chapter 9 text was supplemented with additional information on SFP level instrumentation in Lee FSAR Chapter 9.
    - A departure was taken to correct an inconsistency in DCD Table 3.11-1, Sheet 14 of 51relative to SFP level instrument "Envir Zone" number.

# Summary of Foundation Conditions

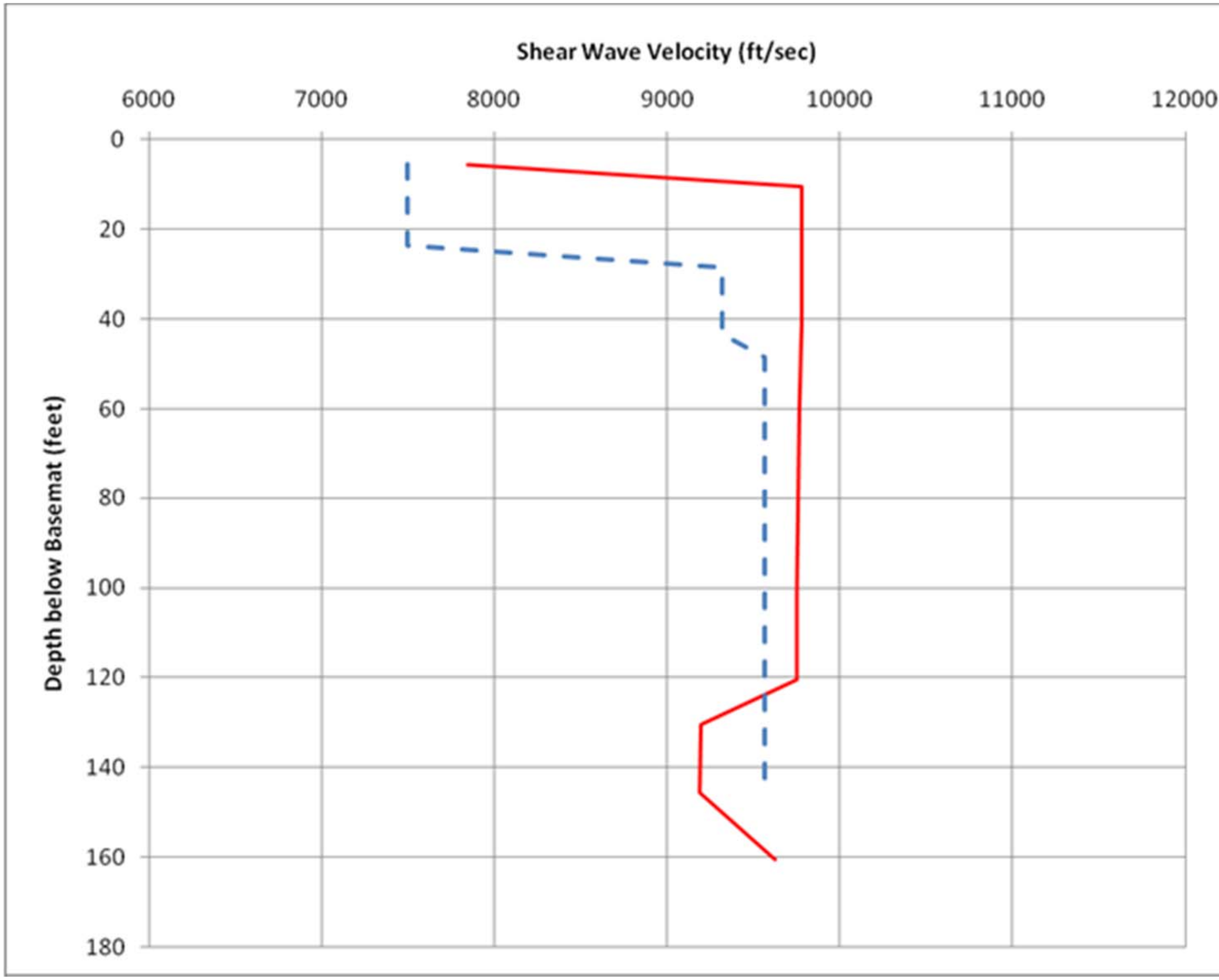
- Uniform, hard-rock site with conditions just as described in the AP1000 DCD
- No tectonic deformation experienced since the Mesozoic (252 to 66 Ma), and possibly not since 219 Ma to 300 Ma
- Measured shear wave velocities for continuous rock under nuclear islands ranges from about 9,000 to 10,000 fps

# AP1000 Certified Design

- For structures and major equipment, APP-GW-GLR-115 demonstrates that forces and moments resulting from CSDRS are greater than those resulting from HRHF; there is therefore no need to separately design structures and major equipment for HRHF
- AP1000 piping systems are designed for the in-structure response spectra resulting from CSDRS, and for the in-structure response spectra resulting from HRHF, considered as separate design loadings (in almost all cases, CSDRS controls the design of piping systems)
- AP1000 high-frequency sensitive electrical and mechanical equipment is qualified by testing to the envelope of in-structure response spectra resulting from CSDRS and from HRHF; no safety-related equipment identified as high frequency sensitive is qualified by analysis

# Comparison of Response Spectra: HRHF vs Duke Lee

## Soil profile comparison: Shear wave velocity




*0 depth is bottom of NI basemat*

# Site-Specific Seismic Analysis (SC-II)

- Horizontal base spectra are very similar to AP1000 envelope criteria, but vertical spectra are higher
- Relative displacements between structures are much less than space provided
- High confidence that AP1000 standard lateral force resisting system is adequate
- Vertical spectrum exceedance may affect design details of floors and roof
- SC-II performance criteria are identified; confirmatory analysis and design update will be completed before start of SC-II construction