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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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698TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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OPEN SESSION

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THURSDAY

SEPTEMBER 8, 2022

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The Advisory Committee met via teleconference at 1:30 p.m., Joy L. Rempe, Chairman, presiding.

COMMITTEE MEMBERS:

JOY L. REMPE, Chairman

WALTER L. KIRCHNER, Vice Chairman

DAVID A. PETTI, Member-at-Large

RONALD G. BALLINGER, Member

VICKI M. BIER, Member

CHARLES H. BROWN, JR., Member

VESNA B. DIMITRIJEVIC, Member

GREGORY H. HALNON, Member

JOSE A. MARCH-LEUBA, Member

MATTHEW W. SUNSERI, Member

ACRS CONSULTANTS:

DENNIS BLEY

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

QUYNH NGUYEN

C-O-N-T-E-N-T-S

PAGE

P R O C E E D I N G S

(1:31 p.m.)

CHAIRMAN REMPE: So good afternoon. The meeting will now come order. This is the second day of the 698th meeting of the Advisory Committee on Reactive Safeguards.

I'm Joy Rempe, Chairman of the ACRS. Other members in attendance are Ron Ballinger, Vicki Bier, Charles Brown, Vesna Dimitrijevic, Greg Halnon, Walt Kirchner, Jose March-Leuba, Dave Petti, and Matt Sunseri.

I note we do have a quorum and similar to yesterday, the Committee is meeting in person and virtually. Communications channel has been open to allow members of the public to monitor the Committee discussion.

Mr. Kent Howard is the designated Federal Officer for today's meeting. During today's meeting, the Committee will consider the following topic: The NuScale Topical Report and Emergency Planning Zone Plume.

And if we finish early, we'll continue with our report preparations. A transcript of the open portions of the meeting is being kept and it is requested that speakers identify themselves and speak with

sufficient clarity and volume so that they can be readily heard.

Additionally, participants should mute themselves when they're not speaking. And at this time, I'd like to ask Walt Kirchner to lead us through our first topic for the day's meeting. Walt?

MEMBER KIRCHNER: Thank you, Joy. Good afternoon, all. Welcome. My name is Walt Kirchner. I am Chair of the NuScale Subcommittee for the NuScale review.

For the purpose of this meeting is to review the NuScale Topical Report, TR-0915-17772, Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones and the associated Staff that did the evaluation.

Just a few comments from me right now about structure of the meeting. We're going to do this in two parts. The first part will be open. We will allow for public comments after the NuScale and Staff presentations.

And then we'll take a break and we'll go into a closed session with NuScale and the Staff. So with that, let me see, we have Mike Dudek on the line. Mike, would you like to make some opening comments?

MR. DUDEK: Thank you, Member Kirchner and

Chairman Rempe. So this is very exciting today for the Staff to present our safety evaluation reports associated with NuScale's Rev. 3 of the Topical Report that you mentioned, the Methodology for Establishing a Technical Basis for the Plume Exposure Emergency Planning Zones for NuScale Small and Modular Reactor.

This is several years in the making. And several revisions in the making and a lot of Staff hours so this Topical Report today was very thought out by all of the Staff Members that had it, bought into it and via edits.

Several audits associated with it and came to this resolution for this SER and I, as I read through, I was very impressed by the level of detail and transformation that was captured into it.

So I'm looking forward to the discussion today. We're going to discuss how and why this Topical Report is just applicable to NuScale. Some limiting conditions that we had on it and some of the intricacies behind the two RAIs, 9830 and 9828.

So a lot of good discussion and planned for today. And with that said, I'll give my DRA brethren a chance to give any opening remarks that they would like to have as well. I think we have Shilp and either Meena or Mr. Franovich on the line.

MR. VASAVADA: Thanks. This is Shilp Vasavada on behalf of the NRC Staff. I don't have any additional remarks compared to what Mike side. Enjoy it all. Thank you.

MEMBER KIRCHNER: Okay and with that, let me thank you both Staff and for those who are not watching this, we have the NuScale team here. So thank you for your trip to the East Coast, it's nice to see you again in person.

And with that, I'm going to turn to Liz English, and you can introduce your report and your team.

MS. ENGLISH: Thanks. My name is Liz English. I am a supervisor --

MEMBER KIRCHNER: You need to get your mic lined up.

MS. ENGLISH: My name is Liz English. I'm a supervisor in licensing for NuScale. Pleased to be here today to present the outline of our Topical Report to you.

With me are Thomas Griffith, also supervisor on SDA, and Jeremiah Doyle who is the EPZ technical lead for NuScale. He's the brains of the bunch. Glad to have him here.

And I'll go to the next slide. We are very

grateful to the DOE for the grant that we have to do this work. Next slide. I'll turn it over to you, Jeremiah. Ready to roll?

MR. DOYLE: Thanks, Liz. I'm Jeremiah Doyle, the EPZ Technical Lead as Liz mentioned. So this slide here is the agenda for the meeting. We'll go over the purpose, introduce the Topical Report and then provide an overview of the methodology and the technical basis for the methodology for sizing emergency planning zones. Next slide please.

The purpose of this meeting is to introduce the methodology and the technical basis for the methodology for determining the size of the plume exposure emergency planning zone around NuScale plant sites. Next slide please.

This Topical Report is applicable just to NuScale small modular reactor designs. It's consistent with the technical basis in the original EPZ basis in NUREG-0396 and the supporting ERA technical information in WASH-1400.

We identify a spectrum of accident sequences, evaluate the source terms of those sequences, compare the dose consequences of those sequences to similar dose criteria as NUREG-0396 and balance this quantitative evaluation with the

qualitative evaluation and engineering judgment.

And this implements the PRA methodology and supporting codes that have been established in the 40 years since the original EPZ basis. And we designed this so that any applicant could pick up this Topical Report with the same information and produce the same EPZ distance. Next slide please.

To use the Topical Report, we have two conditions of applicability in the LTR. The first is that this Topical Report is only applicable to NuScale SMR designs and there are five overarching criteria that define what it means to be a NuScale design.

And this is designed to capture the high level safety attributes of the design while allowing for some room for design improvements in the future. And then the next condition of use is on the underlying technical information that's input to the methodology.

The first condition is that the PRA that's used as input needs to be full scope and capture all hazards and all operating modes. And the second condition is that the PRA needs to be technically acceptable for this purpose.

MEMBER DIMITRIJEVIC: I have a question there. This is Vesna Dimitrijevic. You mean that technically acceptable period or just technically

acceptable for this purpose?

MR. DOYLE: Technically acceptable overall as in it's consistent with the existing PRA standards and has been peer reviewed and has demonstrated as technically acceptable and that it's identified as acceptable for use in the underlying application.

MEMBER DIMITRIJEVIC: All right because you know that for some applications you don't need to satisfy all higher level requirements so I just wanted to make sure that you mean is just generally acceptable for all that, you know, required so.

Okay, thanks. I understood that you said that it's just review and acceptable generally not just for this purpose.

MEMBER HALNON: Yes, this is Greg Halnon. And how, the peer review befuddled me a little bit. How are you going to get a peer review of a design that nobody else can look at?

MR. DOYLE: The peer reviews of the PRA itself and the, their existing PRA standards for technical acceptability that outline the content and scope and underlying information that's part of the PRA and there's different capability categories supporting that and there is peer review guidance.

I forget the NEI document.

MEMBER HALNON: Yes, I understand.

MR. DOYLE: Yes.

MEMBER HALNON: Doesn't that require knowledge, people knowledgeable of the plant itself and some operating experience and other things? I guess, have you looked at that to make sure you can say that it's going to be peer reviewed in accordance with that standard?

MR. DOYLE: We are in the process of developing the peer review, of getting that information in preparation for applying this report, but it is understood that not everything could be met in the standards or paper plan.

MEMBER HALNON: I think that caveat's important. But just don't say it's peer reviewed because it's traditionally commonly understood as certain peer review has very diverse and also very focused, experienced people on it.

And I'm not sure you're going to be able to get all of that with this. So just be, as you go through, keep that in mind.

MR. DOYLE: Thank you. Next slide please.

MEMBER DIMITRIJEVIC: Greg, Matt told me that they don't have people with experience in that

design or experience with the multi-units. But they also will not carry information because, you know, all of the PRA work requires procedures, lockdowns and things like that so they will have also limited information available and experience.

MEMBER HALNON: Yes, thanks, Vesna. That's kind of what I was thinking. That there was going to be kind of a small subset of peer review actually is considered at this point.

MR. DOYLE: Next slide please. So the NuScale methodology over all is a combination of a quantitative evaluation and qualitative evaluation. For the quantitative portion there's a balance of deterministic evaluation of the design basis source term.

And then the probabilistic best estimate with uncertainty evaluation using a PRA and its quantified sequences. And then there's an evaluation of any other type of releases that may lie outside the design basis or Sherman PRA and we'll talk about that in more detail in the spectrum of accidents slide.

Once the spectrum of accidents is identified, then the accidents vary as identified to ensure that the appropriate dose criteria are applied. And once the spectrum of accidents is identified, the

source term, time-dependent source term of the environment for each sequence is calculated.

And then the dose for that sequence is compare it for each sequence is compared against the three dose criteria from the NUREG-0396. Complementing that is a qualitative evaluation of defense in depth to highlight design features and operational strategies to preserve layers of defense in depth in the design as well as a review and disposition of key assumptions and other uncertainties in the underlying PRA so that they are dispositioned for the purpose of EPZ sizing. Next slide please.

This flowchart is just a graphical representation of the quantitative portion of the NuScale method. It reads from top to -- all right. Hello? It's, okay. Oh, okay.

So the flowchart reads from top down, left to right and identifies the PRA spectrum of accident sequence selection process over to the incorporation of the design basis input as well as the uncertainty analysis of the source term and dose consequences.

That dash line is a conditional step in the process where if certain criteria of the uncertainty analysis are not satisfied, the source term and dose consequence evaluations are repeated.

And then finally, the justified source term and dose consequences are applied to the three dose criteria and the plume exposure emergency planning zone is the largest distance from the plant at which all three criteria are met simultaneously.

MEMBER KIRCHNER: Let me ask a question about the dotted line that you just highlighted. What would change when you went back and iterated, are you going to get to that? I mean, you do this analysis and if it's not acceptable, then you go back and do the source term evaluation again?

That's a misinterpretation by my, on my part, but --

MR. DOYLE: That is correct. So the idea is to perform an uncertainty analysis of the most probable less severe and more severe PRA sequences that are evaluated using a parametric evaluation of the severe accident inputs and the dose consequence inputs.

And any inputs that are identified as important to the final dose consequence, which is 5 percent of the, at least 5 percent of the uncertainty regression metric used than those important perimeters need to be justified as best as submitted.

And if they cannot be justified, a conservative value must be justified and that

conservative value would be used and the evaluation would be repeated with that value.

MR. KIRCHNER: Thank you.

CHAIRMAN REMPE: So along those lines, again I don't -- so just tell me to shut up if I'm getting into something that's proprietary. But there was some information regarding how the vessel failure assumption would be invoked that to me (audio interference) more thorough validation for evaluation or assessments, the code that you assume for when you implement this?

MR. DOYLE: Part of the methodology is providing some basis for consequence, for confidence in the MELCOR results that MELCOR's used. And we describe how to do a code to code comparison up to core damage.

But specifically for any type of containment phenomena that would be evaluated as part of the underlying PRA. The EPZ methodology is not modifying the underlying PRA, it's just using that information and so.

CHAIRMAN REMPE: Yes, you're using it for a different application than what was done for the original. In this case, the CD, but of course, this will be all for a SDA or something I suppose. But go ahead.

MR. DOYLE: Right. So the acceptability of the MELCOR evaluations would be, would fall under the peer review aspect of the underlying PRA. And if, there's, again this is where the other risk section also comes into play as a capture.

We specifically talking the methodology about severe accident phenomena like a containment failure and that it's expected to be evaluated in the underlying PRA.

But if it's not and there or there's not confidence, that these releases would be demonstrated to either meet the dose criteria or would be bounded by other sequences that are captured in the spectrum of accidents from the screening process.

So in some form, the doses will be evaluated from an intact containment or a containment bypass event. And if there's uncertainty as to which, as to the status of containment, the methodology requires the user to evaluate both the intact containment and the containment bypass version of the accident.

CHAIRMAN REMPE: I'm concerned about the assumption about the size of the hole for containment value. And it's stated that the size is conservative and I, if I were viewing it either as a peer review or the Staff, I'd be wanting to see the justification

for that.

MR. DOYLE: Okay. I'm not sure I understand the --

CHAIRMAN REMPE: Can you --

MR. DOYLE: -- full --

CHAIRMAN REMPE: -- talk more specifically --

MR. DOYLE: -- or hole, okay.

CHAIRMAN REMPE: -- or can we get into -- although I don't think it's in your slides, but I can bring up the report --

MR. DOYLE: Okay.

CHAIRMAN REMPE: -- assumption and all that, but I just am curious if there was some additional validation of some of the -- in the PRA, they got down below frequency and I know the Staff did not go all the way with their MELCOR validation to containment failure because there's, you get into a lot more uncertainties.

And they did it for a what, up to vessel failure I think or a certain point and they didn't go all the way and they said, okay, it's good enough and we let it go.

But now you're taking those results in a more severe accidents and you're using them to come

up with your EPZ. And I just am wondering if somebody's going to do some more assessment on the validity of the code for that application.

MR. DOYLE: Okay, understood. Next slide please. So the first step is the identification of the spectrum of accident sequences. Consistent with NUREG-0396, the design basis source term and the PRA accident sequences are evaluated for inclusion in the spectrum of accidents.

The design basis source term in the NuScale design is at the core damage design basis source term for offsite builds consequences is a combination of intact containment beyond design basis accidents.

It's a surrogate accident with characteristics from multiple beyond design basis accidents. This viewed accident from the PRA are identified for inclusion based on sequence frequency so non-seismic, single module, multimodule sequences are retained in the EPZ basis if they have a core damage frequency greater than ten to the minus seven per year.

And this frequency captures the complete spectrum of accidents in the underlying basis in NUREG-0396. And the use of CDF as the metric rather than release frequency also adds some conservatism to the screening process.

And additionally, following the initial best-estimate screening, an uncertainty analysis of the screening is performed using the 95th percentile values for screened-out sequences.

The consistent with NUREG-1855, if a sequence that initially screens out is within an order of magnitude of the screening criteria, then if the mean-best estimate CDF value is within an order of magnitude, then the 95th percentile CDF is compared to the ten to minus seven threshold.

And if that sequence 95th percentile value is above the screening threshold, it's retained for analysis in the spectrum of accident sequences. And this ensures that we're not missing any cliff edge sequences beyond that screening limit.

Following the identification of the design basis, source term and PRA accidents, other releases are identified. One specific example that lies outside the design basis source term in PRA is an accident involving failure of the single failure-proof crane where the upper half of the module is dropped onto the open bottom half of the module and the refueling tool.

In this instance, the release wouldn't meet the core damage definition of the PRA because the fuel is not over heating, but there is mechanical damage

and there is the potential for gap release from the fuel.

And so that release would be identified and evaluated as part of the EPZ method. And then finally, once all the accident sequences have been identified, their severity is determined consistent with NUREG-0396.

There's two categories less severe and more severe that are differentiated based on the level of atmospheric release and less severe actions are considered to be those with the containment intact.

And containment failure bypass accidents are more severe. And if the containment status is uncertain, you evaluate both intact containment and bypass versions of the accident. Next slide please.

MEMBER KIRCHNER: One question on that last set of bullets. So if you have a breach of containment, whatever reason, do you take any credit for scrubbing or do you assume that containment breach is above the water level on all the gaseous fission products that are released?

MR. DOYLE: So for the module drop accident which is horizontal under the surface and we have confidence that it would be under the surface, it is scrubbed.

But for other accidents, postulated accidents from an upright module, that's assumed to be above the pool surface.

MEMBER KIRCHNER: Thank you.

MR. DOYLE: So following the identification of the spectrum of accident sequences, the time dependent source terms are calculated using a severe accident code like MELCOR, for example.

And it's expected that these severe accident calculations will have already been performed as part of the PRA. And these source term evaluations will then feed into the off-site dose consequences.

So for the design basis source term, it would be evaluated just as the release from containment to the environment with no other credit for any other type of retention or hold up.

But for the less severe, more severe beyond design basis accidents, credit for additional scrubbing or retention outside of the containment like in the reactor building could be credited in, through separate effects models from MELCOR.

And then these environmental source terms will be fed into MACCS for comparison against the three dose criteria. Criteria A for design basis source terms is that the total effective dose equivalent is

less than one REM or mean, meteorology conditions and five REM for 95th percentile conditions for 96-hour exposure.

The Criterion B is for less severe accidents. The TEDE dose would be less than one REM mean in the 95th percentile over 96-hour exposure. And the Criterion C is that the more severe accidents would demonstrate a reduction in early health effects by comparison to a 200 REM threshold using acute whole-body dose.

Consistent with NUREG-0396, the recommended defaults for performing this modeling in the methodology is that the individuals, the individual, the dose receptor is located outdoors and they're stationary.

They are in the direction of maximum exposure. These receptors are located at least 50 meters from the reactor building and as far out as ten miles to get the full spectrum of distances there.

And these receptors do not undergo any sheltering, relocation or evacuation, no protective actions and all the major short-term dose pathways are evaluated.

And there's no shielding from these different pathways with the exception of groundshine

which is recommended to have a 70, sorry, a 30 percent shielding due to just natural variations of being located on a planar surface and ground variations.

And that's all consistent with the valuation in NUREG-0396. And then following this evaluation of the source term and dose, that's when we get to the evaluation of uncertainty that we discussed on the flow chart slide.

CHAIRMAN REMPE: A good place to bring up this question. Your report states that it expands on the NEI methodology. Right?

MR. DOYLE: Correct.

CHAIRMAN REMPE: And one of the things I like about the NEI methodology that you actually cited in your report is that it mentions that the required site emergency plans will provide a base for expanding response efforts, if necessary, in accordance with regulatory guidance so as to provide an additional layer of defense and data.

And that away, it can, we all know that PRAs do, nobody knows completely what kind of accidents might occur with a first of a kind reactor. I kind of felt more comfortable seeing that.

So how will this methodology be used to or what's your vision on how you'll accommodate that

part of the NEI methodology? And I'm also curious on how the Staff will ensure that that's done in the review process.

MR. DOYLE: Well part of this methodology is that we are just establishing the distance for the emergency planning zone and outside of this plume exposure distance, you know, traditionally there are avenues for expanding this protection.

And because we're not evaluating the every sequence individually, that could potentially happen. But establishing a distance where it is, you know, likely imprudent to have preplanned actions and having the base for expansion for those.

So that's not something that's very detailed in the methodology, but would come out of implementing whatever site, whatever EPZ distance would come out of the method.

CHAIRMAN REMPE: Some design developers which may not be your organization, want to put very small cladding zone site boundary. And so again I'm thinking about one of the managers at SEPCO saying that it's not a good time to come up with an emergency plan during the middle of an accident.

So I really like that part of the NEI methodology and I'm just kind of thinking about in the

future. I realize this is just a topical report, but I'm just kind of thinking that some more acknowledgement -- I'm glad it was in your Topical Report, but I'd like to really make sure that somebody thinks about that in the future and make sure that it gets implemented.

Because if you reduce the emergency planning zone because you don't want to have drills, I'd sure like to see that you've thought about how, you know, what would need to be done. Does that make sense where I'm coming from?

MR. DOYLE: Yes, understood. Thank you for that feedback. Next slide please. So following the quantitative evaluation and the establishment of a specific plume exposure EPZ distance around the plant, that there's a qualitative evaluation of defense and depth and a review of the PRA uncertainties to provide further confidence in the PRA risk numbers and the qualitative or quantitative evaluation itself.

So the defense and depth evaluation will be performed to confirm that the design meets the guidance and INSAG-10 and Reg Guide of 1.174 to demonstrate the five attributes in INSAG-10 and the seven in Reg 1.174 of defense and depth.

I highlight these design features and SSCs that are available and capable to prevent accidents

and mitigate consequences should they occur. And then it confirms that these, that these attributes exist and that they're functional and that they confirm the low risk in sites from the PRA.

The review of PRA uncertainties is performed consistent with, you know, really any risk-informed application of the PRA to address that the underlying assumptions and model uncertainty and completeness uncertainty in the PRA that were evaluated for the specific purpose of that application do not have any impacts or those impacts are evaluated and are evaluated in the context of EPZ sizing. Next slide please.

So in summary, the NuScale Topical Report presents a method for sizing emergency, new emergency planning zones that's consistent with the underlying basis in NUREG-0396 and WASH-1400s and it provides the same level of protection to the public that the existing EPZs provide around operating plants and its limited applicability to a NuScale SMR designs only. And I believe that's the last slide.

MEMBER HALNON: I just had, this is Greg Halnon. I don't know if this question is valid, but you know, we just went through the 50.160 Emergency Planning Rule aspect. If you overlaid this on top of

that, could this maneuvering be used under that rule?

MR. DOYLE: Yes, this is designed to be a stand-alone methodology outside the existing guidance and, or the existing regulations and the proposed regulations.

But overlaying our method with the guidance in Appendix A for the new rulemaking, we do meet those major points of that methodology, that high level --

MEMBER HALNON: Kind of a plug and play type of thing?

MR. DOYLE: Right.

MEMBER HALNON: Thanks.

MEMBER BIER: One other question. Very early on, I think you said that any sequence will load into minus seven would not be used in the calculation of the then, some of these exceptional cases. Is that correct?

MR. DOYLE: That's correct for a non-seismic sequences.

MEMBER BIER: Okay. Have you thought about just what if you have so many zillion sequences at ten to the minus nine that they add up to be worth including overall?

MR. DOYLE: That point is not specifically addressed in the Topical.

MEMBER BIER: Okay. I mean it may be that, you know, if your design is simple enough, maybe you just don't have that many zillion sequences in the PRA. I haven't looked at it but for LWR PRAs, that concerned me.

MEMBER KIRCHNER: Jeremiah, I am just looking ahead to the closed session. Give you some to think about what I'm going to ask. But I think it's important to share for the public.

We would be particularly interested in how you're dealing with, as your report identifies, seismic as being one of the bigger concerns and drivers in this analysis.

And how you handle seismic event that could impact all the modules up to 12 and, you know, simple thinking would suggest that if a seismic event damages one module, it's got a high probability of damaging identical modules even that maybe ones down for refueling at the time.

You could have a common cause failure in the systems. Can you linearly sum up the source terms or --? I would like to hear a little bit more about how you address the multimode, multimodule source term and how you deal with the uncertainty in the seismic probabilities and how that impacts your results.

MR. DOYLE: Okay. I can discuss the multimodule portion, but I'll hold the seismic for the closed portion of the meeting. But broadly, we have a methodology for identifying multimodule sequences from any hazard not just seismic.

And it involves looking at the initiating event for a given sequence and then identifying does that initiating event impact multiple modules, for example, loss of off-site power.

And then would that initiating event either compromise the safe shut down functions of multiple modules like ECCS and DHRS or could it physically propagate to other modules like a hypothetical module drop that tips over and strikes another module.

And so in those cases where you end up with a sequence where there's say six modules that are experiencing the same accident sequence, in the dose calculations we would evaluate six cores with the same timing and release fractions.

In the case where one module is, for example, horizontal under the pool and there may be two vertical modules that are intact containment or bypass, the, we require the use of the MACCS code in the method.

And that allows for multiple difference

source terms to be evaluated simultaneously. And the method would call for the scrubbed horizontal module source term to be added to the containment bypass or intact containment source terms.

And if there was one horizontal module and two intact containments, you would evaluate three cores. One core to the, or one core for the horizontal and two for the intact containment. But yes, it would be explicitly addressed --

DR. BLEY: Yes, this is Dennis.

MR. DOYLE: -- in this calculation.

DR. BLEY: Yes, this is Dennis.

MEMBER KIRCHNER: By the way, let me, I think I hear Dennis. For the record, we have our consultants, Dennis Bley and Stephen Schultz with us for our meeting today. Go ahead, Dennis.

DR. BLEY: Yes, thanks. It sounds like you've done more thinking and more work on the multimodule problem than you had done at the time of the design cert. Is that true and when are we going to see actually some details we can read about that?

MR. DOYLE: So the insights I was discussing are from an audit example calculation that we performed for the NRC Staff in support of the review of the Topical Report.

It's based on the multimodule PRA that we submitted with the design certification. So that's the extent of how we've evaluated multi-modules so far and nothing new since the design certification.

DR. BLEY: Okay.

MEMBER DIMITRIJEVIC: Well that true yes. Dennis, you go.

DR. BLEY: Well I just wanted to ask that response from the audit, is that in one of the RAIs that I haven't read? Is there a place we can go read about that in more detail?

MR. DOYLE: The multimodule analysis wasn't specifically part of an RAI question. And I don't believe that's, that information's in an RAI. It was discussed in the audit.

DR. BLEY: Oh, it was, just in the audit. Okay. Thank you. I'm sorry, Vesna, go ahead.

MEMBER DIMITRIJEVIC: Well my comment was that in the design certification the, you know, that the accident with the unit was, you know, in the horizontal were not counted for that and the latitude too for larger reasons.

So obviously this is something different, you know, since you're counting them for this smaller releases I assume so. Therefore, that's a different

part of the difference with design period. I mean with the design certification period. I mean, at least the design certification PRA Level 2.

MR. DOYLE: In the design certification, yes, we did evaluate the dose consequences of the module drop and demonstrated that did not meet our larger lease criteria.

But in that accident, the containment was assumed to fail. And in the example calculation we preformed, we applied that same source term but to the EPZ dose criteria and not to the larger lease criteria from the DCA.

MEMBER DIMITRIJEVIC: Well, therefore, those sequences are not in the design certification period. Right?

MR. DOYLE: Those sequences were evaluated in the environmental report of the design certification.

MEMBER DIMITRIJEVIC: I see.

MR. DOYLE: And the module drop did contribute to the core damage frequency, but it was not a contributor to the larger lease frequency.

MEMBER DIMITRIJEVIC: Right. And therefore it was not counted in the core damage frequency because it was not the contributor. So okay,

so this settle that and this analyzes from your environmental report. Okay.

DR. SCHULTZ: Jeremiah, this is Steve Shultz. Question. You mentioned as you made your presentation that the methodology that you've used is MELCOR methodology, but that other methods could be used.

That an Applicant, in doing their PRA, their overall evaluation, could use other methods. Is that what you're implying?

MR. DOYLE: Yes, we did not limit the methodology to one specific code. Like for example, if an applicant wanted to use the MACCS code, they could use that for their severe accident evaluations.

But since NuScale used MELCOR, we used that as the example in the Topical, but it's not required.

DR. SCHULTZ: But then that would have to be re-evaluated by the Staff of the application.

MR. DOYLE: Correct.

DR. SCHULTZ: The MACCS code though is specified at least as provided by the Staff as a tool that must be used in the application in the safety evaluation that they performed. Is that correct?

MR. DOYLE: That's correct. The methodology requires MACCS to be used as the dose

consequence code.

DR. SCHULTZ: Thank you.

MEMBER KIRCHNER: Other members? Questions?

CHAIRMAN REMPE: Just a comment. We are actually in the full committee meeting, not subcommittee meeting. I just noticed that your slides and the Staff slides say subcommittee meeting and it's not a big deal, but I wanted everyone to be aware of it. I know it's confusing.

We had originally you guys scheduled for a subcommittee meeting and this is a full committee meeting so.

MEMBER KIRCHNER: One comment I was going to make on that subject is that since you have the full committee, and the full committee is here, this is a good time to ask especially during the closed session, any of the harder questions you have because we are going to look to writing a letter report on this and the Staff's review in our October full committee meeting.

If we can answer all of your questions, we can have a very brief summary presentation --

CHAIRMAN REMPE: Or even have it. It's up to you.

MEMBER KIRCHNER: -- or possibly none for the October meeting so like please fire away now while we have the NuScale people here as well as the Staff. So any further questions or you want to hold some questions for the closed session?

Okay, thank you, Liz. Thank you, Jeremiah. I tell you what, I think we're ready for the Staff --

MR. VASAVADA: Yes.

MEMBER KIRCHNER: -- presentations.

MR. VASAVADA: Thank you. So I have a clarification question. So this is not a subcommittee meeting?

CHAIR REMPE: We are in a full committee. Again, we had scheduled, I'm sorry --

MEMBER KIRCHNER: You might want to turn your microphone on.

CHAIR REMPE: We are in full committee. We had scheduled something earlier in September as an extra session to accommodate your schedule and then we are hoping we can accomplish all of this during full committee week.

And so that's why we're all saying you may not have to present again.

MR. VASAVADA: Okay.

CHAIRMAN REMPE: But it's up to you all.

MR. VASAVADA: There is --

MEMBER KIRCHNER: So we are going to ask you to pick up speed so we can move the Staff into your chairs. And thank you for your presentation.

MR. DOYLE: Sure.

(Off record comments.)

MEMBER KIRCHNER: I don't know if you can see this, but we have a placard there for you and it says you're remote.

MS. SCHILLER: Good afternoon. My name is Alina Schiller. I am a project manager in the NRC Office of Nuclear Reactor Regulation, Division of New and Renewed Licenses, New Reactor Licensing Branch.

Thank you. Thank you, Shilp, for sharing your screen. I would like to thank the ACRS Subcommittee and Full Committee for NuScale Power, LLC and the general public for entertaining the NRC for the presentation of the Staff safety evaluation of NuScale's Licensing Topical Report titled Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones at NuScale's small modular reactor plant sites Revision 3. Next slide please.

In August 2020, NuScale submitted Revision 2 of this Topical Report to the NRC. The NRC showed

two requests for additional information, RAIs, to NuScale in April 2021.

Originally the Topical Report Revision 2 was applicable to light water small modular reactors and non-light water reactors. In May 2021, in response to one of the two RAIs, NuScale removed applicability to non-light water reactors.

From November 2021 to April 2022, NRC performed the regulatory audit as part of its review of the methodology in Revision 2. In June 2022, NuScale provided response to the 2nd RAI and submitted Revision 3 of the Topical Report which is applicable only to the NRC design and its derivatives and which incorporated the responses to the two RAIs.

We are here today to discuss the Staff's advanced safety evaluation of the Topical Report. Next slide please. The NRC Staff reviewers are Marie Pohida, the lead technical reviewer with the PRA Licensing Branch C in the Division of Risk Assessment in NRR, Shilp Vasavada, the acting branch chief of the PRA Licensing Branch C, Elijah Dickson from the Radiation Protection and Consequence Branch, Raymond Hoffman with the Reactor Licensing Branch in the Office of Nuclear Security and Incident Response Division of Preparedness and Response and Todd Smith with the

Division of Preparedness and Response and Answer.

The presenters today are Marie Pohida, Shilp Vasavada and Elijah Dickson. I'm the project manager for this Topical Report supported by Senior Project Manager Getachew Tesfaye.

Now I'm turning over to Marie Pohida, the NRC first presenter.

MS. POHIDA: Thank you, Alina. First I'd like to discuss the outline of our presentation. First, we're going to discuss the regulatory and technical basis for the Staff's evaluation.

Then we're going to go through an overview of the Topical Report methodology. We will then discuss the dose-distance criteria and figures of merit.

We will then discuss the source term and consequence assessment and then the screening of PRA sequences. We will highlight the treatment of uncertainty and the conditions of use for this Topical Report. Next slide please, Shilp.

First, I'd like to discuss this, the regulatory and technical basis for our valuation. Our basis is 10 CFR 50.47 on emergency plans, 10 CFR Part 50, Appendix E, emergency planning and preparedness and 10 CFR Part 20, standards for protection against

radiation.

The documents that I'm going to discuss below, all the ADAMS information where the documents can be found in the reference slide at the back of the public presentation.

So our next document that we relied in is NUREG-0396. It is the planning basis of emergency response plans for light water reactors. And it is the technical basis for the ten-mile EPZ and it is also the technical basis for the draft final EP rule for small modular reactors and other nuclear technologies.

This review was informed by the Commission PRA policy statement of 1995. It was also informed by the SRM SECY 98-144 and it's a white paper on risk informed and performance-based regulations.

This review was informed by Reg Guide 1.174 which is an approach for using PRA in risk-informed decisions on changes to the licensing basis and finally, it was informed by Reg Guide 1.20 which is the, outlines the technical acceptability of PRA results for risk-informed activities. Next slide please.

I would like to discuss NUREG 0396 from 1978. It identifies the purpose of the emergency planning zone. And it's the area within which plume protected actions may be necessary to provide dose

savings in the event of radiological release.

It is the technical basis for our, the current prescribed plume exposure pathway EPZ radius of ten miles. And if you look at NUREG 0396, it states that the taskforce reviewed the dose distance curves 1 NUREG 0396 and they can be found in Figure I-11.

And they concluded that plume accidents can be severe, but the probability of large doses drops off substantially about ten miles from the reactor.

You know, based on the review of licensing basis events and, I mean, this report was based on a review of licensing basis events and a spectrum of accident sequences from WASH-1400.

And these included BWR and PWR accident release categories from WASH-1400. And Elijah will present details of this later in the presentation. I'd like to briefly discuss the Staff's method of review.

It's consistent with a technical basis of NUREG 0396 and it's also consistent with risk-informed decision making and use of PRA in current risk-informed applications.

And our review was supported by a regulatory audit where NuScale provided an example calculation using their design certification PRA and

their SAMDA analysis which has source terms and release frequencies to produce an example dose distance curve demonstrating the entire methodology.

I would also just like to briefly discuss our review of the applicability of the NuScale EPZ TR methodology. It's only applicable to the NuScale design and its derivatives which includes the standard design approval.

And if you look in Section 2.5.1 of the Topical Report, it provides high level design characteristics that determine the applicability. You know, as an example, for it, you'll see that it's applicable for a small modular integral pressurized light water reactor.

And the reactor modules are consisted, composed of a reactor core, a primary coolant loop, depressurizer and steam generators within a reactor vessel which are housed within a containment vessel that is normally operated in sub-atmospheric conditions.

Additional characteristics like these can be found in the SER. We find that these limitations are acceptable because we believe these high level design characteristics are capable of identifying the NuScale design with features and the risk profile that

we considered in our review.

And at this, I'd like to turn over to Elijah to discuss the dose distance criteria in more detail. And I'll break here if there's any questions. All right, thank you. Turn it over to Elijah.

MR. DICKSON: Thank you, Marie. So on Slide 9 here, this slide discusses the Staff's approach in reviewing the source term consequence portions of the Topical Report which include performing review of historical documents to familiarize ourselves on the topic, current research analysis and results from other organizations such as the NRC, NEI, EPRI as well as the NuScale environmental report and other organizations responsible for radiation protection recommendations.

Specially, we paid careful attention to the vintages of systems of dosimetry that were utilized between NUREG 0396 and the Topical Report, the radiological criteria as well as the radiological consequence analysis methods and assumptions.

We did perform limited analyses using the MACCS code, using assumptions drawn from WASH-1400 to better understand the presented dose-based criteria presented in NUREG 0396 and presented in the Topical Report as well.

Now before moving on to the next slide, I'd like to provide some context in how the Staff reviewed and compared the proposed methodologies and criteria to the technical basis of the ten mile EPZ described in NUREG 0396.

In doing so, you'll see that the Topical Report is consistent with the robust analyses and methods and intent of the current ten mile EPZ. NUREG 0396 captures the task force review analysis and decision making insights in developing the planning basis for a radiologically emergency response plans.

This includes members at all levels of government, local, state and federal members. And here they introduce the concept of generic emergency planning zones as a basis for the planning for response actions which will result in dose savings in the vicinities of new purpose facilities in the event of a serious accident.

A selection of the current ten mile EPZ was chosen based on professional judgment considering a variety of lines of evidence rather than being based on a specific prescribed radiological consequence assessment methodology.

The task force recommended considering information from a spectrum of accidents which does

include design basis accidents and a range of beyond design basis accidents typically referred to as Class 9 accidents.

As defined in NUREG 0396, Class 9 accidents are considered to be so low in probability as to not require specific additional provisions in the design of the reactor facility.

Such accidents would include sequences of successive failures of more severe than those postulated for the purposes of establishing the design basis for protective systems and engineered safety features.

With that, I would like you, to point your attention to in your review of the Topical Report as well as reviewing NUREG 0396, is specifically to Appendix I of NUREG 0396.

It does contain a wealth of information and insights from the task force and I'll be referring back to it throughout my portion of the presentation. Specifically, Appendix I of NUREG 0396 describes the various rationales for establishing the planning basis which includes risk, probability, cost effectiveness and consequence spectrum.

The study based the rationale for the planning basis on a special with consequences tempered

by probability and NUREG 0396 also states that the accident probability is important and does have a place in the terms of evaluating the range of consequences from accident sequences and setting some reasonable bounds on a planning basis.

As such conditional probabilities of various consequences were used to provide perspective for critical doses of concern for emergency response planners as were their probabilities.

Of most importance, the Staff reviewed, in depth, NUREG 0396 dose distance curves that were generated for design basis accidents and those are the probability exceedance curves for the beyond design basis accidents.

They also analyzed a number of other important factors important for emergency planning purposes such as accident progression, timing, source terms and estimated arrival times.

With that, I'd go on to Slide 10 please. Okay. This slide summarizes and presents the Topical Reports of dose distance criteria and figures of merit.

For the most part, Topical Report follows the recommendations of the Task Force for the assessed design basis accidents and beyond design basis accidents derived from their PRAs, the accessed

accident progression and timeliness.

They derive source terms and then perform the applicable radiological consequence analyses. Probably one of the primary differences between what was done in NUREG 0396 back in the late '70s and with being presented in the Topical Report, is that they do utilize different systems of dosimetry.

And they do utilize updated tools and analyses and updated codes and programs. So with that, let me describe this table. It presents three criteria.

Listed in each row in, it presents three criteria and then listed in each row in the middle column are the analyses used to derive the source term and then lastly the figures of merit within each column.

The first row is Criterion A, specific to design basis accidents, Criterion B and Criterion C, rows 2 and 3 are for beyond basis accidents. As you move from Criterion A to Criterion C, the analyses become increasingly more mechanistic and rely on additional realism.

So for Criterion A, I'll first discuss insights from NUREG 0396. During that time when they're developing the planning basis, the task force had assessed already cited nuclear facilities safety

analysis reports.

Specifically, the accident analyses that were performed to demonstrate compliance with the Part 100 citing criteria, that is the 25 REM over a two-hour period, they re-analyzed a handful of those analyses and they determined at what distance you would compute consequences less than one REM.

You can review these results, these are the dose distance curves or dose distance analyses in Tables I-2 and Figures I-1. The title of this figure would be the upper bound plume exposure pathway projected doses based off of 10cc per part of Part 100.11.

And what they found was that around ten miles the doses would drop down below one REM with an estimated time of arrival of that plume around five hours.

So this was important information in regard to emergency response planning. Not only, of course, knowing what the projected computed doses are at different RADI from the facility, but also what the estimated time of arrival of that source term or plume would be at that location.

Now we'll talk about the Topical Report. The Topical Report methodology is generally consistent

with NUREG 0396 in that the EPZ should encompass those areas in which projected doses from design basis access could exceed early phase PAGs.

The source term that would be derived are those that you would typically see from NUREG 0800 which is a standard review plan, Chapter 15 accident analyses.

These are very stylized analyses and deterministic in nature in which you're only applying, for the most part, safety related structure systems and components that meet single failure criteria and do not rely on offsite power to mitigate the source term and they do not consider accident frequency.

They are deterministic in nature. The criteria used, the figures of merit criteria is one to five REM total effective dose over 96 hours which is consistent with the EPA PAG manuals early phase PAGs.

Now on to Criterion B and Criterion C. These are the beyond design basis accident sequences derived from the PRA. First let's talk about some insights from NUREG 0396.

The task force was very focused on the more severe accident sequence that involved large releases. Primary consideration was given to prevention of early health effects.

Early health effects that they had looked

at were one to five REM which corresponded to the lower range of paths. Fifty REM corresponded to doses at early, which early illnesses could occur.

And then 20 REM whole-body acute dose is a dose at which significant early injuries would occur. They generated a series of probability exceedance curves for critical dose values at which emergency planners would be concerned with.

Specifically, these exceedance curves were generated for the source term frequency weighted and in some yield the resulting curves. The primary curves that were focused very heavily on by the task force in NUREG 0396 were Figures I-11, I-12 and I-13.

And Marie had discussed this as well. As quoted in NUREG 0396, it can be seen from Figure I-11. Core melt accidents can be severe, but the probability of large doses drops off substantially at about ten miles from the reactor.

Such conclusions can be reached by evaluating the other critical organ and lung dose values. And these are in respective figures of I-12 and I-13.

As such, the shape of the curve itself that you see in these exceedance frequency curves is very important in the decision-making process for the

current ten-mile emergency planning zone.

I'll now go on to Criterion B and Criterion C as they presented in the Topical Report. The EPZ for Criterion B, the EPZ should encompass those areas in which consequences of less severe accidents that is contained and intact, sequences could exceed the early phase PAG.

In this, for this criteria, the source term that would be derived would be derived from PRA specific accident sequences or BINs utilizing, for instance, the MELCOR code to derive source terms which would then utilize additional mitigating the design features and operator actions.

The figures of merit that they would be compared to would be the one to five REM total effective dose equivalent evaluated over a four-day timeframe which is consistent with the EPA PAG manual.

On to Criterion C. The EPZ should be a sufficient size to provide for substantial reduction early health effects in the event of more severe accident sequences.

The source terms that would be derived for these analyses would also be PRA specific accident sequences or BINs of accident sequences. In this case utilizing the MELCOR code and also perhaps maybe

separate effects models to derive source terms which would utilize additional mitigating design features or phenomena and it would include operator actions.

The figure of merit that these would be compared to would be the 200 REM acute dose metric based on substantial reductions of early health effects.

And this too is consistent with NUREG 0396. NuScale also has an acceptance criteria considered proprietary and the Staff have, are still reviewing this at this time for the 200 REM figure of merit.

It is based on analysis and discussions presented in NUREG 0396. However, the Staff already have reviewed this acceptance criteria and find that it is within the residual risk discussed in NUREG 0396 Appendix I.

As such, I think that I'd also like to point you to the bottom of this slide. We have a, we did a little extra research with the Office of Research in regard to providing a little more guidance in producing the actual figures of merit utilizing the MACCS code.

The MACCS code has many vintages of dose conversion factors for many different ICRP recommendations and so we provided a little extra guidance on how one would compute the total effect of

dose equivalent versus the EPA's total effective dose or how would you go when you compute the acute dose?

And that would be utilizing specific dose conversion factors for lead bone marrow. So we did provide the Staff report that you can see it at the bottom of this screen. On to Slide 11.

MEMBER KIRCHNER: Elijah, before you go on, --

MR. DICKSON: Yes.

MEMBER KIRCHNER: -- just to characterize things, I would submit that the uncertainty between the dose conversion that were used then and we use now using MACCS is, they're comparable.

There's not a big difference there. These uncertainties come in questions like Joy ask earlier. So how does the system perform?

MR. DICKSON: Right.

MEMBER KIRCHNER: And you know, the probability of a melt through and a containment breach, how big are those breaches, et cetera, et cetera.

I mean, there's so much, compared to dose conversion, there's so much uncertainty in the in deriving that source term, --

MR. DICKSON: Right.

MEMBER KIRCHNER: -- that the dose

conversion is, it's an important thing too and I'm glad you pointed that out, but it's not, it's not a big factor in --

MR. DICKSON: You're --

MEMBER KIRCHNER: -- coming up with a distance.

MR. DICKSON: You're right. There is more of a regulatory purpose behind it.

MEMBER KIRCHNER: Yes.

MR. DICKSON: The whole system of Part 20 radiation protection is based off of, you know, the ICRP 2630 system and those tissue weighting factors from that system of dosimetry are directly codified in Part 20.

And so if you were to compute TEDE, the total effective dose equivalent which is also codified by definition in Part 20, you need to use the right dose conversion factors.

We find at times that applicants or licensees may utilize the wrong dose conversion factors and might compute the TED, the total effective dose, so we're just trying to make that important distinction here.

That if you're computing TEDE, you got to use these dose conversion factors that way you are

consistent with the regulation.

MEMBER KIRCHNER: Thank you.

MR. DICKSON: Thank you. Then lastly, on Slide 11 for my section of the slides, the source term and radiological consequence analyses, the top of the report recommends the use of MELCOR and RELAP to perform design specific source terms and then requires the MACCS code to perform the radiologic consequence analyses.

And the Staff finds that these computer codes are appropriate to perform these analyses. And with that, I'll go on to the next slide which Marie has if there's no other questions.

DR. BLEY: Yes, before you go on, I have one. I almost didn't ask you. I've been waiting for a while. This is Dennis Bley.

MR. DICKSON: Hi.

DR. BLEY: 0396 was done 50 years ago. It was done when there was one PRA in existence. In the last 10, 20 years, the Staff has made a very big deal about how much more they've learned and how much better they can calculate than they could way back then.

Why, what's the justification for still hanging on to 0396? Just that it's perhaps conservative with respect to these issues? What's your thinking on that?

MR. DICKSON: It's, I think it's more the process in which those individuals and organizations came up with the planning basis. Not so much that very specific WASH-1400 PRA, but that they went through a process of considering risk information, they went from a process of considering design basis type information and then made that final selection.

That process is being echoed more or less in this Topical Report.

DR. BLEY: Okay, well what I was really getting at and I agree with what you just said. But since we have learned how to calculate things better and we have a lot of PDRAs since that time, not so many Level 3s, but there are some, if we take that same process and lay it up against what we know now, might we come up with different results? It seems like we ought to.

MR. DICKSON: Yes, that would be outside I think the Topical Report review. That's more of a policy type of question.

DR. BLEY: Yes, it is.

MR. DICKSON: It is.

DR. BLEY: You willing to talk about it?

MR. DICKSON: No, I'm not. I'll take that one back with me. How about that?

DR. BLEY: Okay.

MR. DICKSON: Yes.

MEMBER KIRCHNER: I think what you're suggesting, Dennis this is Walt, is that based on the SOARCA analyses, you could pull back on the ten mile radius of the large plants. Maybe you might be thinking that.

DR. BLEY: You can guess.

MEMBER KIRCHNER: I certainly was thinking that. No comment necessary.

MR. DICKSON: Marie, are you next?

MS. POHIDA: Yes, thank you. I'd like to discuss now event selection for EPZ sizing and how it needs to be consistent with NUREG 0396. The first point that I'd like to bring up is the spectrum of accidents is it's not equal.

It's not similar to licensing and designing new nuclear power plants against the QHOs. The screening of accident sequences must ensure that there's an adequate spectrum of events included in the EPZ technical basis.

And so this task is completely different and distinct from the licensing and review of a new reactor's design against the Commission goals for new reactors. And as you know, these goals are, you know,

a CDF of ten of minus four, any large release frequency of 20 minus six.

And that's stipulated in the S-REM D-SECY-90-016. So the spectrum of accidents for EPZ sizing has to include the characteristics of radiological consequences from design basis access and from a design basis, beyond design basis access.

So it has to include some the key characteristics of more severe accidents and more severe is the containment not intact with large releases and it has to ensure that there's a capability to reduce early severe health effects, injuries or death in the event of the most severe beyond design basis events.

So the selection of the spectrum of accidents for EPZ sizing does not, you know, alter the design or operation of the plant. You know, new reactors, you know, transition from large release frequency to large early release frequency at or before initial fuel load.

But emergency planning, you know, follows the design and operation of the plant. Next slide please. I'd like to continue this discussion of this event selection on for EPZ sizing on Slide 13.

You know, the purpose of EPZ is dose savings, not dose avoidance. And I'd like to present

a quote from NUREG 0396. It's while the EPZ should not be solely dependent on the most severe and most improbable beyond design basis event, the determination of the EPZ size needs to include some of the key characteristics of very large releases.

Now, we expected that seismic risks would be a dominant contributor to the NuScale risk profile, you know, and factor into EPZ sizing. Okay. If you look at the results of the NuScale design certification PRA in their FSAR, and it's in Table 19.1-80, NuScale reduced the risk from internal events, you know, logos, losses of DC power and external events such as high winds, internal fires and internal floods.

We also realize that the timing of these seismically initiated sequences would be different to non-seismic events. If you look at the seismic margin results from the design certification PRA, it's dominated by structural failures such as seismically induced failure of the reactor building crane supports and seismically induced failure of the reactor building exterior walls.

And they are, if they occur or are soon to result in core damage. So the inclusion of seismic events in the spectrum of accident sequences is important to maintain consistency with NUREG 0396.

And we can go to Slide 13 please.

And what I would like to do is discuss these two donut charts. On the left you'll see the results of the NuScale design certification PRA as it's documented in the FSAR in Table 19.1-80.

And that's without any contributions from seismic core damage frequency. If you look on the right, you see an example risk profile of an existing, you know, operating nuclear power plant site which includes seismic core damage frequency assuming that a NuScale design certification plant is built there.

So I'm going to note again that the EPZ methodology was to ensure that there's an adequate spectrum of seismic events to be consistent with NUREG 0396.

Now if you look at the donut chart on the right, you'll note that this site lies within the NuScale certified design response spectrum. And these seismic core damage frequencies were derived using the seismic hazard information from NTTF 2.1.

And the seismic hazard was convolved with the fragilities of structural components that are listed in Table 19.1-35 in the NuScale design certification FSAR. And they were convolved to obtain core damage frequencies.

If you look in Table 19.1-34, you know, seismically induced failure structural components were assumed to lead to core damage. I will break here, see if there's any question on this slide.

MEMBER PETTI: Just a lot of the NuScale, philosophically, doesn't surprise me that a designer would try to design away the internal --

MS. POHIDA: Yes.

MEMBER PETTI: -- threat. And so you're left with the external so I think you're going to see this over and over again with the advanced reactors that are coming in where they've got inherent and past features that are going to create the same dichotomy, if you will, of the core damage frequencies.

Some may not even be able to describe a core damage frequency, but upset frequencies are going to be significantly different and you might want to think about longer term, about as some guidance.

You know, in this regard that's generic, you know, sort of a cross, but you know, independent of a reactor technology because I think we're going to, you're going to see this over and over again.

MS. POHIDA: We agree. And Shilp will touch on this issue when he discusses seismic risks and how we treat it in the methodology and how we

reviewed it. Is there any more questions?

We can go to next slide please. All right, I'd like to discuss the Staff review of the non-seismic single modules sequence screening. The Topical Report uses a sequence screening of 20 minus 7 per reactor year.

And that threshold would have screened in all of the WASH-1400 release sequences. None of these release sequences had a frequency less than 20 minus 7 per year. So we found this to be an acceptable screening threshold.

May I go to the next slide. Thank you. Second, I would like to discuss the Staff review of the multimodule impacts for non-seismic hazards. Okay. WASH-1400 did not explicitly model common mode mechanisms such as fire, floods, tornadoes, which have the potential to impact multiple modules in the event trees and the fault trees.

I went and reviewed Appendix 4 of WASH-1400 and they, it states that these common mode mechanisms were assessed as impacts when the system fault trees.

So the core damage sequence screening was of 10, 20 minus 7 was also applied in the Topical Report to multimodule core damage sequences. And once again is I'll note that none of the WASH-1400 release

sequences had a frequency less than 20 minus 7 per reactor year.

So the Staff found this screening threshold for multimodule non-seismic hazards to be acceptable. And then I'd like now to turn the discussion over to Shilp so he can discuss seismic. Thank you.

MR. VASAVADA: All right. Thanks, Marie. First of all before I start, I just wanted to make sure I can be heard clearly at least on the phone. I have a mask on so please let me know.

PARTICIPANT: Still has it.

MR. VASAVADA: Okay, how about now? Good?

PARTICIPANT: That's better.

MR. VASAVADA: Okay. All right, so I'll start with the seismic screening threshold and then go towards the end of the presentation. We have two of the Topical Report proposed a seismic screening threshold of 20 minus 5 per year based on the initially frequency.

This was a long-standing open item in the review. And not because the Staff decided to pay excessive attention to seismic or treat it differently from all the other hazards, but because 20 minus 5 per year screening threshold resulted in an incomplete spectrum effects.

This is because there's negligible, if any, beyond design it is seismic risk at that particular frequency. The reason is that if the, what's called a ground motion response spectrum which is used too for the design purposes, is determined per the guidance in Reg Guide 1.208 which it usually is than the approach or their results in a target failure frequency for the SSCs of 20 minus 5.

What that basically means and this is explicitly mentioned in the Reg Guide that you have negligible, if any, failure property of the SSCs at that particular frequency.

So therefore you have negligible zone design with assessment risk and the spectrum of accidents is incomplete as was pointed out. 0396 does call for a complete spectrum of accidents for EPZ sizing.

So you do not have risk insights from the dominant risk contributor. In addition, in WASH-1400, seismic risk was considered although it was considered qualitative.

The 20 minus 5 does not even cover the extent of expirations that were considered qualitatively in 1400s. From that perspective, it also would be inconsistent.

And it would be inconsistent with my view from the principles of risk informed decision making because you do not have risk insights from a dominant risk contributor or a risk informed decision.

That was primary reason why the 20 minus 5 in Version 2 was the concern, open item, and Staff found that there was gap in the spectrum of accidents that was being considered and therefore the risk in size are EPZ size.

I'll fast forward to the Topical Report which provides, proposes a proprietary value for the screening curve. So the value at this and the acceptability of this were and is consistency with 0396 as well as WASH-1400.

What the Staff did was it doubled up an upload which we call the risk gap approach. The purpose of the risk gap approach is to determine whether the proposed screening threshold captures insufficient spectrum effects against spectrum of seismic sequences for consideration EPZ sizing.

As I talked about it in the previous slides, zero percent at 20 minus 5 per year is inconsistent, but so is 100 percent, the entirety of the seismic risk.

As Marie pointed out, 0396 clearly states you do not have to use the worst case scenario for EPZ

sizing. You need to have a good spectrum of facts. And that's what the objective of this risk gap approach was.

And the appropriate amount on the spectrum of beyond design is -- please stop me if there are any questions. I'll keep going. I'm on Slide 19 which provides like an overview of the risk gap approach.

There are details provided in the Staff safety evaluation and at this score, the approach is simple to implement. It has four steps. I won't go into the details, but overall, collect an ensemble of hazard curves representing different sites within a design and discuss most scales certifies seismic design response spectrum.

You identify of land load fertility in the mean scales marked for fertility and provides additional details about sector ratios. You can wonder too to get an estimate of the seismic core damage frequency.

And you can let how much risk is being essentially left off the table. And you can do sizing determinations below the threshold. Either a prescribed threshold or you can use this to identify the property threshold.

And we will talk about the exact value.

So how often implemented this risk gap approach determine if NuScale is proprietary in threshold admitted and was acceptable.

We did this using nine of risk gap to size. Let's go to the next Slide 21 to show the totally where the sites are with respect to the NuScale certified seismic design response spectrum of CSDRS.

As can be seen in the slides cover a range of seismicity. They cover western and the central eastern United States and they have different like characteristics of the rock while back filled.

MEMBER HALNON: Shilp, this is Greg. How did you assure yourselves that was representative of any place a NuScale plant could be built?

MR. VASAVADA: Right, so the primary reason was by selecting the site, removal of sites that covered the regions, western United States, eastern United States, different types of soil characteristics and/or IP of seismicity from low seismicity as you see the mustard line on the way to the yellow line.

MEMBER HALNON: Okay. But so your sample was broad enough and the results close enough to have you, give you confidence that was characteristic of pretty much any soil types in the United States.

MR. VASAVADA: Right. So that --

MEMBER HALNON: Did that include Alaska as well?

MR. VASAVADA: So anything within the NuScale's CSDRS, we did not go to Alaska.

MEMBER HALNON: Okay.

MR. VASAVADA: We did consider California. Other than that, out of the NuScale CSDRS as NuScale presented --

MEMBER HALNON: Okay.

MR. VASAVADA: -- and we talk about in the conditions of use. This is --

MEMBER HALNON: A continuous --

MR. VASAVADA: -- only on the NuScale design so it's been NuScale design.

MEMBER HALNON: Okay. They stayed within their design.

MEMBER BALLINGER: Where does New Madrid fit on this?

MR. VASAVADA: I'd have to go back and check, but it would be somewhere --

MEMBER BALLINGER: But it's there.

MR. VASAVADA: Yes, it would be somewhere --

MEMBER BALLINGER: Okay.

MR. VASAVADA: -- close to the CDCRS in

the top. What is at the bottom is some of the cited updates like for example Texas where it has low seismicity. Any further question?

MEMBER KIRCHNER: Yes, Shilp.

MR. VASAVADA: Yes.

MEMBER KIRCHNER: Explain to the public the last sub-bullet on Slide 20.

MR. VASAVADA: Yes, I was getting to that.

MEMBER KIRCHNER: Why don't you capture 20 to 50 percent of the seismic risks.

MR. VASAVADA: So --

MEMBER KIRCHNER: Which is not captured so in lay person terms explain this convolution that you've gone through --

MR. VASAVADA: Okay.

MEMBER KIRCHNER: -- to address this risk gap.

MR. VASAVADA: All right, so basically going through that particular approach often watering it and getting the seismic CDF looking below how much risk is left off the table with all the proposed proprietary screening threshold, we determined that it was around between 50 to 80 percent of the seismic risks would be not included, but EPZ sizing for the majority of the plants.

For more than half of the plants, we did not include 50 to 60 percent. Does that help?

MEMBER KIRCHNER: It will not include what 50 to 60 percent?

MR. VASAVADA: The seismic risk and the sequences that guide.

MEMBER KIRCHNER: Okay.

MR. VASAVADA: And we also looked at the absolute value of the risk gap in addition to the relative contribution. And all of that information and the details, including the numbers are in the Staff safety evaluation.

I'm going to Slide 22 because I talked about 21 in conjunction with 20. We also looked at the multimodule risks impacts and I'll talk about that in detail in a subsequent slide and --

MEMBER PETTI: Can I just take you back because I'm a little confused on that. The threshold, the list that it's not capturing seismic events that are extremely low frequency.

MR. VASAVADA: I'm sorry, yes.

MEMBER PETTI: Okay. I mean, that's what I assumed. So you had taken the more frequent seismic events?

MR. VASAVADA: Correct. I mean that was

a part of the consideration in determining where the property is, yes, how much is lost absolute terms, relative terms. And what's the acceleration levels at which we are talking about.

So I go to the Slide 18. At 100 percent if you consider the entirety of seismic risk, you are talking about like extremely unlikely accelerations of 2Gs, et cetera.

And that was also, it would be found as inconsistent with the fundamental digits in 0396. You need a spectrum of accidents not designed in digital in the worst case.

MEMBER PETTI: Fine, thanks.

DR. SCHULTZ: How is it that you used in the, just go back to that slide, how is it -- this is Steve Schultz. How is it that you used before the --

MR. VASAVADA: Before it?

DR. SCHULTZ: Yes. During the Slide 20.

MR. VASAVADA: Oh, got it.

DR. SCHULTZ: That you used the HCLPF, that the NuScale high confidence low probability of failure?

MR. VASAVADA: So --

DR. SCHULTZ: It's at 95 percent values so just to follow onto Dave's question.

MR. VASAVADA: All right, so the HCLPF high

confidence of low probability of failure is 95 percent confidence with 5 percent failure or less. On the 95th percent or what is also on the mean curve, 1 percent or less failure probability.

And we use the values from their NuScale SRA for the DCA design for this purpose, for the convolution purpose.

DR. SCHULTZ: And when you say then the threshold captures the 20 to 50 percent seismic risk across the majority of nine sites, can you, can I get something from the next slide that tells me what that is in going to explain this to the public?

MR. VASAVADA: I'm sorry, if you can please clarify like --

DR. SCHULTZ: How was HCLPF used, how was that value of HCLPF used?

MR. VASAVADA: Okay. I can get in, so go to Slide 19 for the steps. Step 2 is you determine the plant level HCLPF are identified in the case of NuScale.

You use that to provide the conditional failure for the public of the plant considered as a whole. And then you can roll that with the seismic hazard.

And that convolution will give you the

equal, or an estimate of the seismic core down issues. So that's how it was used for the purposes of this evaluation.

DR. BLEY: Can, this is Dennis Bley. Can I jump in with a kind of a question. This is an, it's an interesting approach and it seems reasonable, but what it's kind of telling me is that for the purposes of looking at this report, nothing jumps out that's truly unreasonable.

But eventually there will be a complete plant design and a complete plant being built at a particular site. And then they're going to have to come and actually look at this for their site with the actual seismicity at that site so that this is just kind of a screen to say nothing crazy is sitting here that would be bad.

But you get it right before you have a real plant with a real, entering real operations. Is that a reasonable statement?

MR. VASAVADA: Yes, I believe if I understand you correctly, that is reasonable. And when we get to the conditions of use, you will see that a couple of conditions, actually three of them which I believe speak to what you just provided as a comment.

DR. BLEY: Okay. I'd like to see. Thank

you.

MR. VASAVADA: Okay. All right, so as on Slide 22, we've talked about how we looked at the multimodule risk aspect on a couple of other slides. But what we found based on our evaluation again, found that in the risk gap approach, was that the proposed proprietary seismic hazard screening threshold achieves consistency with NUREG 0396 and with WASH-1400 in that it results in a complete spectrum of accidents, includes seismic sequences in that spectrum of accidents and again, seismic is the dominant or we expect it to be the dominant distributor.

While at the same time it does not penalize NuScale for its mis-profile. Yes, they have reduced the other risks and that is a benefit. And it does not, you can say, provide extra focus to anything more than what was done in 0396 in terms of determining an adequate spectrum of accidents.

Nor does it include that extremely unlikely seismic explorations of 2Gs and beyond. The one difference I would point out compared to 0396 or in terms of consistency is that the methodology.

And we believe it's appropriate to use as quantified seismic sequences compared to the qualitative approach that was used in WASH-1400. We

believe that's, that is necessary because it is a dominant interest contributor.

And since Revision 2, the Topical Report has called for a technically acceptable seismic PI, but that's never been a point of contention. And remember at this point to spend a minute or so hopefully on this particular slide that we think this risk gap approach has broader applicability.

Technology clean and close of applicant routines or designers and other technologies to identify what will be the appropriate spectrum and maintain consistency with 0396 in determining if being threshold for the seismic hazard.

Because a single one-size-fits-all value may not work, given the technologies that are expected to be out there. It may be too much for cert. Some cases it may be too little for others.

The approach as well as pointed out, uses design specific information. One doesn't have to go about developing anything new and it can be used with the metrics of the density LERF reused or risk gap.

One can go all the way to consequences and use a consequence gap. And finally, the authority itself can provide regulatory stability. You can get different numbers that are as is usually done for

guidance, the approach can provide a consistent highly reproducible way of achieving a decision on the seismic screen.

I'm moving on to the treatment of uncertainties for the seismic hazard. We will get into the details in the proprietary section, how we have already reviewed which was aided by the regulatory audit in term and the approach and the lower bound threshold for this uncertainty evaluation are sufficient to identify any new risk insights.

And address any potential side effects because the window that is adopted by this uncertainty evaluation is large enough on that potential cliff as you have scantly adorned it.

Plus the methodology, it brings in these new sequences if they are identified in the evaluations if they are not lost. They're actually comparatively pleasing sizes.

For multimodule impacts from the seismic hazard, we'll start with the bottom line of one that we believe the methodology appropriately identifies and includes multimodule impacts on seismic events.

We performed the primarily qualitative evaluation and some of the considerations are listed on the slide so. Slide, including the fact that based

on our risk gap evaluation, the accelerations that were being acquired or reached for at the screening special included those where multimodule impacts are expected.

And I think NuScale talked about how multimodule sequences will also be reflected in the source term by amplifying the source term based on the modules and pattern.

There's one difference in the seismic multimodule consideration compared to non-seismic which is that there's a screening at 20 minus seven for your, or non-seismic multimodule sequences which is not applied to the same sequences.

This is primarily because of the way seismic events are screened and the value compared to non-seismic sequences which can result in double screening if there are, if the 20 minus 7 were to be applied for the seismic hazard.

I'm on Slide 26. It's a pictorial of the type of information one can get at different stages, licensing and our FSAR Part 52. And the purpose of this slide is to state that the PR calls for the use of technically acceptable PRA including a seismic PRA.

And it's that combined license stage and beyond that one would get that so this Topical Report would essentially be used at the COL stage or beyond

and we have a condition of use to provide equal and you can say treatment for an operating license under operating.

In terms of treatment of the modeling uncertainty, I think NuScale talked about it that there's a section, section 3.8 in the Topical Report which includes a Board discussion of more uncertainty of the need to be considered and disposition.

And we appreciate the discussion because if it doesn't overlook any important piece of the items in the, and based on our review, we determined the need for consistency with established guidance for identification and disposition of key assumptions and sources of uncertainty which is Reg Guide 1, 200 and 1855.

So the Staff has included a corresponding condition of use to achieve that. Next slide. I'm on Slide 28. In terms of the consideration of defense and depth, we find that methodology appropriately identifies the key features that are necessary for doing this defense and depth including SAMGs and then those reaction I went got strategies and flex guidelines.

It is consistent with the PRA policy statement and the certain considerations in 1.174 and it also looks at the five levels of defense and insight

and which adds a level of confidence to the defense and depth evaluation.

The qualitative defense and depth evaluation as part of this method was.

CHAIRMAN REMPE: What flex strategies would be required for, remind me, for NuScale? I mean, are you going to bring in extra water sources or, and if so, to be considered if the connectors are consistent with what's needed for flex strategies?

MR. VASAVADA: Marie, you have any idea? Marie?

MS. POHIDA: We may have to take that back. I can't remember the specific --

MEMBER MARCH-LEUBA: Put your microphone on.

MS. POHIDA: -- strategies used for design certification.

MEMBER MARCH-LEUBA: Can --

CHAIRMAN REMPE: I can't remember either. But it's something I've been thinking about for non-LWRs and what you'd do for flex and that's why when I saw this, it kind of made me wonder. I don't recall us --

MEMBER MARCH-LEUBA: Does NuScale know?

MR. VASADA: I mean, we have, --

MEMBER MARCH-LEUBA: -- you need to find the microphone.

CHAIRMAN REMPE: I'm just curious about flex strategy. Sorry to just talk to the mic, but I'm curious about flex strategies and I can't remember if we talked about flex strategies when we were dealing with the EC review. Did we?

And which ones would you use? The other recommenders?

MS. ENGLISH: We have --

MEMBER MARCH-LEUBA: No, you need to come to microphone here and borrow this.

CHAIRMAN REMPE: So maybe you can come up here.

PARTICIPANT: There on the floor which side I see, indeed. See this mic is all ready.

PARTICIPANT: Just say who you are.

MS. ENGLISH: Hi, this is Liz English from NuScale. The DCA did cover, addressed flex although it's not a requirement of the design certification. But in our Chapter 20 of the DCA, bottom line, is you don't need to implement other than just keeping the pool water adequate.

CHAIRMAN REMPE: So you dump it in a pool? You don't need any connectors in the --

MS. ENGLISH: It's already in the pool.

CHAIRMAN REMPE: Okay. That helps, thank you.

MS. ENGLISH: You're welcome.

DR. BLEY: In that -- this is Dennis. In that whole area, I remember we asked if they would be participating in flex and I don't think we ever got an answer on that from NuScale.

MS. ENGLISH: Right. And I believe that's because it is not the design certification function to look at, I'm not going to say this the right way. Flex is a requirement of the licensee or the license holder and not the design center.

CHAIRMAN REMPE: So when you have this on your slide, you thought about what was going to be dumped into the stint fuel pool is what gave you confidence to say that you considered consideration or are you just are repeating something that was in their Topical Report?

MR. VASAVADA: So yes, we are including something that is in Topical Report, but what we're trying to say is that its own features and operational characteristics considered for a defense and depth evaluation include MGs and flex.

It's not like excluded. It's the entire

plan defense and depth that is considered. That is what we are trying to say.

CHAIRMAN REMPE: Okay.

MR. VASAVADA: Thank you, Liz. I'm going to Slide 29. So I'll talk about the Staff's conditions of use. Based on our review and to ensure that the key importance to the methodology and our findings are addressed by the user of the Topical Report, we included eight conditions of use.

The Slide 29 summarizes them. The exact language is in the safety evaluation. At this point, quickly go through them. So alpha is there to ensure consistency between an operating license under Part 50 and a COL under Part 52.

Currently there's a need to ensure the sense of consistency. Bravo talks about consistency with an NRC guidance for technical acceptability. Charlie is to demonstrate the treatment of key assumption sources of uncertainties consistent with NRC guidance.

Delta and Echo are about making sure that the site, actually the GMRS is bounded by the NuScale's CSDRS. And that the plant level fragility is in fact attuned to the value that was in the DCN that was used for the Staff's evaluation.

And foxtrot talks about the demonstration of both of those items, GMRS and HCLPF plant level for duty at both application and prior dose load so I think that I go and foxtrot together speak to the comment that Member Bley had earlier about having a plant specific demonstration that the assumptions and inputs are actually valid.

Golf talks about the 120 degrees of the 200 REM dose exceedance curve as you remember Elijah talked about and Marie did too, how 0396 states that the consequences of severe accidents degrees substantially.

And she informed the curve is important so golf, make sure that the shape of the curve is not overlooked by either the Applicant or Staff. And hotel is speaking to the principle of the performance monitoring in risk informed decision making so it calls for a periodic evaluation to make sure that like there with HCLPF.

It is indeed what it was at the beginning of the plant's life and that the conclusions from the EPZ sizing methodology conclusion remain valid as the plant changes or changes are made to the plant over the lifetime of the plant.

MEMBER KIRCHNER: Let me explore number

G, golf.

MR. VASAVADA: Okay.

MEMBER KIRCHNER: How do you measure, obviously in 0396 their Appendix I, that curve or that ten miles has a sharp drop off. But as we pull or potentially as the EPZ shrinks, will we see such a steep drop off?

I don't know, have you kind of calculated that out or has the NuScale curves convinced you that we'll see the same thing if the calculations suggest that the 200 REM threshold, I'm just thinking, how do you measure that?

I know what you mean by that versus Appendix I 0396, that curve has a steep fall off. But I think what we're going to see is people are going to use a methodology like this and be pulling in the -- I project that the EPZs will come in.

We saw this with the early site permit work for Clint River, you know, within a mile or so, but what I don't know and maybe you've looked at this with MACCS, do you see that same kind of steep fall off?

Because the general take away from 0396 is and I'll quote, that the EPZ should be a sufficient size to provide substantial reduction in the early other if that's in the event of a more severe Class 9 accident.

Now I think that's what you're getting at, but gee, I'm just curious how you measure that. So you're looking at the shape of a curve or are you looking again at some uncertainty in the shape of a curve or how do you achieve that substantial reduction?

In other words, it's just like the existing dose ends and can see afar 50 and 52. I mean, the idea is not to run up to 25 REM in two hours.

It's to be substantially below so how in your mind do you think there's enough conservatism in the methodology such that the public will be substantially protected by this guidance?

MR. VASAVADA: I think Elijah has his hand up. I'll let him go first and then I can --

MR. DICKSON: Yes, I, this is something of considerable discussion with the Staff. The way it's addressed in 0396 is rather qualitative. Right? That they look at the curve and they see that it drops off quite quickly.

Our, I think our concern was we don't want to see curves that have like sawtooth-type shapes or ones that kind of just asymptotically decrease. We don't want to see curves that may increase.

You know, it's hard to say what the, I use the word measure and I, it's a bit more qualitative

than that. You know? It's hard to perceive what types of curve we would be seeing.

And it, if we don't, it would be a collective Staff decision in regard to whether or not that proposed EPZ would be acceptable if they have something that differs drastically from what you're seeing in 0396.

MEMBER PETTI: So Elijah, the decrease, Appendix I, is that tied to just fall out from a plume?

MR. DICKSON: Yes, it's --

MEMBER PETTI: Yes?

MR. DICKSON: -- for the most parts, it, for the most part, it's the meteorology and the transport calculations that have a fall off that way.

MEMBER BIER: Yes, I have a follow up question on that condition G which is can you talk about which features would potentially lead to an increase or saw-tooth nonmonotonic shape? How would that come about?

MR. DICKSON: I do not know. I do not have an answer for that question.

MEMBER BIER: So for now it's just stated kind of --

MEMBER KIRCHNER: I can give an example I think.

MEMBER BIER: Okay, great.

MEMBER KIRCHNER: In answer to your question. A near, if it really theoretically when you calculate it came in very close, then building wake effects and such will give you a different shaped curve than a traditional plume description.

And so you may have a drop off and then an increase. And then a fall off. Depending how close you are so then using ARCON or something --

MEMBER BIER: Okay.

MEMBER KIRCHNER: -- near end might be an important consideration. I don't know, does MACCS use ARCON for close in distance or I'm trying to remember. Are you just, it's just a classic plume dispersion?

MR. DICKSON: I do believe it's been included now. I think we have one of our MACCS experts, Keith Compton, on the phone on standby. He's here. Keith?

MR. COMPTON: Yes, I, can you hear me?

MR. DICKSON: Yes.

MR. COMPTON: Yes. So yes, just so a few comments. Yes, we have --

MEMBER KIRCHNER: Keith, just identify yourself first please.

MR. COMPTON: I'm sorry. This is Keith

Compton from the Office of Research.

MEMBER KIRCHNER: Okay.

MR. COMPTON: Yes, we have recently upgraded MACCS to improve its near field capabilities and you can include models that are comparable to the ARCON model or to the full reg at 1.145 model at shorter distances.

And that would help you as I believe one of the members mentioned. Yes, if you had, if you had a close-in distance and you had an elevated release or plume rise or something like that, you could actually have low, you know, kind of a low dose close in.

It would rise when you got plume impaction and then it would start dropping so yes, certainly you can have any number of different shapes on that curve.

MEMBER BIER: Yes, the high elevation release is another one that occurred to me. It starts out high with a low dose and it drops eventually, but --

MR. COMPTON: That's right.

MEMBER BIER: Thank you.

MEMBER KIRCHNER: Thank you, Keith.

MR. DICKSON: Any other questions on that?

MEMBER HALNON: On the earlier question on peer review for the PRA and the technical aspect,

did you all have a discuss about what, how far that needs to go and how much it needs to look like the traditional peer reviews?

MR. VASAVADA: I'll, pardon my, what we did on way back along. If you look at OR, a condition of use, bravo, is basically asking for consistency with the established guidance for PR technical acceptability which will include the peer review.

We do recognize that at certain stages in the design, or when this article of methodology is used, not every aspect of the supporting requirements as they are called for the PRS standard can be excused.

For example, operating experience. NSRC does talk about how when the results of seismic tech was of a review being formed by what's called a ISG 028 which talks about making allowances for such cases.

MEMBER HALNON: Okay, --

MR. VASAVADA: There's nothing like --

MEMBER HALNON: -- depending on what stage they're in. Thanks.

MR. VASAVADA: Anything else?

MEMBER KIRCHNER: Marie, I don't want to cut out questions. Can you do your conclusion and then I'll go around? Because we've run --

MR. VASAVADA: No, no, go ahead.

MEMBER KIRCHNER: -- over.

MR. VASAVADA: Okay, no, no, go ahead.

MEMBER KIRCHNER: Okay. If you want to conclude. We've run over a little bit on time.

PARTICIPANT: Walt.

MEMBER KIRCHNER: Thank you. We've gone over a little on time, but that's okay. We're asking questions that we might have asked later. Could you just go through your conclusions and then we'll go around and ask for Member questions.

MR. VASAVADA: Absolutely. So on Slide 30, this provides kind of the overarching conclusions that the Staff primarily Maria, Elijah, and I would support from those acute reach.

We found that the Topical Report methodology is generally consistent with the underlying basis in 0396 and it provides a reasonable assurance that the methodology is adequate for assessing the plume exposure causeway emergency planning zone ties.

Obviously, the applicants have to meet the scope of applicant ready in Section 2.5 which defines the characteristics for the NuScale design and it's definitiveness and the conditions of use in Section 5 of the Staff's safety evaluation.

We also think that the NuScale EPZ TRA is

indeed of this conformed and reflective of the underlying approach in 0396. It meets all of the principles of risk informed decision making either on its own or in conjunction with the Staff's conditions of use.

And I'll end by providing some caveats. I think they're important. Firstly, the methodology and the Staff's findings are applicable only to this TR for EPZ sizing and they do not extend to the design and operation or licensing.

The QHOs are applicable to those and they also do not cover other aspects of emergency planning besides these. On the screen thresholds are only applicable for this particular methodology not for the underlying PR development which needs to follow either endorsed PRA standards or justified alternates.

And finally, the Staff is not making or defining what is meant by credible events or any hazard through the screening thresholds for this particular Topical Report.

That's outside the scope of the Topical Report and we are not making any findings of that. That I'll end and open up for any questions. Thank you.

MEMBER KIRCHNER: So let me turn to Dave

first. Thank you.

MEMBER PETTI: So you know, my sense is that a, this is an incredibly important topic for the advanced reactors -- adding the NuScale. Others are going to look to this.

And it seems like you guys have really broken ground in terms of kind of connecting dots between what was then in 0396, what the intent of 0396 was and how to turn that into something more quantitative for today with today's tools, today's PRA capabilities.

I just think some of these nuggets need to be in guidance somewhere. That the Topical Report is good, as long as you can make sure you don't, you know, touch on proprietary stuff with NuScale.

I think what you guys have done deserves a little bit more elevation in the infrastructure of this. One Member's thoughts.

MR. VASAVADA: Thank you.

MEMBER KIRCHNER: Other Members?

MEMBER DIMITRIJEVIC: Walt?

MEMBER KIRCHNER: Yes, go ahead Vesna.

MEMBER DIMITRIJEVIC: Well I've kept actually too many questions to ask so I decided that are we going to have additional, I was looking at the

schedule, meeting on this because this is before we write the letter.

MEMBER KIRCHNER: So what I would propose here is we still need to allow for public comment. If you have questions, that's good. Hold onto them, Vesna, because I think we would be best served if we go into a closed session and proceed then. Can you hold onto those questions until then?

MEMBER DIMITRIJEVIC: I can hold on actually which I was going to do is actually take some -- because I went through all these documents except that I didn't really went through the NUREG 03, you know, the 396 and see how it complement to the WASH-1400 to see how this all fits together. So I have already the question which starts with this very high-level picture.

And then I was going to devote more time in my own research before I, you know, reduced the questions. So I was just wondering how own schedule. But I will check on that much during the break so

And then I will decide when should I, you know, ask my questions. All right?

DR. BLEY: Well, it's not, Vesna, you're not going to find it on the rainbow chart.

MEMBER KIRCHNER: No.

DR BLEY: It's going to be the next full Committee meeting. There's going to be another --

MEMBER KIRCHNER: In October.

DR. BLEY: Yes, another meeting like this going a little further. Right?

MEMBER DIMITRIJEVIC: Well, yes, I was going to check on the AWS, when do we write letter on this and how --

MEMBER KIRCHNER: It's --

MEMBER DIMITRIJEVIC: -- this will look like.

MEMBER KIRCHNER: -- in the October full Committee meeting. So it would --

MEMBER DIMITRIJEVIC: So that's what it is, okay.

CHAIRMAN REMPE: Vesna, there was supposed to have been an extra meeting on September 1st or 2nd, I forgot which day. And we moved it into this full Committee meeting. Remember?

And we did that because of various reasons, but anyhow, this is what would have been the subcommittee meeting, but always this has been proposed for a topic for October full committee letter writing as indicated on the AWS. Okay?

MEMBER DIMITRIJEVIC: Okay. All right,

it's good to know. Okay, so I will hold on to my questions to then today and then hopefully I can use them myself. All right?

MEMBER KIRCHNER: Okay, thank you. Other members?

CHAIRMAN REMPE: Yes, a couple of things. Maybe the answers are kind of related to this adequacy of the peer review and guidance, but I also believe that this is like a start of something new or you might have a much smaller EPZ.

And so the questions I raise to NuScale are the kind of ones that I am interested in the Staff's thoughts on this because one, to me it seems like the adequacy of the MELCOR model that was used for the design certification is suddenly becoming, the integrity of that model might become more important since you're deciding on whether you need to think about the size of the EPZ.

And so I'm just curious if maybe in that guidance you might say we need to think more carefully in the peer review of what and it's just one Member's comment, but I am interested if you're thinking about that because suddenly if I, this is just a review of the Topical Report, but someone comes in and says, I want to have it to be the plant boundary and follow

EPZ.

So I don't need to worry about any sort of emergency planning and they don't do what is in the NEI report to think about how to expand for emergency planning.

I might have a different view of the this than I do for something that's theoretical. And have you thought about where this is going and maybe this is beyond the scope of your review for the Topical Report, but I'm just a little concerned and I'm curious to hear your thoughts on it.

MR. VASAVADA: Hello, this is Shilp. From my point of view, I think the items that you are talking about they will part of the review somewhere else, maybe in the scope of the SDR or DCA or some other speaker.

And then they'll flow into this Topical Report because I mean, at the end of the day, they have to use the underlying PRA morals which have been record either by the Staff or through the peer review process.

Which in the peer review process and PRA standard, does have specific supporting requirements for the containment and all methodology in the Level I are kind of aspects.

CHAIRMAN REMPE: Okay, we were reviewing this very accident phenomena when we were reviewing

the severe accident phenomena for something that was a very low frequency even though there wasn't a lot of data.

We might have said, okay, it's a low frequency, but now suddenly there's this screening frequency. I've heard you talk about the non-seismic hazards that though a spectrum of events and having a bypass failure for a more severe accident being the dictating.

Well maybe we might have, so maybe we need more integrity in the MELCOR vessel failure model or the containment vessel failure model. And I just am wondering if what we thought was okay for some things if we, in our mind we thought well we'd always have some sort of sight emergency planning in place.

You get where I'm going? I'm sorry if I'm too vague on what I'm trying to say here.

DR. BLEY: Well I think it's, Joy. This is Dennis.

CHAIRMAN REMPE: Yes.

DR. BLEY: This, maybe the Staff will comment on this a little bit. 0396 essentially points to we got to be real careful on things that we think are very low and at least have an idea that we'll be able to reduce the consequences if any of those happen.

And I, from what you folks have said and written, I think that's where you're headed. If there's even a, what appears to be extremely low frequency event, you want to be somehow convinced that it will be possible to take steps immediately following an accident to deal with those and that there's an infrastructure to support that. Is that the reason for --

CHAIRMAN REMPE: Well okay, I look and it's not in the proprietary markings of the Topical Report, but for the more severe accidents, they only considered bypass failures. They didn't and so how big was the release?

Did they really have a severe accident? From what I recall from the DC, no they didn't have the orb out of the vessel into the containment. I just wondering if you, did your spectrum of accidents consider that or was that just below the threshold?

And I again, I know that the containment failure thing was very little data to support that analysis. It was okay for the DC, yes, you're going where I'm going, Dennis, about saying do they still, will they still have the capability and will that still be considered? And it's in the NEI document.

MS. POHIDA: I'd like to take a stab at

that and I recall what you're discussing. Because there was a lot of discussion during design certification of NuScale design regarding issues on in-vessel retention.

So now I would anticipate that those issues would be re-evaluated during, you know, the standard design review.

CHAIRMAN REMPE: Yes, because it's a higher power. I would hope so. But if this, again, when we're doing this, I hope people realize that someday we may need more integrity in the PRA than we need if they're going to say that the emergency planning zone is a site boundary.

MS. POHIDA: Yes, now this is the Topical Report so we're reviewing the process, but when it comes well not logical uncertainties like we're discussing regarding in-vessel retention that were evaluated and designed, you know, in design cert and I anticipate it will be re-evaluated under SDA approval.

They will, they would be considered, they could be potentially considered as sources on certainty. You know, that would have to be re-evaluated in this Topical Report as it impacts the results.

CHAIRMAN REMPE: Yes, the -- again, maybe

the SDA just like the DC would make it through that hoop if we don't consider that there's this, they may not have an emergency planning zone option.

And we might, what I'm wondering is if like Dave was saying, maybe some guidance is needed for accident event selection. Maybe we ought to say that we get, somebody may say I want a 25 mile emergency planning zone or ten mile or whatever.

But maybe that there needs to be some guidance about and you've said that we want a spectrum of events not just cut off frequency and that would be a good way to address what I think is my concern.

And then having a peer review of the phenomena for addressing that concern for this would be something that would help too. But again, maybe that's the ultimate answer is having some sort of guidance document that say there's an additional considerations because if an applicant comes in and says I don't need an emergency planning zone.

Does that make sense and what are your thoughts on something like that?

MR. VASAVADA: This is Shilp. I think we will have to take that back. I mean, the point about guidance, yes, it makes sense, but and we'd have to take that back electively and make a decision of where

we land and how do we need this? I don't think at least I can give you an answer right now.

CHAIRMAN REMPE: It's beyond the scope of this Topical Report although we can say guidance is needed in our letter if that's what the Committee wants.

But I just think that where this is going that the Staff may want to think about it and how to anticipate what could occur for something like this in some cases.

MEMBER PETTI: I still anticipate that the advanced reactors will engineer away the internal events if you will. And that's why the seismic stuff here is so important because it really sort of breaks some new ground and it's going to dominate I think when you look at the advanced reactors.

CHAIRMAN REMPE: But there's always the unknown unknowns and then if you can have a way to say --

MEMBER PETTI: It's like, Joy, but Joy, we're supposed to be risk informed. The unknown unknowns out there at a level, right now, was it forward as a magnitude and frequency between the internal events and the seismic. Okay, we're off.

By a factor of a hundred, by a factor of a thousand and seismic still dominates. And that's

the perspective --

CHAIRMAN REMPE: Right.

MEMBER PETTI: -- that I think we just have to keep in mind.

CHAIRMAN REMPE: And what I believe in analysis that --

MEMBER PETTI: Well we --

CHAIRMAN REMPE: -- but unplanned things happen and then I want to be able to expand.

MEMBER PETTI: But Joy, you can't, you can't in my opinion, you can't, you can't regulate unknown unknowns.

CHAIRMAN REMPE: But you need to have the take that the --

MEMBER PETTI: And it depends on --

CHAIRMAN REMPE: -- NEI said.

MEMBER PETTI: What do you mean, what do you mean, I didn't understand what you meant by the capability to expand.

CHAIRMAN REMPE: That's what's in the NEI documents and the --

MEMBER PETTI: Well, tell me what that means.

CHAIRMAN REMPE: -- Topical Report.

MEMBER PETTI: But I don't understand what

that means.

CHAIRMAN REMPE: Means that you make sure that the outside agencies and that there's some way of path even though you don't have drills, it means you have a path and you've thought about it somehow. What you would do --

MEMBER PETTI: To make sure that, to make sure -- so similar to what we've already been doing.

CHAIRMAN REMPE: Absolutely.

MEMBER PETTI: Okay.

CHAIRMAN REMPE: That's where I'm going.

MEMBER PETTI: I just didn't understand that logic and --

CHAIRMAN REMPE: That's where I'm going and I -- just thinking of the future where it could go. Okay?

MR. VASAVADA: I just wanted to add again --

CHAIRMAN REMPE: Sorry we're arguing.

MEMBER PETTI: No, we're not.

MR. VASAVADA: Because you brought up this, the Topical Report is only for the EPZ sizing and then some EPZ that need to be met after the, after we --

MEMBER DIMITRIJEVIC: Sorry, I cannot hear

you.

MEMBER KIRCHNER: Use your mics please.

CHAIRMAN REMPE: Okay. You'll have to get close to your mic.

MR. VASAVADA: Okay. I just wanted to reiterate that this Topical Report and the slide, on the side this is Shilp Vasavada from the NCR Staff. The Topical Report is only about EPZ size.

CHAIRMAN REMPE: I agree.

MR. VASAVADA: The other elements of EP, emergency planning, are not within the scope. They still have to be met, regulations still have to --

CHAIRMAN REMPE: But right now we're looking at everybody wants to try and reduce what the requirements are and I'm just looking at where it's all kind of coming together and pointing toward that additional review of the phenomena is also one of the things that it falls into that.

DR. SCHULTZ: This is Steve Schultz. The major requirement here is that the applicant has to perform a site specific seismic PRA and use this technical report to perform the evaluation to determine whether they can do anything associated with the emergency planning zone limits.

MR. VASAVADA: Not just seismic. You're

right. But also site specific PRA is part of the --

DR. SCHULTZ: Yes, and it has issues too.

MR. VASAVADA: -- part of the NuScale.

DR. SCHULTZ: But that all has to be done as part of the application.

MR. VASAVADA: Correct.

DR. SCHULTZ: As you indicated in the safety evaluation.

MR. VASAVADA: That's correct and the conditions of use have to be met so an applicant has to demonstrate all of that.

MEMBER KIRCHNER: Other questions? At this point let me take a pause here and turn to the public. This is an opportunity for public comment. If you would like to make a comment, please state your name and make your comment.

And I think for those of you on Teams, just unmute your microphone and for those of like listening in for on the bridge line, I think you have to press star six to unmute.

We have about 15 seconds here for someone to make a comment. I'm not hearing anyone out there. One last time, any public comments? Okay, thank you. At this point, I think we need to take a break.

We have from both the applicant and the

Staff closed presentations. There's none, I don't know if you during the time of the break and organize your questions, but this will give you another opportunity if you have some questions that you would like to ask today before next month when we go to a letter writing exercise.

MEMBER DIMITRIJEVIC: Yes, after I hear --

MEMBER KIRCHNER: So with that --

MEMBER DIMITRIJEVIC: Yes. Right after I hear the new schedule presentation too. Okay?

MEMBER KIRCHNER: Okay. So with that, let us close the open session, take a break for 15 minutes and then come back and we'll be in closed session for those presentations and any final questions. Okay, Larry, yes, I see your hand up. Thank you.

MR. BURKHART: Yes, I just wanted to say that depending on what the Chairman and the Committee decide, the Committee may go into letter report writing and later on and that would be in the public. So we may be back --

MEMBER KIRCHNER: Yes.

MR. BURKHART: -- on this line so I don't know if the Chairman wanted to say anything about that.

CHAIRMAN REMPE: It depends on how long

it takes. I'd rather just hold off if that's okay, Larry.

MR. BURKHART: Oh, it's totally up to the Committee. There is the option of going to report writing if things do --

MEMBER MARCH-LEUBA: Keep it open. Keep the possibility open.

MR. BURKHART: Yes.

CHAIRMAN REMPE: Yes, keep the possibility open.

PARTICIPANT: Keeps us out on that.

CHAIRMAN REMPE: Yes, and just somebody can maybe you could get Quynh to -- or you could put some messages out, Larry.

MR. BURKHART: We can do that. We'll do that.

CHAIRMAN REMPE: Thank you.

MEMBER KIRCHNER: Thank you. We are on recess for the moment.

(Whereupon, the above-entitled matter went off the record at 3:48 p.m.)

Emergency Planning Zone (EPZ)

Licensing Topical Report (LTR) ACRS Subcommittee Meeting

(Open Session)

September 8, 2022

Liz English, Licensing Supervisor
Jeremiah Doyle, EPZ Technical Lead, PRA

Acknowledgement and Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0008928.

Agenda

- Purpose
- Introduction
- Overview of NuScale topical report TR-0915-17772, Revision 3
- Summary

Purpose

- Present content of NuScale topical report TR-0915-17772, Revision 3
- Provide a general understanding of the NuScale method to identify a spectrum of accident sequences and the associated severe accident and dose consequence analyses that form the basis for sizing plume exposure pathway (PEP) emergency planning zones (EPZs) surrounding NuScale plant sites

Introduction

- Topical report provides a method for determining the size of the off-site PEP EPZ surrounding NuScale plant sites
- Applicable to NuScale small module reactor (SMR) designs only
- Consistent with the technical basis in NUREG-0396 and WASH-1400
  - Identifies and evaluates a spectrum of accident sequences and potential releases
  - Satisfies the same dose criteria at and beyond the EPZ boundary to provide an equivalent level of protection to the health and safety of the public
  - Risk-informed, consequence based method based on a combination of quantitative evaluation and qualitative engineering judgement
- Implements state-of-the-art codes and methods established in the 40+ years since the development NUREG-0396 and WASH-1400
- Designed to be self-contained, consistent, and repeatable

Conditions of Applicability

- Applicable to only the NuScale SMR designs
  - small modular integral pressurized light water reactors,
  - operating modules partially immersed in water that serves as the ultimate heat sink (UHS),
  - the UHS is retained below grade in a structure with up to 12 reactor modules per UHS,
  - a safe shutdown earthquake with a peak ground acceleration of 0.5g, and
  - structures, systems, and components (SSCs) capable of performing their safety functions without AC electric power, DC electric power, or operator actions for at least 72 hours following a design basis event.

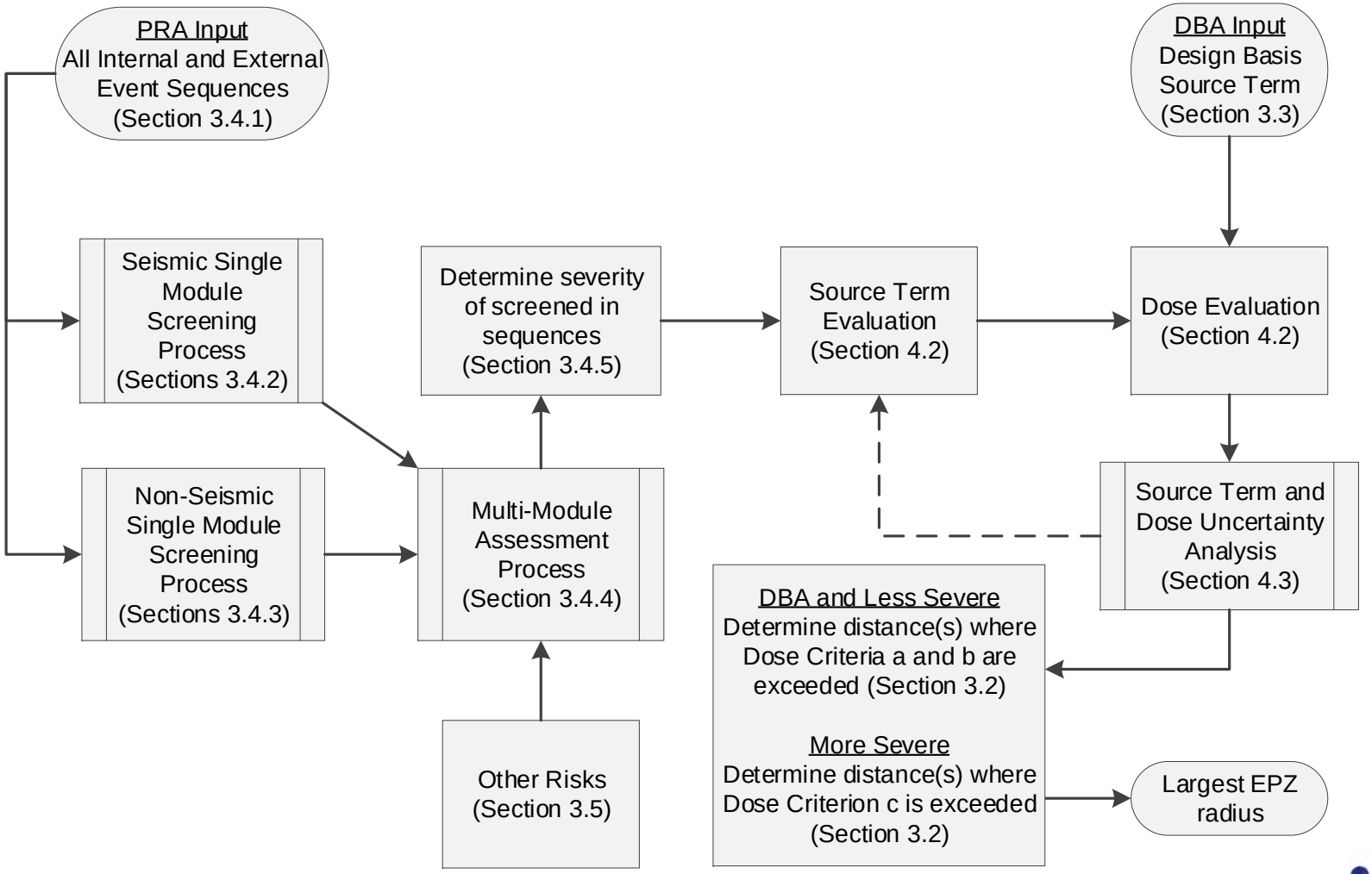
- The following conditions apply to the PRA used in implementing the EPZ methodology:
  - Condition 1: The PRA addresses internal and external hazards and all operating modes
  - Condition 2: The PRA is demonstrated to be technically acceptable for this purpose

Overview of the NuScale EPZ Method

- Quantitative evaluation
  - Identify the spectrum of accidents sequences that form the basis of EPZ sizing
    - Core damage design basis source term (DBST) from final safety analysis report (FSAR) Ch 15
    - Probabilistic risk assessment (PRA) single and multi-module sequences from FSAR Ch 19
    - Other radiological releases outside of the DBST and PRA
  - Identify accident severity
  - Calculate the time-dependent source term to the environment
  - Final EPZ distance is the smallest distance at which all dose criteria are satisfied
    - Criterion a – total effective dose equivalent (TEDE) dose from the DBST ≤ 1 rem mean and 5 rem 95th percentile
    - Criterion b – TEDE dose from less severe accidents ≤ 1 rem mean and 5 rem 95th percentile
    - Criterion c – substantial reduction in early health effects, acute whole body dose from more severe accidents ≤ 200 rem
- Qualitative evaluation
  - Evaluation of plant-level defense-in-depth against INSAG-10 and RG 1.174
  - Review and disposition of key assumptions and uncertainties in the underlying PRA

Basis: NUREG-0396
RG-1.174

Overview of the NuScale EPZ Method Quantitative Evaluation



Spectrum of Accidents

- Design basis source term (DBST) from FSAR Ch 15
- Severe accidents from the site and design-specific PRA
  - Identify non-seismic single module and multi-module sequences with core damage frequency (CDF) ≥ 1E-07 per year
    - Screening at 1E-07 captures a spectrum of accidents with similar frequencies to the EPZ basis in NUREG-0396
    - Use of CDF as the screening mechanism conservatively ignores the conditional probability of radionuclide release
  - Non-seismic sequence uncertainty against screening threshold considered consistent with NUREG-1855
    - Retain sequences with point-estimate CDF > 1E-08 and 95th percentile CDF > 1E-07
    - Ensures cliff-edge sequences are captured in the spectrum of accident sequences
- Other releases – potential radionuclide releases not captured by the DBST and PRA
  - For example: spent fuel pool risks or mechanical damage to the fuel
  - One of the following criteria are met
    - The release meets the dose-based criteria for the appropriate accident severity
    - The consequences of the release are bounded by the DBST and screened-in PRA sequences
- Accident severity
  - Intact containment accidents are less severe
  - Containment failure or bypass accidents are more severe

Basis: NUREG-0396
WASH-1400
NUREG-1855

Off-site Dose Consequences

- Dose criteria provide level of protection to the public that meets or exceed the basis in NUREG-0396
  - Criterion a – total effective dose equivalent (TEDE) dose from the DBST ≤ 1 rem mean and 5 rem 95th percentile
  - Criterion b – TEDE dose from less severe accidents ≤ 1 rem mean and 5 rem 95th percentile
  - Criterion c – substantial reduction in early health effects, acute whole body dose from more severe accidents ≤ 200 rem
- Modeling of dose receptors consistent with the NUREG-0396 basis
  - Stationary individual located:
    - outdoors
    - in the azimuthal direction of maximum exposure
    - at and beyond the site boundary distance
  - No sheltering, relocation, or evacuation
  - Cloudshine, groundshine, inhalation, resuspension inhalation, and skin deposition dose pathways
    - No shielding from cloudshine, inhalation, and skin deposition
    - Natural groundshine shielding due to variations in terrain
  - 96 hour exposure for TEDE, 24 hour exposure for acute red marrow
  - Parametric evaluation of uncertainty in source term and dose calculations

Basis: NUREG-0396

Defense-in-Depth Evaluation and Review of PRA Uncertainties

- Defense-in-depth evaluation using the guidance in INSAG-10 and RG 1.174
  - Highlight design features and SSCs available to prevent and mitigate the consequences of postulated accidents
  - Confirms the existence, functionality, and capability of features and strategies to provide confidence in the acceptably low plant risk and demonstrate protection of the health and safety of the public
- Review of PRA Uncertainties
  - Complete a review of the assumptions and sources of uncertainty in the underlying PRA to identify and address any potential impact to EPZ sizing
    - Key assumptions in the PRA
    - Model uncertainty
    - Completeness uncertainty

Basis: RG 1.174

Summary

- Topical report provides a method for determining PEP EPZs surrounding NuScale plant sites consistent with the EPZ technical basis in NUREG-0396 and WASH-1400
- Provides a level of protection to the public that meets or exceeds the NUREG-0396 EPZ basis
- Applicable to NuScale SMR designs only

Acronyms

CDF	core damage frequency
DBST	design basis source term
EPZ	emergency planning zone
FSAR	final safety analysis report
LTR	licensing topical report
PEP	plume exposure pathway
PRA	probabilistic risk assessment
RAI	request for additional information
SMR	small modular reactor
SSC	structures, systems, and components
TEDE	total effective dose equivalent
UHS	ultimate heat sink

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Staff Presentation to the ACRS Sub-Committee

NuScale Licensing Topical Report Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones at NuScale Small Modular Reactor Plant Sites (TR-0915-17772, Revision 3)

Open Session

SEPTEMBER 8, 2022

Topical Report Review Chronology

- NuScale submitted topical report TR-0915-17772, Revision 2, “Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones,” on August 4, 2020
- NRC issued requests for additional information (RAIs) 9828 and 9830 in April 2021
- Initially, TR was applicable to light-water small modular reactors (SMRs) and non-light water reactors (non-LWRs). In May 2021, in response to RAI 9830, NuScale removed applicability to non-LWRs.
- NRC performed a regulatory audit as part of its review of the methodology in Revision 2, from November 2021 to April 2022
- NuScale provided response to RAI 9828 and submitted Revision 3 of the TR on June 10, 2022, titled “Methodology for Establishing the Technical Basis for Plume Exposure Emergency Planning Zones at NuScale Small Modular Reactor Plant Sites,” applicable only to the NuScale design and its derivatives and incorporating the RAI responses
- NRC issued the advanced safety evaluation on August 8, 2022

NRC Staff

Reviewers:

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Outline

- Regulatory and technical basis for staff's evaluation
- Overview of TR methodology
- Dose-distance criteria and figures-of-merit (FoMs)
- Source term and consequence assessment
- Screening of Probabilistic Risk Assessment (PRA) sequences
- Treatment of uncertainty
- Conditions of use

Regulatory and Technical Basis for Staff's Evaluation

10 CFR 50.47, Appendix E to Part 50, 10 CFR Part 20

NUREG-0396 (1978)

Probabilistic Risk Assessment (PRA) Policy Statement
SRM-SECY-98-144
RG 1.174
RG 1.200

NUREG-0396 (1978)

- Identifies the purpose of the EPZ
  - Area within which prompt protective actions may be necessary to provide dose savings in the event of a radiological release
- Technical basis for current prescribed plume exposure pathway EPZ radius of 10 miles
- Based on a review of licensed design-basis events and a spectrum of accident sequences from WASH-1400

Staff's Method of Review

- Consistent with technical basis in NUREG-0396
- Consistent with risk-informed decision making and use of PRA in risk-informed applications
- Supported by regulatory audit
  - Included example calculations implementing nearly entire methodology

Staff's Review of Applicability of NuScale's EPZ TR Methodology

- Only applicable to NuScale design and its derivatives, including Standard Design Approval
- TR Section 2.5.1 provides high-level design characteristics that determine applicability
  - All characteristics must be met
- Applicability limitations are acceptable
  - High-level design characteristics capable of identifying NuScale designs with the features and risk profile considered by the staff in its review

Staff's Review Approach for Dose-Distance Criteria and FoMs

- Considered recent research efforts to re-assess current 10-mile EPZ technical bases in NUREG-0396
- Considered updated information from guidance, methods, models, and analytical tools
- Assessed TR methodology consistency with analyses, assumptions and considerations of NUREG-0396 and current information
- Important topic areas:
  - Radiological consequence assessment modeling approaches
  - Dosimetric criteria and dose-distance curves
  - Considerations derived from assessments

Dose-Distance Criteria and FoMs[1]

Criterion	Description	Source Term	Figure of Merit and Acceptance Criteria
a	Encompass those areas in which projected dose from DBAs could exceed the early phase PAGs	NUREG-0800 Chapter 15 analysis	1 rem and 5 rem TEDE over 96 hours, **consistent with the EPA PAG Manual early phase PAGs**
b	Encompass those areas in which consequences of less severe accident (containment intact) sequences could exceed the early phase PAGs	PRA-specific accident sequences with MELCOR analyses utilizing mitigation design features and operator actions	1 rem and 5 rem TEDE over 96 hours, **consistent with the EPA PAG Manual early phase PAGs**
c	Sufficient size to provide for substantial reduction in early severe health effects in the event of more severe accident sequences	PRA-specific accident sequences with MELCOR analyses and separate effects models utilizing additional mitigation design features and operator actions	200 rem red marrow dose, within 24 hours, is less than the TR specified acceptance criteria, **consistent with NUREG-0396**

1 – See staff report, *Use of MACCS Dose Coefficient Files to Compute Total Effective Dose Equivalent*, which provides information on how to compute TEDE and red marrow FOMs using the MACCS computer code. (ADAMS Accession No. ML21211A584)

Staff's Review of Source Term and Radiological Consequence Analysis

- For source term and radiological consequence analyses, the TR:
  - Recommends computational codes such as MELCOR and RELAP to develop design-specific source terms
  - Requires the MACCS code to perform radiological consequence analyses
- The staff finds these computer codes to be appropriate to perform these analyses

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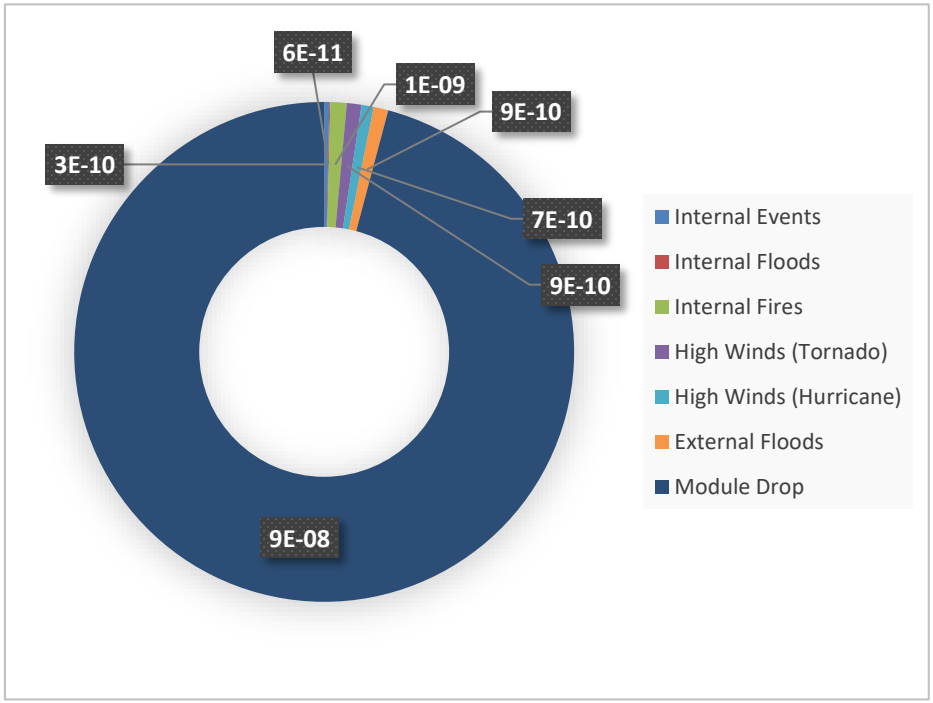
Fundamentals of Event Selection for EPZ Sizing Consistent with NUREG-0396

- Spectrum of accidents ≠ licensing and design against QHOs
- Spectrum of accidents for EPZ sizing includes characteristics of radiological consequences from DBAs and BDBAs
  - Includes some of the key characteristics of more severe accidents (with large releases)
  - Ensures capability to reduce early severe health effects (injuries or deaths) in the event of the most severe BDBAs
- Selection of spectrum of accidents for EPZ sizing does not alter the design or operation

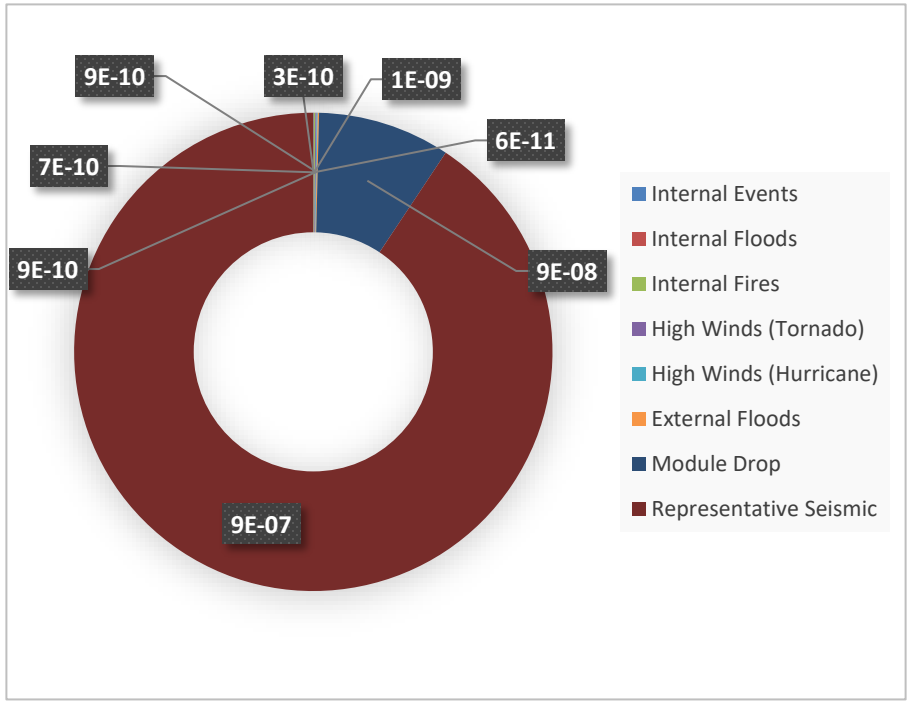
Fundamentals of Event Selection for EPZ Sizing Consistent with NUREG-0396 (cont'd)

- Purpose of EPZ is dose savings and not dose avoidance
  - NUREG 0396: "…while the EPZ should not be solely dependent on the most severe and most improbable BDBEs, the determination of the EPZ size needs to include some of the key characteristics of very large releases."
- Seismic risk expected to dominate NuScale risk profile and EPZ sizing
  - Design reduces the risk from internal events
  - Timing of seismically-initiated sequences different compared to non-seismic events
  - Inclusion in spectrum of accidents maintains consistency with NUREG-0396

Seismic Risk – Potential Dominant Contributor for the NuScale Design



NuScale Core Damage Frequency (per year) Profile Without Seismic Contribution



Estimated NuScale Core Damage Frequency (per year) Profile for Site Within NuScale Certified Design Response Spectrum

Staff Review of Non-Seismic Single Module Sequence Screening

- TR sequence screening of 1E-7 per reactor year CDF would have screened in all the WASH-1400 release sequences
  - None of these release sequences had a frequency less than 1E-7 per reactor year

Staff Review of Consideration of Multi-Module Impacts for Non-Seismic Hazards

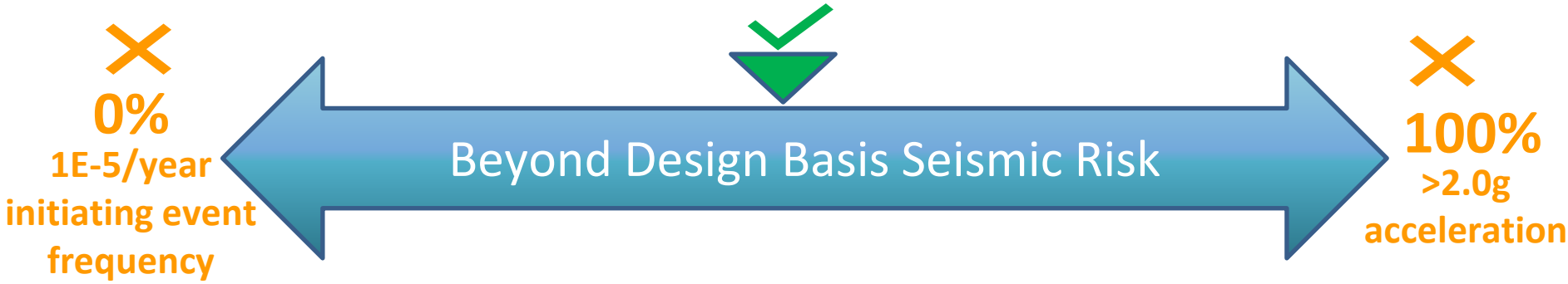
- WASH 1400 did not explicitly model “common mode mechanisms” such as fire, flood, and tornadoes (which have the potential to impact multiple modules) in the event trees and fault trees
- Appendix IV of WASH 1400: “common mode mechanisms” were assessed as impacts on the system fault trees
- Core damage sequence screening of 1E-7 per reactor year was also applied to multi-module core damage sequences
  - None of WASH 1400 release sequences had a frequency less than 1E-7 per reactor year

Staff Review of Screening Threshold for Seismic Hazard in TR, Revision 2

- Proposed threshold was 1E-5 per year initiating event frequency
- Proposed threshold did not provide spectrum of accidents consistent with NUREG-0396
  - Negligible beyond design basis seismic risk
  - Excluded key characteristics of more severe seismic accidents
  - Risk gap in EPZ sizing insights
- Proposed threshold was inconsistent with technical basis in NUREG-0396 and consideration of seismic events in WASH-1400

Staff Review of Screening Threshold for Seismic Hazard in TR, Revision 3

- TR identified a proprietary screening threshold for seismic hazard
- "Risk gap" approach developed by staff for evaluation
  - Determine appropriateness of screening threshold for seismic hazard consistent with basis in NUREG-0396



Staff Review of Screening Threshold for Seismic Hazard in TR, Revision 3 (cont'd)

- Overview of "risk gap" approach
  - Step 1: Collect ensemble of hazard curves representing different sites within the certified seismic design response spectrum
  - Step 2: Identify plant-level fragility and spectral ratios
  - Step 3: Convolve hazard curves with plant-level fragility
  - Step 4: Calculate simple average absolute and relative "risk gap" below screening threshold value

Staff Review of Screening Threshold for Seismic Hazard in TR, Revision 3 (cont'd)

- Staff evaluation used "risk gap" approach with 9 operating reactor sites
  - Within NuScale Certified Seismic Design Response Spectra
  - Using NuScale high confidence of low probability of failure (HCLPF) plant-level fragility
  - Threshold captures 20% – 50% of seismic risk for the NuScale design across majority of 9 sites

Staff Review of Screening Threshold for Seismic Hazard in TR, Revision 3 (cont'd)

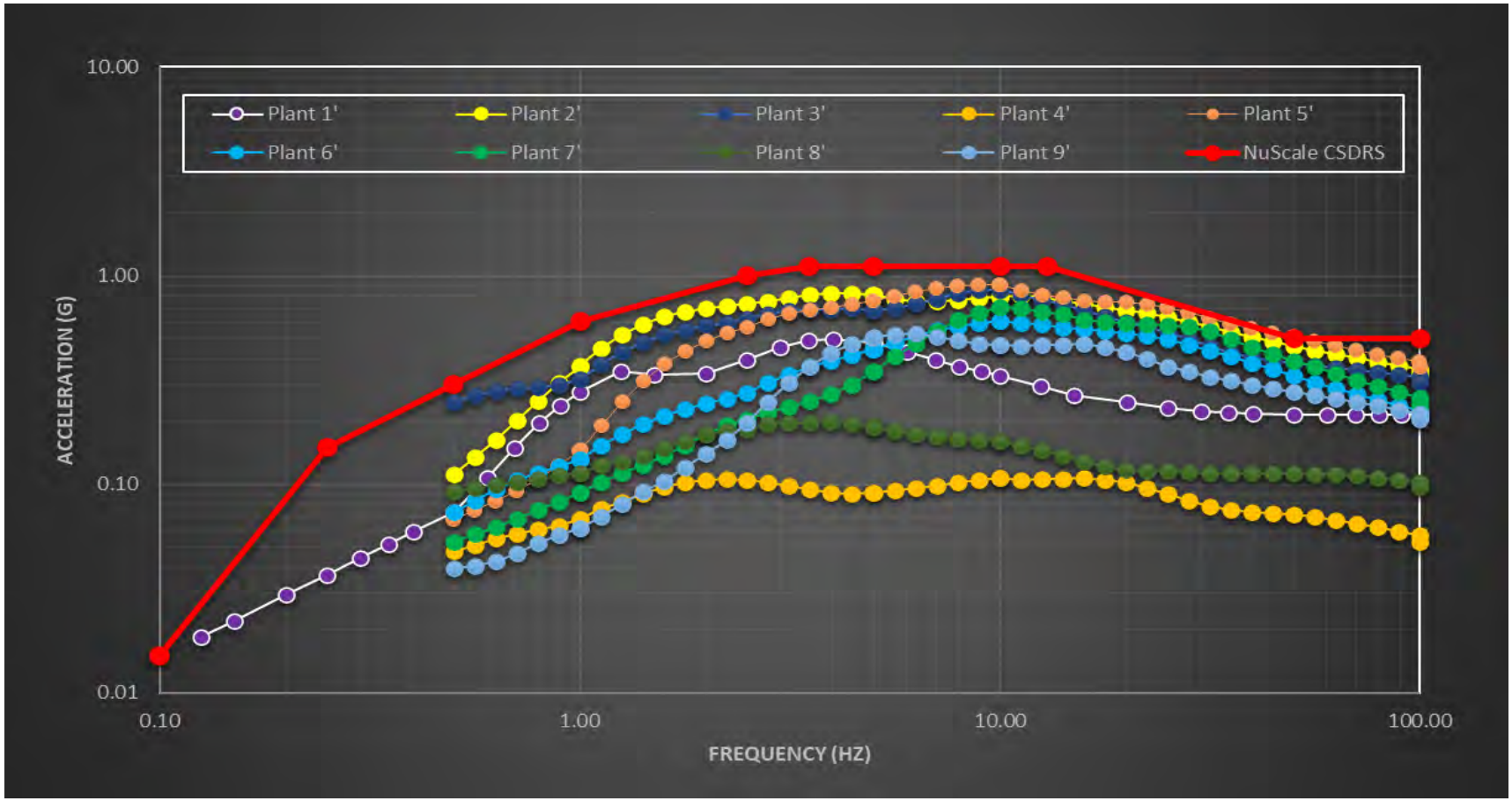


Figure 1 in NRC staff's safety evaluation (ML22118A760)

Staff Review of Screening Threshold for Seismic Hazard in TR, Revision 3 (cont'd)

- Achieves consistency with NUREG-0396 and WASH-1400 for seismic events
  - Results in a complete spectrum of accidents
  - Avoids extremely unlikely seismic accelerations
  - Does not 'penalize' NuScale for its risk profile
- Addresses multi-module risk (details in subsequent slide)
- Uses quantified seismic sequences because they can be dominant contributor to plant risk and EPZ sizing

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Technology-Inclusive Applicability of "Risk Gap" Approach for Risk-Informed EPZ Sizing

- Provides design- and site-specific screening threshold value(s) consistent with technical basis in NUREG-0396
  - Single value across technologies and sites is difficult to defend
- Uses accessible design-specific information
- Compatible with risk metrics other than CDF or LERF
- This approach provides regulatory stability

Staff Review of Treatment of Uncertainty in Screening Threshold for Seismic Hazard

- Sufficient to identify new insights
  - Addresses uncertainty in context of identification of spectrum of accidents for EPZ sizing
  - Addresses potential for cliff edge effect (i.e., large change in EPZ size decision with small change in event screening)
- New sequences included in remaining steps of methodology

Staff Review of Consideration of Multi-Module Impacts for Seismic Hazard

- Methodology appropriately identifies and includes multi-module impacts from seismic events
- Considerations in staff evaluation:
  - Seismic events are a common-mode initiator
  - Screening threshold results in inclusion of accelerations with potential multi-module impacts
  - Dominant contributors to NuScale's seismic large release frequency impact multiple modules
  - Impact of multi-module sequences reflected in source term for those sequences

Information at Various Licensing Stages Under 10 CFR 52

Part 52:	PRA Based Seismic Margins Analysis (SMA) **Allowed**	PRA Based SMA **Allowed**	Site-Specific Seismic PRA
EPZ TR:	Not Applicable	**Site-Specific Seismic PRA**	Site-Specific Seismic PRA

Staff's Review of Treatment of Modeling Uncertainty for Seismic and Non-Seismic Hazards and Staff Review

- TR contains broad discussion of consideration of assumptions and sources of uncertainty in the underlying PRA
- Staff determined that consistency with established guidance applied for voluntary risk-informed applications is important
  - RG 1.200, Revision 3 and NUREG-1855, Revision 1
- Includes a corresponding Condition of Use

Staff Review of Consideration of Defense-In-Depth

- Methodology identifies key plant design and operational characteristics necessary for achieving defense-in-depth
  - Includes consideration of severe accident management strategies and diverse and flexible coping strategies
- Consistent with PRA Policy Statement and RG 1.174, Revision 3
- Five levels of defense in INSAG-10 adds confidence in consideration of defense-in-depth

Staff's Conditions of Use

- Ensure user addresses key inputs for methodology and staff findings
- Eight (8) conditions of use:
  - A. Consistency in use between applicant for operating license application under Part 50 and COL under Part 52
  - B. Consistency of PRA technical acceptability with established guidance
  - C. Treatment of PRA key assumptions and sources of uncertainty consistent with established guidance
  - D. Limit seismic event screening threshold to sites with GMRS bounded by NuScale's CSDRS
  - E. Limit seismic event screening threshold to NuScale's HCLPF plant-level fragility
  - F. Demonstration of GMRS and HCLPF plant-level fragility at application and prior to fuel-load
  - G. Monotonic decrease of 200 rem dose exceedance curve
  - H. Periodic evaluation to ensure (1) E is met AND (2) conclusion on EPZ size remain valid. Periodicity consistent with 10 CFR 50.71(h)(2)

Staff's Conclusion

- TR methodology is generally consistent with technical basis of current 10-mile EPZ prescribed in 10 CFR 50.47 (i.e., NUREG-0396)
- Reasonable assurance that methodology is adequate for assessing plume exposure pathway EPZ sizing
- Applicants using the methodology as the technical basis for assessing plume exposure pathway EPZ sizing need to meet :
  - Scope of applicability in Section 2.5 of the TR
  - Conditions of Use listed in Section 5.0 of staff's SE

Staff's Conclusion (cont'd)

- NuScale EPZ TR is risk-informed and reflective of NUREG-0396 approach
  - Uses risk information from design- and site-specific PRAs, with explicit consideration of uncertainty
  - Explicitly addresses defense-in-depth
  - Staff evaluated impact on safety margins
  - Includes performance monitoring (based on corresponding Condition of Use)

Caveats on Scope of Staff's Findings

- Only applicable to this TR for EPZ sizing
  - Not extended to design and operation for licensing
  - Quantitative Health Objectives applicable for design and operation for licensing
- Screening threshold, especially for the seismic hazard, not applicable to PRA development
  - Follow applicable endorsed PRA Standard
- Does not define "credible" events for any hazard

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Acronyms

BDBA/E	beyond design basis accident/event
CDF	core damage frequency
CSDRS	certified seismic design response spectrum
DBA	design basis accident
EPZ	emergency planning zone
GMRS	ground motion response spectrum
HCLPF	high confidence of low probability of failure
LERF	large early release frequency
LRF	large release frequency
LWR	light water reactor
Non-LWR	non-light water reactor
ONT	other nuclear technology
PRA	probabilistic risk assessment
QHO	quantitative health objective
RG	regulatory guide
SMR	small modular reactor
WASH-1400	Nuclear Regulatory Commission Reactor Safety Study, 1975

References

10 CFR 50.47 “Emergency Plans”

10 CFR Part 50 Appendix E “Emergency Planning and Preparedness”

10 CFR Part 20 “Standards for Protection Against Radiation”

NUREG-0396, “*Planning Basis For The Development Of State And Local Government Radiological Emergency Response Plans In Support Of Light Water Nuclear Power Plants*” (ML051390356)

Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory, 60 FR 42622

SRM-SECY 98-144, “*White Paper Risk Informed and Performance-Based Regulation*” (ML003753601)

Regulatory Guide (RG) 1.174, “*An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*,” Revision 3 (ML17317A256)

RG 1.200, “*Acceptability of Probabilistic Risk Assessment Results for Risk-Informed Activities,*” Revision 3 (ML20238B871)