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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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SUBCOMMITTEE ON ACCIDENT ANALYSIS AND

THERMAL HYDRAULICS

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THURSDAY

JUNE 22, 2023

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The Subcommittee met via Teleconference, at 1:30 p.m. EDT, Jose A. March-Leuba, Chair, presiding.

COMMITTEE MEMBERS:

JOSE A. MARCH-LEUBA, Chair

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VICKI M. BIER, Member

CHARLES H. BROWN, JR., Member

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MATTHEW W. SUNSERI, Member

ACRS CONSULTANT:

STEPHEN SCHULTZ

DESIGNATED FEDERAL OFFICIAL:

KENT HOWARD

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

1:31 p.m.

CHAIR MARCH-LEUBA: The meeting will now come to order. This is a meeting of the Accident Analysis Thermal Hydraulics Committee. I am Jose March-Leuba, the SC Chairman. In addition to in-person attendance at the NRC headquarters, the meeting is broadcasted via MS Teams.

Members in attendance are Ron Ballinger, Vicki Bier, Vesna Dimitrijevic, Greg Halnon, Bob Martin, Matt Sunseri, and Charles Brown will be joining us shortly. Our consultant is Steve Schultz. He's also present.

Today, we are reviewing Framatome topical report ANP-10339P entitled ARITA, ARTEMIS/RELAP integrated transient analysis methodology. This report describes a new statistical methodology Framatome has developed for analyzing most transients in pressurized water reactors.

This is a comprehensive methodology update that require a very thorough safety evaluation and final report by the staff. I am looking forward to seeing the details from the topics today.

Portions of our meeting will be closed to

the public to protect Framatome proprietary information.

We have not received requests to provide comments, but we have an opportunity for public comments before the beginning of the closed session of the meeting.

The ACRS was established via statute and is governed by the Federal Advisory Committee Act, FACA. As such, the committee only speaks through its published letter reports. The rules for participation in all ACRS meetings were announced in the Federal Register on June 13, 2019.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, agendas, reports, and full transcripts for the open portions of all full and subcommittee meetings, including the slides presented there.

The designated federal official today is Kent Howard.

A transcript of the meeting is being kept. Therefore, speak into the microphones clearly and state your name for the benefit of the court recorder. And if you're in a conference room with multiple people on the line, it includes the people in this room, please remember to identify yourself regularly

for the accuracy of the transcript.

Please keep all of your electronics and microphones on mute when not in use.

Gregory Suber of the staff will present some introductory remarks. Greg?

MR. SUBER: Good afternoon. My name is Gregory Suber and I am the deputy director of the --

(Audio interference.)

MR. SUBER: -- for this opportunity for the staff to present its draft safety evaluation for the Framatome ARITA topical report.

The staff will present their review of important technical issues, findings, conclusions, and limitations and conditions regarding ARITA. This effort is the culmination of a significant amount of work over the past four years.

We would like to express appreciation and commend Framatome on its efforts to work with the staff in resolving a significant number of technical issues during numerous meetings, audits, and other interactions.

The staff is approving the ARITA statistical methodology that has been used to evaluate SRP Chapter 15 non-LOCA events, including departure from nucleate boiling, fuel centerline melt, transient

cladding strain, and primary and secondary system pressure.

Framatome has indicated that they have several customers who are ready to use ARITA and the NRC staff expects to conclude their review very shortly and issue a final SE, and we will hear more of the interactions that we had with Framatome while the staff does their presentation.

And with that, I'll turn the presentation over to Framatome if they have any opening remarks.

CHAIR MARCH-LEUBA: Great, thanks, Greg. So, we are now ready for the presentation. Alan Meginnis of Framatome will present some opening remarks and introduce the Framatome presenters.

Remember that this is the open section of the meeting, which means the need for proprietary information should be disclosed in the closed section. So, Alan, just stay on the green light and talk loudly.

MR. MEGINNIS: Okay, hi, I'm Alan Meginnis, licensing manager for Framatome. Actually, our vice president of fuel design, Steven Lydzinski, is here today to provide opening remarks, but I wanted to just give a special thanks to the ACRS.

I know that you guys juggled the schedule

at the last minute when we ran into some issues and got us into this meeting --

(Audio interference.)

CHAIR MARCH-LEUBA: Thank you. Take over.

MR. LYDZINSKI: My name is Steven Lydzinski. I'm the fuel engineering vice president at Framatome. Good afternoon and welcome to all of those attending our discussion today on Framatome's topical report ANP-10339, the ARTEMIS/RELAP integrated transient analysis methodology commonly referred to as ARITA.

Framatome's objection is to get innovation and improved performance methods to the industry. The ARCADIA, COBRA-FLX, and GALILEO codes were submitted and approved in the early 2010s, all of which have been thoroughly benchmarked and validated.

ARITA demonstrates the value of coupling these codes, proven transient simulator RELAP, and the methodology that establishes improved confidence in the fidelity of results that our customers can apply to demonstrate compliance with all safety regulations and requirements.

ARITA was created by a team of global Framatome experts and dedicated staff that applied decades of industry experience. Improvements in

modeling capabilities and advances in safety analysis benchmarked the industry test data.

It was submitted for review in 2018 and has undergone extensive NRC review. To date, there were 19 audits and meetings conducted by the staff, 92 requests for additional information, and over 1,000 pages of additional information provided by Framatome that supports the submitted topical.

Technical support for the staff's review provided by a multi-discipline expert team at PNNL was also part of the original review plan. This was seen by Framatome as a positive recognition by the NRC to supplement their skills with industry experts.

Over the last two years, PNNL contributors have not been active in our discussions and it's not quite clear how the PNNL review factored into the final safety evaluation.

As the industry moves forward to embrace improvements in modeling capabilities and computing capabilities, it's prudent to carefully consider the appropriate level and sources of conservatism. Furthermore, it is vital to establish the appropriate level of reasonable assurance of adequate protection.

While it may be easy to add additional layers of conservatism in reaction to new approaches,

the benefits of advanced modeling approaches can quickly be lost to the industry and the level of assurance moves from reasonable assurance to absolutely assurance, which is clearly not in the line with the Commission's policy.

Throughout the review cycle, there have been multiple exchanges with the NRC staff that have resulted in many limitations and conditions that further increased the level of conservatism, that Framatome considers that many of the 28 limitations and conditions go beyond reasonable assurance of adequate protection.

For example, limitation and condition 18 and 19 require that an uncertainty be applied that is two times the bounding value proposed by Framatome. We must accept them at this time to advance the industry forward and we will be evaluating the need for a topical report supplement in the future.

Framatome is fully committed to the nuclear industry and has continued to invest in the development of our people and our technology. We appreciate your time and welcome your questions, your feedback, and your insights throughout this meeting. Thank you.

CHAIR MARCH-LEUBA: Will you go ahead and

introduce your presenters?

MR. LYDZINSKI: Yes, joining me here today we have Keith Maupin, one of the lead developers through the methodology, and Mr. Buck Barner, who was also one of the main contributors through the development of the methodology. If you don't mind, thank you very much.

CHAIR MARCH-LEUBA: And a reminder, just so the court recorder recognizes your voice, say your name at the beginning.

MR. BARNER: Thank you. This is Buck Barner. I'm excited to be here today. I appreciate everyone's time and willingness to be here as Alan mentioned earlier, so I'm excited to share this with everybody. It's a great step forward for us and I look forward to presenting what we have here today.

If we go onto the next slide, for this open session, just a quick overview of the agenda. We'll do an overview at high level of what the topical is, some background and history, the approval request and the range of applicability of the topical, a few key areas of interest, and end up with the summary.

So, what is ARITA? We already talked about it, the ARTEMIS/RELAP integrated transient analysis methodology. This defines a method for non-

LOCA safety analysis for Chapter 15 events. It does use a non-parametric statistical approach. Through that, it makes a statistical statement for multiple failures and merits, and using one of (audio interference) approach to do that.

Through this process, we used SRP Chapter 15.0.2 guidance to develop this methodology and to develop our evaluation models. That provided the framework for the topical and how everything was developed inside of there.

In addition to base topical that has the Chapter 15 events, there are several other aspects that are included in the topical, including mixed core evaluations, power distribution control, set points analysis to support the set points that remain outside of the scope of typical non-LOCA methodology, and fuel assembly reconstitution.

Just note that this does not include the Chapter 15 control rod ejection analysis. This is in a separate topical under AREA which has already been approved.

CHAIR MARCH-LEUBA: ACRS has the custom of interrupting you often and early, so let me ask a question. When I look at ARITA, I see similarities with the CSAU, code scaling, applicability, and

uncertainty analysis that has been in place since the '80s. What are the main differences, if any? Do you see the same similarities I do?

MR. BARNER: Yeah, so there are similarities between them. I think we did use a different approach to it. There are pieces to it. We do not follow that exact process, but there are aspects to it that are built into this.

Because of the amount of data available to us, there are some other different key pieces of that I think you'll see throughout the presentation. I don't know if, Keith, if there's anything you would like to add to that?

MR. MAUPIN: Yeah, this is Keith Maupin. The question may be touching on the CSAU and the relationship to the Reg Guide 1.236 and the way LOCA methodologies tend to build their evaluation models.

We definitely were aware of 1.236 as we built this, but we felt like Chapter 15.0.2 was a set of guidance that we were more equipped to use. So, we don't have some of the test data that LOCA would have to do separated effects testing on various phenomena for non-LOCA application.

So, yeah, there are a number of similarities to it. We, in fact, consulted many of

the practices that are involved in that CSAU work.

CHAIR MARCH-LEUBA: My point on bringing it is that this is not a new methodology. You are not breaking group with a theory. It's basically we've been applying this for 40 years, well, 30, so you're just massaging and correcting a little bit here and there, but basically it's nothing extraordinary, right?

MR. MAUPIN: Yeah, I agree with most of that. I think that I would say that what's really new here with respect to the methodologies we've had in the past is that we're replacing a point model representation of the core during transient analysis with a full 3D core and that's the big difference that we're introducing with this. Sorry, and this was Keith again just in case.

CHAIR MARCH-LEUBA: And for those in the room here, we're having a problem with the mouse, with the way it keeps popping up. All right, so let's start with the presentation. We have only one afternoon to go through 100,000 slides, so go for it.

MR. BARNER: I'll go faster. Just a quick background and history, so at Framatome, we started about the 2006 time frame is when we really began our internal development on the new sets of codes and

methods. We talked about ARCADIA, and COBRA-FLX, and GALILEO as our advanced codes that started this effort, so around that time frame is when we started.

At the same time within history, around the 2010 time frame is when there was an industry push to replace those legacy codes and methods, so that was a fortuitous time for us both in the industry and internally to be working on this.

And with those two things going on, with those motivations, our goal was to develop new methodologies using our state-of-the-art modeling, using our global expertise, and provide a simplification of our topical reports that removed all of the smaller topical reports and made one consistent topical report. Ultimately, this was to facilitate our future development and be able to prepare ourselves for the future of the industry.

Just noting the AREA has been approved and is using a very similar evaluation model, so as you said, that's not particularly new here, so it is something that's been seen before, but ARITA does ultimately represent that final realization of the use of our advanced codes and methods, and our commitment to the industry to transition away from our legacy codes and methods and provide our advanced codes and

methods.

(Simultaneous speaking.)

MR. BARNER: So, again, what's the advantage of that? What advantage does that provide to the industry? Through this better modeling, we actually understand our plant behavior and understand our responses and our safety margins better than we have in the past.

So, this is value that we previously had unavailable to us and we're hoping this opens up new opportunities to the industry to use this value in ways that we were unable to do in the past without impacting the underlying safety margins, but better understanding them.

So, this has allowed us to address things like regulatory changes, Reg Guide 1.236, or any other future regulatory changes that may be coming, allows for increasing operating margins, power uprates, things like core design authorization.

We're no longer having to design cores to deal with conservatisms that were just part of the method. We can optimize our core designs and things like load follow, and looking forward to things like advanced fuel management with increased directional burn.

And so, really, none of these things are one piece in themselves, but it's really what's most important to the industry, what's most important to the utility, and how we like to use this value that allows us flexibility and options going forward.

So, really it's that higher fidelity simulation that provides that understanding and removes those excessive conservatisms that were built into simplifying assumptions that allow us to provide this value.

So, speaking of AFM, I believe the ACRS has probably seen this slide before in the past, but just looking forward to the future, if you look here, there are some blue boxes and green boxes. Green boxes are what we consider part of our advanced codes and methods package and the blue boxes are what we have as far as our existing methods.

So, as you see in the green boxes, we talked about the previous codes with ARCADIA, GALILEO, and COBRA-FLX, and now we have AREA, and ARITA over there in yellow as the final unapproved piece of this package, but with ARITA now, we have all of the final building blocks of that foundation we need to move forward with our AFM initiatives.

Just a little brief history and timeline.

So, we started having pre-submittals as early in February of 2015 that resulted in the topical being submitted in August of 2018.

Since August of 2018, there's been a lot of interaction with the NRC through RAIs, additional audits, meetings. We provided responses to the, initial responses to all 92 RAIs in June of 2021, though continued meetings and audits were held after that and we supplied second final updated responses of all RAIs on June of 2022.

Since then, we've continued to work with the NRC, and we received the final set of draft LOCs in March of this year and the draft SE was transmitted in April of this year.

CHAIR MARCH-LEUBA: Since this is the public portion of the meeting -- I apologize. The mouse keeps clicking the right button on its own. Since this is the public section of the meeting, I wanted to clarify or maybe the staff can clarify better for us that the staff does not provide a draft SER to the vendor.

What they do is they send it to the vendor for a proprietary check and factual errors, right? So, it's not that we write the SER. By we, I mean the staff doesn't write SERs in conjunction with the

vendor, but you have a chance to review it for factual errors.

MR. BARNER: Thank you for that correction. At a high level, so what is the approval? It's for a non-LOCA Chapter 15 methodology, excluding control rod ejection, but also includes these different pieces for mixed core.

We talked about set points, but that really boils down to the LPD LCO for CE plants and core safety limit lines, power distribution control methodology and fuel assembly reconstitution.

It's ultimately applicable to Westinghouse two, three, and four-loop pressurized water reactors, as well as CE designs. It was approved only for use with approved CHF correlations, whether that's currently approved or future approved. There are wording in there that allow us to permit future correlations into this once they are approved.

CHAIR MARCH-LEUBA: And how about different fuels, like chromium-doped, chromium-coated, high enrichment, high burnup?

MR. BARNER: In general applicability, no. So, it's for current fuel designs and I think the wording is for evolutionary type fuel designs, but anything that goes beyond that, there would be

separate type submittals, and that's why I say this ultimately supports AFM, but through the AFM and chromium-type things, those will need to be further addressed.

CHAIR MARCH-LEUBA: Okay, thank you.

MR. BARNER: And, of course, they are within the range of applicability constituent codes that were used.

Here are some high level areas of interest. We talked about the codes. One we have not really mentioned yet is S-RELAP5. That is the system thermal hydraulics code and that is now -- a big piece to ARITA is that being coupled with the ARTEMIS nodal simulator.

So, with these four codes, we've developed three evaluation model variants. They are described in the topical. One is that coupled system thermal hydraulic with a neutronics model, and that's the main piece of the topical, but there are two other evaluation models, what we call the 0D system transient system thermal hydraulic model, but we're passing, similar to legacy methods, passing one kinetics data from a neutron simulator to the system thermal hydraulic marker in the static core model for events that don't have a system response such as a

misaligned rod or a misloaded assembly.

How this is all accomplished is through code coupling. It's that coupling between ARTEMIS and S-RELAP5 that is used for all of the events that have SAFDL-type limits and figures of merit break analysis use for non-SAFDL-type figures of merit.

For the 0D, it is only used for non-SAFDLs and then the static EM is applicable for SAFDLs, but only for those events that do not have a system thermal hydraulic response.

EM statistical approach, it is using Wilks as the basis for the method. As I said earlier, it does also account for multiple failures of merits within a single event, and this approach is applied for all three EM variants, not just (audio interference).

And finally, we talked about this earlier as well, the EM development. We followed the steps based in SRP 15.02. That goes through and breaks down into basically four major components of the scenario identification process.

This provides us the roadmap when we look through the events and decide what is the purpose of the event, what are the figures of merit, what's important to the event, what does it look like, and

how to perform the analysis.

This ultimately feeds a PIRT, or a PIRT phenomenon identification and ranking were based on that scenario identification. We look at the important parameters that are needed to both model the event and important to the figures of merit.

That ultimately feeds the next step which is the assessment and matrix table were then based off of that PIRT and the importance of the modeling. We look at our EM variants and the constituent codes to see if they are modeling everything properly.

And then based off of that, we ultimately provide what we call the true and key parameters where we account for the uncertainty treatment and identify which is the appropriate EM model to be used within the different transients.

So, just to summarize, it is a non-LOCA methodology. It does represent a culmination of our commitment to developing advanced codes and methods. It is the final piece to that.

It provides that future looking forward to areas such as AFM and only provides a single consistent topical report covering multiple areas related to plant safety, and tries to consolidate that whole to a single topical that is consistent.

CHAIR MARCH-LEUBA: Thank you very much. Any questions from the members, especially those in the cloud? Hearing none, let's have the open presentation by the staff.

(Pause.)

CHAIR MARCH-LEUBA: I'm not sure exactly who is doing the talking, but whenever you're ready, just start talking and introduce yourselves, and again, so the court recorded recognizes your voice, identify yourselves a couple of times. He only sees one microphone here in the room.

MR. OTTO: Good afternoon. I'm Ngola Otto, the project manager for this topical report review. With me is Kevin Heller and John Lehning who were the reviewers.

MR. LEHNING: Thank you, Ngola. So, my name is John Lehning and it's our pleasure here to be in front of the subcommittee. We're going to give you a presentation here, our open presentation on the ARITA topical report of the review the staff did. With me, obviously, is Kevin Heller. I'll be giving this portion of the discussion.

As the slide notes here, we had Pacific Northwest National Laboratory as our consultant on this review and I believe they will be dialing in at

some point maybe later on during the presentation. They served as our consultant. They assisted us also in drafting, providing input for our draft SE that it was based on, so that's a little bit of how they assisted in some of the review. So, onto the next slide, please?

Okay, this, you know, obviously we have a lot of slides to cover here in our safety evaluation, based on the safety evaluation we did, which was pretty thorough and covered so many things. We're going to pick out some highlights here that we thought would be of interest. We're going to go through some of the introductory stuff quickly, but please stop us if you have questions. Go ahead, Ngola.

Okay, so for the introduction, I think Framatome did a good job explaining what the evaluation model is. The only thing that I'll stress on this slide is that the staff's review of ARITA focused on the unique aspects of it.

And so, we didn't, in fact, do a real review of codes like S-RELAP5 or GALILEO, ARTEMIS that has been previously reviewed independently, but we did look at things like the coupling of these together, the calculational procedure, how the calculation is done within ARITA, why it provides adequate assurance,

and then some of the uncertainty treatments, things like the event-specific assessments, so that was somewhat the focus of our review. Next slide?

So, this slide here, slide four, discusses some of the key regulatory requirements and guidance that governed the staff's review. There's a full list in the safety evaluation. These are just highlights.

Among the key requirements are the general design criteria in Appendix A to 10 CFR 50. GDC 10 covers fuel integrity, specified acceptable design limits or SAFDLs. GDC 15 covers pressure boundary of the RCS and things like over-pressurization and so on. There are a number of those.

The technical specifications in 50.35, those are important because the safety analysis and the allowable operating domain need to have an alignment together, and we'll go through that in a little bit more detail later on.

The dose limits come into play because for accidents, the number of fuel failures that can be tolerated is ultimately a function of what the dose limits are for those events.

And as far as guidance goes, the standard review plan Chapter 15 has guidance on how to develop evaluation models, or how the staff ought to review

those, I'm sorry, as well as different guidance for the review of different types of events that the SRP covers, and we'll show you a slide of what those different event categories are later.

And then finally, the EMDAP, which we have spelled out on the slide, in Regulation Guide 1.230 was used to sort of structure some of the parts of the safety evaluation and make sure it was comprehensive to the types of expectations there in that guidance.

Okay, so the next slide here goes into a little bit of the review history, and so I'm going to talk about this at a little bit of a high level.

There's a lot of detail on this slide, but I think just first off, this ARITA review was one of the most complex, challenging, and intense reviews that Kevin and I have been a part of, and I've worked at the agency over 20 years now.

It's not only because of first-of-a-kind issues in applying this technique that was mentioned based on the original CSAU, but applying it to a much wider set of events for the first time and some of the challenge with getting the data that's necessary for that.

I think also ARITA tends to compress down what was originally other independent free-standing

topical reports into certain chapters in that method, so it really brings a lot of different things together in a confluence of things, and there are a whole lot of intricacies in the calculational process as well.

But I think one of the main challenges, and Ngola, if you could advance the slide maybe one time there, that I'll just talk about at a high level, so there was quite a lot of information that needed to be reviewed, and so when we first did the acceptance review, the staff noted that there was some missing information and also some items where the position Framatome was coming in with, we weren't sure that it would ultimately meet regulatory acceptance criteria.

And so, all of those things were made clear. The decision was made based on consultation with Framatome to proceed with the review and then they would try to address the issues during the review.

Okay, but we didn't have enough information really at the beginning, at the get-go to even sort of draft the SE or to know which direction some of these things were going to turn out with, and it took quite a bit of time, I think, to resolve a number of the RAIs.

You can see that orange bar extends

probably two and a half years. Normally, we might be talking about six to nine months, maybe a year, but this took quite a bit of time.

And really by the time I think we got the final initial response in May 2021, we started to get enough information where we could really start understanding the direction this was going and start working on the safety evaluation, but even come June 2022, there were still quite a number of updates.

And I think Framatome alluded to the amount of work that they did. It was probably 1,600 pages of material there that was submitted at that time. I think probably about three-quarters of the RAI responses were updated and changed.

So, this was almost like, I don't want to say a new review because we had been working with them throughout, and we note there the number of audits and meetings that we participated in, but it certainly took quite a lot of time to review that information.

And I think that's part of why we weren't able at that point in time to have further dialogue with Framatome, and they did note a couple of limitations that came out of that phase of the review, but in order to sort of make the deadline, we couldn't continue to interaction with them.

We made the decision based on what was on the docket and what gave us reasonable assurance at this time. It's not to say that with more information or had the review been differently, we couldn't have gotten to a different conclusion, but we ended up where we are based on that part of the review process.

CHAIR MARCH-LEUBA: Let me ask you, interrupt for a moment.

MR. LEHNING: Sure.

CHAIR MARCH-LEUBA: I have to stipulate that this is the most complex and biggest review I have seen in all my years working in this area, but, and everyone complains that the 100 RAIs these teams are using.

Now, in your opinion, the reason for the large number of RAIs was a deficiency on the original submittal that was not sufficiently detailed to reach a conclusion or was it because this code was so large that we had to cover a lot of area?

MR. LEHNING: Yeah, probably mostly the latter. I think it just was a very complex methodology. There's no doubt about that. Framatome put a lot of work into developing it.

I think they also had a different idea of what that method ought to look like, and the idea that

they had at the get-go was that there would be a lot of flexibility for them to decide things on an individual plant analysis level, and then the staff said, well, during the review, we sort of talk through.

That might take away some of the efficiency because if we've got to review all of the different choices you're making on each one of these plant reviews, what do we gain by doing this generic review up front? And so, they revised that and somewhat to sort of address that critique.

And so, I don't want to say the word deficiency, but I do want to say they had a different vision of what the end product would look like than the staff did.

CHAIR MARCH-LEUBA: Thank you.

MR. LEHNING: So, I think we can go on.

DR. SCHULTZ: Excuse me, John.

MR. LEHNING: Oh, sorry.

DR. SCHULTZ: I just want to follow up on that. So, the number of RAIs, they were issued in a fairly short range of time. Most of those or many of those were because of this different approach where you were looking for a generic evaluation versus to go beyond a plant-specific, or not to go to a plant-

specific evaluation in the future?

MR. LEHNING: There's a certain number of them that I would say that fall in that category. It is very complex and I think a number of them were for clarification. Maybe there were a few where we thought there were things missing, but I think -- and then some of them had to do with some other things that we'll get into maybe more in the closed session. I don't want to --

DR. SCHULTZ: That's fine. Thank you.

MR. LEHNING: And then this last slide, I don't think we plan to go over now. We'll repeat it in the closed presentation after we've given you some more of the detail that will help justify these points, so.

CHAIR MARCH-LEUBA: One of the reasons for ACRS to exist is to give confidence to the public that we, an independent body, are looking over these shoulders. So, this is the only part of the presentation that the public will read, so do tell us what the conclusions are.

MR. LEHNING: Certainly, then so the staff's conclusions, which we'll go into a little bit more of the basis for in the closed presentation, but the staff found ARITA methodology acceptable for

modeling the events that are within the scope of the method in SRP Chapter 15, including all of the evaluation model variants, the coupled, the static and the 0D, as well as the associated calculational process and the methodology for doing the statistical uncertainties.

Staff also found the supplementary evaluation model features that are talked about in the closed presentation in Section 3.8 of our safety evaluation, we found those acceptable.

Obviously, the staff's conclusions are predicated upon a couple of things here, that the method is being used within this range of applicability, and that's defined in the topical report Section 13, as well as licensees acceptably addressing the staff's limitations and conditions in Section 5.2 of our safety evaluation.

CHAIR MARCH-LEUBA: And since you brought up the limitation and conditions, which is the meat of the review, this also, the same way there was a large number of RAIs, I saw a large number of limitations and conditions.

In the open session, can you summarize not what the 28 were, but some were applicability range, some where the product of uncertainty? Can you give

us a high level flavor or you're not prepared to do that?

MR. LEHNING: I think it's difficult. I would say it is from a wide variety of things, that some of them are from uncertainty items, very specific things like on this uncertainty parameter, staff reviewed it differently and saw that that range ought to be different.

And then there are some where we're attempting to ensure licensees submit enough information in the license amendment request process that we could have assurance that we know how they implemented the methodology in that plant-specific detail, and there are some where, yeah, just a number of other different categories probably that are hard to characterize.

CHAIR MARCH-LEUBA: In my experience, I'm not scared by a large number of limitations and conditions if they are well-established and well-described, and indeed, they remove regulatory uncertainty at the license amendment request stage because it sets up the rules of the game. Thou shalt do this. Thou shalt do that. And so, I don't have any problem with the number. The question maybe I should have asked Framatome is can they live with

that? Do they think they're okay?

MR. LEHNING: Yeah, Ngola, could you go back to the slide on the review timeline? Because I just will just say one more thing about that, and I think during the review, and we have one point there on perspective, L&Cs first discussed in December 2020.

And so, we tried as early as possible where we foresaw a potential limitation condition to raise that during the review, and a number of them, we did get I would say grudging acceptance that we can live with this one even though it may not be what we originally wanted.

Now, as I said, there were a few, and Framatome pointed out 18 and 19, but there were a couple more that came in this final phase of the review where there was no more opportunity for interaction and basically we had to go with whatever we had on the docket there, and just a few of them that they want to come back in the future and come back to.

CHAIR MARCH-LEUBA: I mean, it is our intention to issue -- the SER that we have reviewed, that ACRS has reviewed is final as far as you're concerned?

MR. LEHNING: It will become final after,

yeah, this meeting --

(Simultaneous speaking.)

CHAIR MARCH-LEUBA: There's always conformance edits and one will always have some comments here and there.

MR. LEHNING: Right, it's not our intent to revise a number of things based on further dialogue and interaction between us and Framatome before issuing the final.

CHAIR MARCH-LEUBA: But the path forward for the areas of dissent, since they brought it out, limitations 18 and 19, will be for Framatome to provide additional information in the supplement, or a letter, or something, and you will be able to turn it around quickly?

MR. LEHNING: We'll go through in the closed session a little bit more. We have a slide on that.

CHAIR MARCH-LEUBA: I know.

MR. LEHNING: Okay.

CHAIR MARCH-LEUBA: But this is the open session.

MR. OTTO: This is Ngola Otto. We're still in discussion with Framatome with respect to that, so we'll know more in the coming weeks and

months what, in fact, it's going to be on the --

CHAIR MARCH-LEUBA: We need to have -- if this is an area of disagreement, we need to have a path forward for resolution, and, I mean, ACRS can be completely silent on this issue, but knowing that it's a problem, we need to say something in our letter.

MR. LEHNING: And, I think, yeah, the slide that we talk about will talk about it from a technical standpoint. There are some logistical details like what's the best path forward that compromises everybody's interests in the right way? That's still being worked out though.

CHAIR MARCH-LEUBA: My personal problem is I have to write a draft ACRS letter for this July full committee to discuss with the committee and we can write proprietary letters, but we've never done it in the seven years I've been here, so I would rather it be a non-proprietary letter.

So, certainly we'll go through review on whatever I provide, but anything that I can say non-proprietary would help.

MR. OTTO: So, we've had discussions with respect to probably an additional submittal that we'll address later in a separate review.

CHAIR MARCH-LEUBA: And you can turn it

around relatively quickly?

MR. OTTO: Right, that's the plan.

CHAIR MARCH-LEUBA: Because I don't know, but typically, power plants order fuel in the spring, so we have ten months until the next reload. So, I'm sure Framatome would like to get some conclusion, some finality on what they are looking to do.

MR. OTTO: Okay.

(Simultaneous speaking.)

MR. SUBER: This is Gregory Suber. So, what I wanted to say is that the NRC and Framatome have aligned on the current draft safety evaluation report, and that safety evaluation report will be sent to Framatome for their dash A read and approval and that's what we're bringing before the committee today.

CHAIR MARCH-LEUBA: Yes.

MR. SUBER: So, from this perspective, we have a current resolution with this version of what we have agreed upon for all of the limitations and conditions.

CHAIR MARCH-LEUBA: And if I --

MR. SUBER: Now, if Framatome in the future decides to submit additional information, then that would result in a Rev. 1, correct --

CHAIR MARCH-LEUBA: Or supplement.

MR. SUBER: -- or that would result in a revision of the approved NRC --

CHAIR MARCH-LEUBA: And the SER that the staff will issue within the next couple of months or maybe earlier can be used -- if I'm a licensee that wants to buy fuel for them next spring, they can use this SER?

MR. SUBER: They can use it, yes, they can.

CHAIR MARCH-LEUBA: Framatome, do you want to make some comments?

MR. LYDZINSKI: Yeah, this is Steve Lydzinski here.

CHAIR MARCH-LEUBA: Speak up.

MR. LYDZINSKI: Yeah, sorry. So, we have discussed this particular limitation and condition earlier this week. While the uncertainty proposed in the limitation and condition is conservative, we do need to move forward with that conservative value.

We've discussed different options, whether it be a formal letter, whether it be the topical report supplement, or some other licensing action that further reduces the very conservative value proposed in that limitation and condition, but it's something we need to assess in terms of time and effort and the

impact to the safety studies, but certainly the value input by the limitation and condition is conservative.

CHAIR MARCH-LEUBA: Right, because you can always issue a change during the licensing amendment request, but that's decidable because it's regulatory uncertainty.

MR. LYDZINSKI: Correct.

CHAIR MARCH-LEUBA: Okay, so thank you for placing all of this discussion in the open record so I can write my letter. This is why I wanted to have it here. So, any questions from the members, including those in the cloud? No questions?

Since this is going to be the end of the open session, we'll give an opportunity to any members of the public to place comments on the official transcript. If there is a member of the public that wants to issue a comment, please do so now. No?

MR. NEVLING: Okay, I'll give you one, Jim Nevling, manager for special projects with Constellation Energy Generation in the nuclear fuels' organization.

We do intend to adopt ARITA methods into our licensing basis for Byron and Braidwood Stations in the relatively near future, and we very much appreciate NRC's hard work and support for this, and

we look forward to timely completion and issuance of the SER.

CHAIR MARCH-LEUBA: Thank you very much. Any more comments from the public? So, Jim, can you lower your hand? Thank you. So, I don't hear any more comments. We are done with the open portion of the meeting. We are going to close this line and will not come back to this phone line at all this week.

Anybody that belongs in the closed session, you have the number and you can call in within the next ten minutes. Let's take a short break until 2:25 Eastern to set up the thing. So, the open session of the meeting is closed.

(Whereupon, the above-entitled matter went off the record at 2:15 p.m.)

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ARITA
ARTEMIS/RELAP Integrated Transient Analysis Methodology

Buck Barner and Keith Maupin

ACRS Subcommittee, June 22, 2023

Agenda

Overview

Background and History

Approval Request and Range of Applicability

Key Areas of Interest

Summary

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Overview

- ARITA - ARTEMIS/RELAP Integrated Transient Analysis Methodology
  - Defines a methodology to analyze non-Loss-of-Coolant (non-LOCA) events
  - Uses a non-parametric statistical approach to make a 95/95 statistical statement for each figure of merit (FOM) using a Monte Carlo approach
  - Standard Review Plan (SRP) Chapter 15.0.2 was used as guidance in development of the method
  - Addresses mixed core, power distribution control, setpoints and fuel assembly reconstitution
  - Excludes Control Rod Ejection (CRE) which is analyzed using AREA – ARCADIA Rod Ejection Accident Topical Report

Background and History

- In 2006, Framatome began the development of a new set of advanced PWR codes
  - ARCADIA (ANP-10297PA, Revision 0 and Supplement 1, Revision 1)
    - Includes the 2D cross section code APOLLO-2A and the 3D nodal code ARTEMIS
  - COBRA-FLX (ANP-10311PA, Revision 1)
  - GALILEO (ANP-10323PA, Revision 1)
- Around the same time (2010) there was a push in the industry to replace legacy methods
- The goal was to develop new methodologies that:
  - Use state of the art modeling
  - Take advantage of best practices from US, French and German experience
  - Simplify topical report interdependences and reduce the number of topical reports
  - Facilitate future method development
- AREA (ANP-10338PA, Revision 1) was the first methodology topical approved.

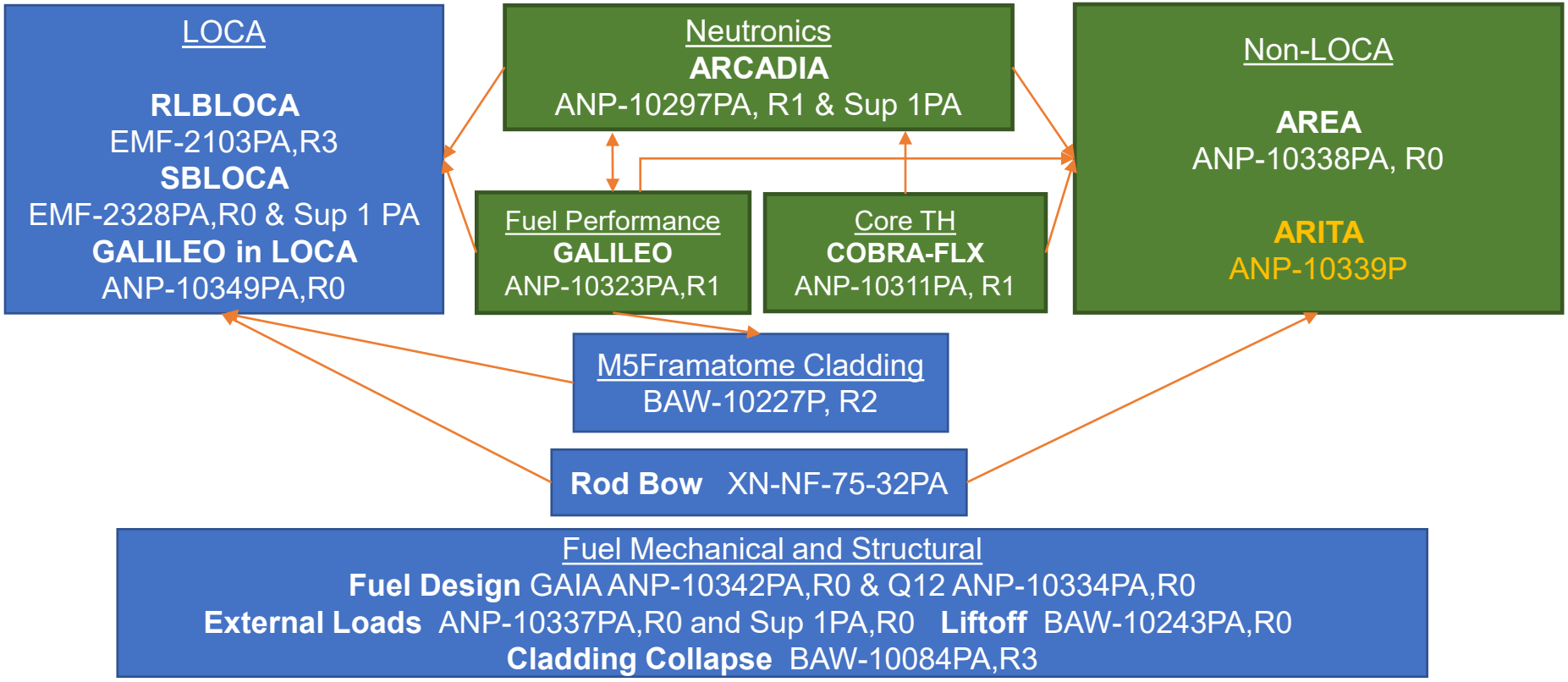
➢ **ARITA represents the realization of Framatome's goal of advanced codes and methods.**

Background and History

- What advantage does this provide to the industry?
  - Better modeling of the actual plant behavior leads to better understanding of plant response and the actual safety margins.
  - Value (or margins) that were previously unavailable open new opportunities for the industry without impacting the underlying safety margins established by the regulations
    - Address Regulatory Changes (e.g., RG 1.236)
    - Operating Margins
    - Power Uprate
    - Core Design Optimization
    - Load Follow
    - Advanced Fuel Management (AFM) - Increased Enrichment and High Burnup
    - Whatever is most important to the utility!

➢ **Higher fidelity simulations and modeling provides increased understanding of plant response and allows reduction in the excessive conservatism associated with simplifying assumptions in lower fidelity legacy methods**

Background and History



Only major methodology connections shown

Background and History

- Pre-submittal meetings held February 2015, June 2016, and July 2017
- **The ARITA Topical Report was submitted August 2018**
- A post-submittal acceptance meeting was held November 2018
- The first set of RAIs (1-13) were transmitted to Framatome December 2019
- Supplemental information was transmitted to the NRC March 2019 in response to the post-submittal meeting
- Responses to RAIs 1-13 were transmitted to the NRC April 2020
- Additional RAIs (14-92) were transmitted to Framatome April 2020
- Responses to RAIs 14-92 were transmitted to the NRC in 3 separate submittals July 2020, November 2020 and June 2021
- Audit and meetings were held during this time to aid in the review of the RAI responses
- Audits and discussions continued through April 2022
- **Final updated responses to all RAIs to address reviewer comments were transmitted to the NRC June 2022**
- The final set of draft L&Cs was transmitted to Framatome March 2023
- **The Draft SER was transmitted to Framatome April 2023**

Approval Request and Range of Applicability

- Non-LOCA “Chapter 15” methodology, excluding CRE
  - Mixed Core Method
  - Local Power Density Limiting Condition of Operation (LPD LCO) and Core Safety Limit Lines (CSLL)
  - Power Distribution Control (PDC)
  - Fuel Assembly Reconstitution

- Applicable to Westinghouse (2-, 3-, and 4-loop) Pressurized Water Reactor (PWR) designs and Combustion Engineering (CE) PWR designs
- Use of approved Critical Heat Flux (CHF) correlations
- Within the range of applicability of the constituent codes (ARTEMIS, S-RELAP5, COBRA-FLX, GALILEO)

Key Areas of Interest – Evaluation Model (EM) Description

- Constituent codes
  - ARTEMIS – 3D nodal simulator code previously approved in ANP-10297
  - COBRA-FLX – Subchannel core thermal-hydraulics code previously approved in ANP-10311
  - GALILEO – Fuel performance code previously approved in ANP-10323
  - S-RELAP5 – System thermal-hydraulics code previously applied in EMF-2310
- EM Variants
  - There are 3 EMs described in the ARITA topical:
    1) Coupled system-thermal hydraulic and neutronics model,
    2) 0D system thermal-hydraulic model, and
    3) Static core evaluation model.
- Code Coupling
  - In the Coupled EM, ARTEMIS and S-RELAP5 are coupled together to solve time-dependent multi-physics problems (Specified Acceptable Fuel Design Limits (SAFDLs) and non-SAFDL FOM)
  - In the 0D EM, point kinetics data generated in ARTEMIS is to provided the S-RELAP5 (Non-SAFDL)
  - In the Static EM, ARTEMIS is used for events that do not require a system thermal-hydraulic solution (SAFDL)
- Statistical Approach
  - Non-parametric approach based on the Wilks method is used to make a statistical statement on the FOM.
  - Account for multiple FOM.
  - The statistical approach is used for all 3 EM variants described above.

Key Areas of Interest – EM Development

- The EM development process used the following development steps (based on SRP 15.0.2)
  - Scenario Identification Process– Provides and roadmap to perform a non-LOCA event evaluation including 1) the purpose of the analysis 2) the event scenario and 3) the event analysis.
  - Phenomena Identification and Ranking Table (PIRT) – Establishes important parameters and conditions for each event analysis based on their importance to modeling the event and their impact on the FOM.
  - Assessment Matrix Table (AMT) – Assesses the capabilities of the EM variants and constitute codes to appropriately model the given event.
  - Treatment of Parameters – Using the Scenario Identification Process, PIRT and AMT, the key parameters and uncertainty treatments are identified and used in the appropriate EM variant.

Summary

➢ ARITA…

- Is a Non-LOCA (excluding CRE) method applicable to CE and Westinghouse Plants
- Represents the culmination of Framatome's commitment to developing advanced codes and methods
- Provides the foundation for future development in areas such as AFM
- Is a single, consistent topical report that cover multiple areas related to plant safety analysis

Acronyms

AFM – Advanced Fuel Management

AMT – Assessment Matrix Table

AREA – ARCADIA Rod Ejection Accident

ARITA – ARTEMIS/RELAP Integrated Transient Analysis

CE – Combustion Engineering

CHF – Critical Heat Flux

CRE – Control Rod Ejection

CSLL – Core Safety Limit Lines

EM – Evaluation Model

FOM – Figure of Merit

LOCA – Loss of Coolant Accident

LPD LCO – Local Power Density Limiting Condition of Operation

Non-LOCA – non-Loss of Coolant Accident

NRC – U.S. Nuclear Regulatory Commission

PDC – Power Distribution Control

PIRT – Phenomena Identification and Ranking Table

PWR – Pressurized Water Reactor

RLBLOCA – Realistic Large Break LOCA

SAFDL – Specified Acceptable Fuel Design Limits

SBLOCA – Small Break LOCA

SRP – Standard Review Plan

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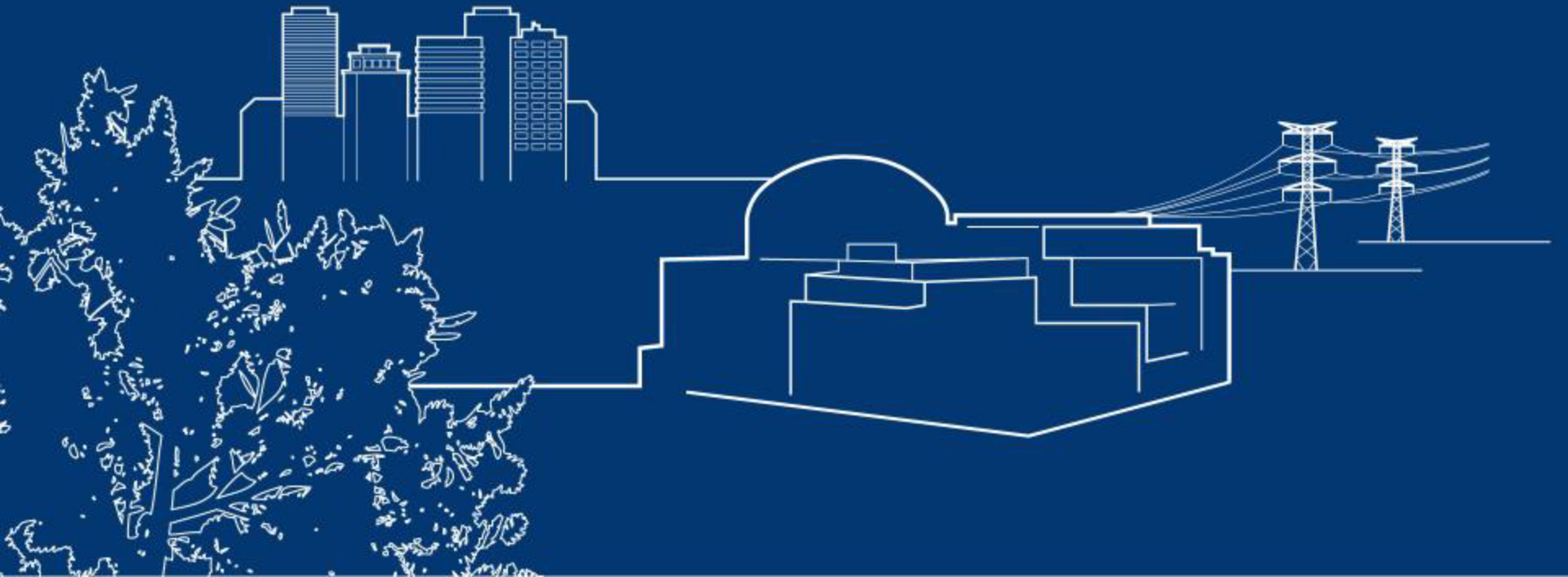


NRC Staff's Review of Framatome Topical Report ANP-10339P, *ARITA – ARTEMIS/RELAP Integrated Transient Analysis Methodology*

Open Presentation to

Advisory Committee on Reactor Safeguards, Thermal-Hydraulics Subcommittee

June 22, 2023

K. Heller, U.S. NRC
J. Lehning, U.S. NRC
K. Geelhood, D. Richmond, T. Zipperer,
B. Schmitt, D. Engel, PNNL

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Presentation Outline

Topic	# of Slides
Introduction (Open)	3
Review History (Open)	1
Technical Evaluation (Closed)	36
• Scenario Identification / Applicable Regulations	[4]
• Phenomenon Identification and Ranking	[1]
• Evaluation Model Development	[4]
• Calculational Procedure	[8]
• Treatment of Uncertainty	[10]
• Evaluation Model Assessment	[6]
• Supplementary Evaluation Model Features	[3]
Limitations and Conditions (Closed)	17
Conclusions (Open)	1
Presentation Total	**58**

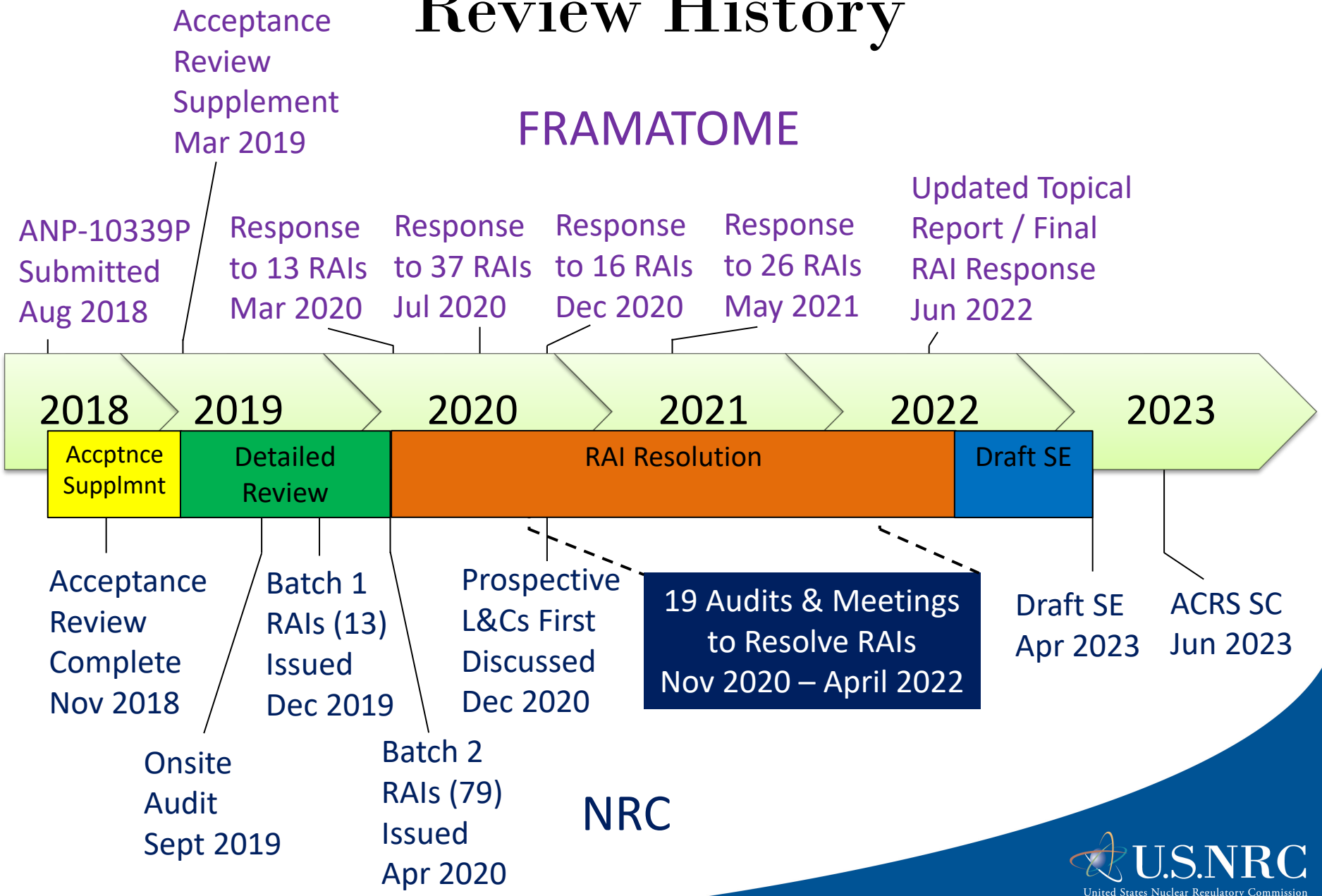
Introduction

- The ARITA methodology is a statistical approach for performing most Standard Review Plan (SRP) Chapter 15 reactor safety analyses
  - Not including LOCA and rod ejection
  - Applicable to conventional Westinghouse and Combustion Engineering PWRs
- ARITA involves three distinct evaluation model variants
- The codes used in the ARITA methodology have been previously reviewed by the NRC staff
- NRC staff's review focused mainly on the calculational procedure and uncertainty treatments

Key Regulatory Requirements and Guidance

- 10 CFR 50, Appendix A, General Design Criteria, e.g.,
  - GDC 10, Reactor Design
  - GDC 15, Reactor Coolant System Design
- 10 CFR 50.36, Technical Specifications
- 10 CFR 50.67 or 10 CFR Part 100 Dose Limits
- Standard Review Plan, Chapter 15
- Regulatory Guide 1.203, Evaluation Model Development and Assessment Process

Review History



Conclusions

- The NRC staff found the ARITA methodology acceptable for modeling in-scope SRP Chapter 15 events, including
  - all three ARITA evaluation model variants
  - the associated calculational process
  - the statistical uncertainty methodology
- The NRC staff found the supplementary evaluation model features described in Section 3.8 of its safety evaluation acceptable
- The staff's conclusions are predicated upon
  - the ARITA methodology being used within its proposed range of applicability in Section 13.0 of ANP-10339P
  - licensees acceptably addressing limitations and conditions in Section 5.2 of the staff's safety evaluation