Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
Subcommittee on Global Nuclear Fuel
Licensing Topical Report Subcommittee
Open Session

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Tuesday, December 3, 2019

Work Order No.: NRC-0732 Pages 1-29

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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 GLOBAL NUCLEAR FUEL (GNF) LICENSING TOPICAL REPORT (LTR), NEDE-33885P REVISION 0, "CONTROL ROD DROP ACCIDENT (CRDA) APPLICATION METHODOLOGY" - OPEN SESSION

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TUESDAY

DECEMBER 3, 2019

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2D30, 11545 Rockville Pike, at 8:30 a.m., Jose March-Leuba, Chair, presiding.

COMMITTEE MEMBERS:

JOSE MARCH-LEUBA, Chair

RONALD G. BALLINGER, Member

JOY L. REMPE, Member

DESIGNATED FEDERAL OFFICIAL:

WEIDONG WANG

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

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

8:51 a.m.

CHAIR MARCH-LEUBA: This is a meeting of the Thermal-Hydraulics Phenomena Subcommittee of the Advisory Committee on Reactor Safeguards. I am Jose March-Leuba, Chairman of today's Subcommittee meeting.

ACRS members in attendance are Joy Rempe and Ron Ballinger. Weidong Wang of the ACRs staff is the federal official for this meeting.

During this meeting the Subcommittee will review a draft safety evaluation report for Global Nuclear Fuel Americas, also know as GNFA, Licensing Topical Report NEDE-33885P Revision O, and GNF-CRDA Application Methodology. The Subcommittee will hear presentations by and hold discussions with NRC staff, GNF-A representatives, and other interested persons regarding this matter.

The rules for participation in all ACRS meetings, including today, were announced in the Federal Register on June 13, 2019. The ACRS section of the U.S. NRC public website provides our charter, by-laws, agendas, reports, and full transcripts of all full Subcommittee meetings including the slides presented there. A meeting notice and agenda for this meeting will be posted there.

We have received no written statements or requests to make an oral statement from the public.

The first part of today's meeting is opened to public attendance. The second part of the meeting will be closed in order to discuss information that is proprietary to the licensee and its contractors pursuant to 5 USC 552(b)(c)(4).

Attendance at this portion of the meeting that deals with such information will be limited to the NRC staff and those individuals and organizations who have entered into an appropriate confidentiality agreement with them.

Consequently, we need to confirm that we have only eligible participants in the room for the closed portions when we get there.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the Full Committee.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. Therefore, we are requesting the

participants in the meeting use the microphones located throughout the room when addressing the Subcommittee.

The participants should first identify themselves and speak with sufficient clarity and volume so they may be readily heard. Just a reminder, if your name is in front of you, you don't need to say your name every time you talk. If your name is not in front of you, you tell your name so the court reporter knows who you are.

We will now proceed with the meeting. Another reminder. Please place your phones on mute because somebody always forgets and it's annoying when it sounds.

Now I'll call on the NRC staff to provide some introductory remarks.

MS. ROSS-LEE: Good morning and thank you for your patience with shifting rooms and trying to get all the technology aligned appropriately. My name is MJ Ross-Lee. I'm the Deputy Division Director for the Division of Safety Systems. I want to thank you for coming this morning and for your patience as we've shifted rooms.

GNF submitted this topical report in 2008 with the intent of implementing the proposed

methodology into GESTAR II in 2020 as an option for licensees to analyze the control rod drop accident event. GNF's legacy CDRA analysis methodology is based on generic analysis performed to show compliance with old NRC regulatory guidance.

The proposed methodology is an updated approach to explicitly verify that the more recent NRC acceptance criteria are met as well as provide flexibility to licensees for analysis on a case-by-case basis. New regulatory guidance on reactivity-initiated events, accidents in the form of a Draft Guide 1327, will be reviewed by ACRS within the next few months prior to being finalized.

In the interim, the proposed GNF methodology was reviewed with the criteria from the current guidance in Appendix B to the SRP Section 4.2, as well as the Draft Guide. As a result, the staff expects that licensees will be able to utilize the methodology with the most recent regulatory guidance, whether it be the current SRP guidance or the Draft Guide.

The interaction between GNF and NRC staff was very productive in effectively identifying and addressing several potential issues with the finding of applicability of the methodology implementation for

specific licensees and to clarify potential uses of the methodology not explicitly identified in the topical report.

MEMBER REMPE: So I have a question. If I look at your SE, there's a statement in there, and I'm pretty sure it's not proprietary so I can quote it, saying that the time this SE was written, "The Draft Guide is not expected to be finalized." Are you planning to fix that statement?

MR. KREPEL: This is Scott Krepel. The Draft Guide was recently finalized. We finished the public comments just a couple of months ago and it's going to go to the ACRS sometime in the next couple months. The safety evaluation is expected to be completed before the Draft Guide becomes finalized as regulatory guidance so the statement will stay as is.

MEMBER REMPE: It's a word thing, but if I read this verbatim, at the time this SE was written, Draft Guide 1327 is not expected to be finalized as a regulatory guide. That sounds like ain't never going to happen to me. Probably it should be revised a bit.

MR. KREPEL: Sure, I can go ahead and revise that.

MEMBER REMPE: Thank you.

MS. ROSS-LEE: Yeah, that makes sense now

as you read it, the wording. It will still be draft but it will be finalized at some point in time.

MEMBER REMPE: Sounds like it's never going to happen. Thank you.

MS. ROSS-LEE: I understand the question now.

CHAIR MARCH-LEUBA: With this discussion we'll pass the gavel to -- for the record, I will call you GE, GEH, GNF, and GNF-A. You let me know what I mean by that. Please tell us what the name of your company is and introduce yourselves.

MR. HALAC: Hello. My name is Kent Halac. I work for Global Nuclear Fuels and GE Hitachi. I am here today -- I am the lead licensing engineer for fuel licensing at Global Nuclear Fuels. With me is Scott Pfeffer from Global Nuclear Fuels, GE Hitachi also. He is our technical lead in the area of stability and control rod drop.

We appreciate you hearing this topic today. We've come a long ways with this particular methodology and we are looking forward to final closure. We submitted the topical in February of 2018 and we had a detailed audit which was scheduled for September 2018 but Hurricane Florence had something to say about that and got delayed to October of 2018 and

was executed successfully subsequent to the hurricane in Wilmington.

Scott Krepel has done an amazing job digesting our technology and providing excellent feedback on the content and narrowing it to be appropriate and consistent with the draft guidance.

We have read and have digested the draft SE associated with this and some of the feedback I've received from our consulting engineers is it's arguably the best SE he's every seen. We want to give complements to Scott for his thorough detailed approach toward this particular technology.

With that, I will yield to NRC.

CHAIR MARCH-LEUBA: I believe you're up.

MR. HALAC: Okay, that's right. Sorry.

MR. PFEFFER: I'm Scott Pfeffer. I'm the technical lead for the radiological side of the stability and radiological team at GNF GEH. Prior to that I spent eight years on the stability and radiological team mostly doing stability work previous to that.

We'll get into the open items on the control rod drop accident methodology. We'll start off with a brief overview of the drivers and the approach that we took in developing the LTR, and then

a brief discussion on the documentation status, so the REIs, limitations and conditions, and the draft safety evaluation.

Drivers, as has been previously mentioned, were to align with the latest guidance from the staff related to reactivity-initiated accident fuel damage guidelines, specifically for CRDA for BWRs. The idea was to more thoroughly evaluate possible CRDA scenarios.

We also want to improve plant operations to allow a person more flexibility than is currently available under the old methodology which is a banked position withdrawal sequence methodology. As part of that, we've had some fuel changes and things, some difficulties in start-up at plants, and one of those is an inadvertent subcriticality event that can occur so we wanted to allow some flexibility for that.

CHAIR MARCH-LEUBA: Subcriticality?

MR. PFEFFER: Subcriticality. The old methodology has some generic requirements on banked positions that must be met during the start-up and mostly developed as part of older fuel designs. The banked at four, which is right at the top of the fuel, especially at BOC conditions, can have very little worth.

During the start-up if they are too slow in pulling those rods, if they can't pull them fast enough with zero worth as the reactor is heating up, they can actually drop and become subcritical. That happened at LaSalle, I believe it was. We wanted to start to allow for flexibility in those banked positions and that's part of the new methodology.

As part of that, also looking for potential dose improvements, the goal for our LTR was to demonstrate no fuel failures and that would allow for some benefit in terms of the dose consequence for control rod drop accident.

CHAIR MARCH-LEUBA: And this single rod failure, is that the goal, or is it a requirement, or 99.9?

MR. PFEFFER: It is a requirement of the methodology that we demonstrate as part of our analysis that there are no failures.

The approach we used was to use previously approved methods so that includes PANACEA or PANAC which is our core simulator of PRIME or thermal/mechanical methodology, and TRACG BWR systems code to do our analysis.

We wanted to implement the newest guidance. We discussed specifically items that were

implemented were hydrogen efficient gas release models and then the pellet-cladding mechanical interaction, and high temperature cladding failure thresholds as far as the acceptance criteria for rod failures.

Sources for that guidance were the memoranda on the RAs and hydrogen pickup, as well as SRP 4.2 Appendix B, as well as then supplemented by Draft Guide 1327 as was mentioned previously.

Documentation. The LTR that was mentioned was submitted in February 2018. We conducted the audit in October 2018 and had good discussions there. We resolved all RAIs in March 2019, again after some back and forth and good resolution there.

LNC notification along with the draft SE was issued in October with a final SE anticipated in January 2020. At that point we would then issue the approved version of the LTR in 2020 after receiving the final SE.

As part of the LTR we also included the required markups for GESTAR II, a General Electric standard application for reactor fuel to allow us to update GESTAR with approved modifications once the LTR for CRDA is approved. Those modifications are part of the LTR and will be part of the improvement.

That's all I have for the open session.

Any questions?

CHAIR MARCH-LEUBA: Thank you to the presenters. I have to confess while I was writing the draft letter we issued in the full committee, I had serious problems writing anything that was not proprietary and that's why this presentation -- thank you for having given us this.

Now we will proceed with the staff presentation open. We are still in non-proprietary session. You will need to turn on your mic.

MR. KREPEL: Good morning. I'm Scott Krepel and you should all be familiar with me by now. Just a quick reminder of my background. I graduated from Purdue about 20 years ago now. I've had the honor of studying under some of the former ACRS members there.

Then I moved to TVA and I worked there as a fuel engineer for about 10 years. Then I came to the NRC where I've had experience in research, as well as NRR doing licensing reviews for a lot of different thermal-hydraulic events and accident events.

I'm sure that it may make it a little easier on you that both of the presenters here today are named Scott so here I am.

With no further ado, I'll go ahead and get

started with my presentation doing a review of the CRDA methodology for GNF. First quick background on this. Previously NRC had guidance for the reactivity initiated accidents for CRDA. Also control rod ejection events for PWRs that was developed quite some time ago. I believe several decades ago. That's fairly old and obsolete at this point.

More research from facilities like NSRR in Japan and CARI in France, among others, have provided a lot more information and data on fuel failure during this type of accident event which has led to interim criteria and SRP 4.2 Appendix B which eventually we hope Draft Guidance 1327 will replace and become a permanent guidance for the foreseeable future.

Currently the GE methodology is based on BPWS, as the other Scott mentioned earlier. Really that is a generic analysis that is designed to look at the limiting notch worth to determine whether a problem is going to occur or not. This methodology, this new methodology, provides an approach that can be used to explicitly analyze different rod withdrawal sequences and confirm whether they match the current guidance.

Next slide. As you see, there are four codes listed here that were used by GNF to be able to

do the analysis. I am not going to talk about TGBLA again but I just have it there so you know it was a cross section that goes to PANACEA. The other three will be discussed further on as different models that were used for direct CRDA analysis, or to provide a bounding parameter for the input.

For the most part, we have already validated a lot of the events of concern, but there were some additional validation that needed to be done that we needed to confirm the application of the cores for the CRDA events and the cold conditions.

Next slide. I'm sure that you're familiar with CRP 15.0.2 and that's the framework that we've talked about before, but just a reminder that the last two were not addressed explicitly. They were more implicit as part of our review. If I looked at the documentation and understood it, then I made the finding that the documentation was sufficient. Those are the asterisks for those last two.

Next slide. Before I talk about specific areas and summarize that for the benefit of the public, if there are any present, I wanted to go ahead and summarize the regulatory acceptance criteria which is outlined here on the slide. There's different SFR 50.34, but basically there's just a summary here of

the requirements.

First of all, you have to analyze CRDA events and demonstrate that they are bounded by your plant operations and those parameters. Secondly, if a CRDA event happens, you have to look at the dose consequence and it has to be within the design basis limitation. Those are basically the two things that summarize this slide.

Next slide, please. In SRP there are specific criteria to demonstrate the regulatory compliance as outlined here. There are interim criteria, but Draft Guide 13.27 has very similar criteria as well. GNF, as already mentioned, their goal with this methodology is no fuel failure.

Out of those, it doesn't really matter to GNF for their methodologies since they are going for no fuel failure because then you don't have to worry about the fission gas release and there would be no change in any of the other things as well. We'll be focusing on basically the first two criteria that are listed there which is the high temperature cladding failure.

Next slide. There are four areas from SRP 15.0.2 that I wanted to talk about. First is that the licensee describes and characterizes the CRDA event

and identifies the key parameters, output parameters. We've got NFLP for example.

NRC staff, me basically, compared their description of the event to the parameters with other PIRTs. For example, GNF did not include a formal PIRT in their topical report, but they did include enough information for me to be able to compare with other vendors' PIRTs, a PIRT that the NRC even developed, for example.

Question?

MEMBER REMPE: I do have a question. Thank you for noticing. Again, if this is proprietary, stop me. I know in your SE you did talk about it wasn't quite a typical PIRT. Do you want to elaborate or can you about why it differed?

MR. KREPEL: Sure. Typically a PIRT is a more systematic approach where you identify a whole list of specific phenomena that are of interest for the accident. Then you assign them a value of either high, medium, or low importance. That is consistent with the NRC approach.

GNF didn't formally officially do that in their topical report, but what they did do is provide a description of the phenomena and how they addressed the most important ones. NRC staff identified that

there were no other phenomena that would be important for this event.

MEMBER REMPE: Thank you. That helps.

MR. KREPEL: Sure.

All right. Next slide. So for the code assessment, as I mentioned earlier on an earlier slide, most of the codes have already been analyzed previously for code fidelity, thermal hydraulic modeling for physics.

The only thing is the gap assessment and looking at the cold conditions for reactivity initiated accidents. That was the one little difference. Also looking at the doppler feedback, for example, in previous ones are the turbine trip events. I did an assessment using the SPERT III test.

Next slide. For the CRDA evaluation method, there are generally two areas that the NRC staff review; looking at the modeling guidance and the CRDA analysis procedure.

Next slide. For the modeling guidance, basically you summarize all of the different recommendations for the input parameters for the modeling and how they model within the code to perform the analysis. They are listed here on the slide and these are generic categories.

Next slide. Yes?

CHAIR MARCH-LEUBA: This is still non-proprietary but on the fission gas inventory, I assume that information goes from PRIME. Correct?

MR. KREPEL: Prime is used to generate some of the information that is used in the analysis.

CHAIR MARCH-LEUBA: But the real question is, is it provided how much fission gas is in the cladding in the gap, or the one that is inside the oxide pellet?

MR. KREPEL: In the topical report methodology, and I don't know if this is proprietary or not, Scott.

MR. PFEFFER: I don't think so.

CHAIR MARCH-LEUBA: You need to talk in the microphone. Sorry. Say your name.

MR. KREPEL: I'm just trying to avoid proprietary information so just wanted to check in.

MR. PFEFFER: This is Scott Pfeffer. I think that question is okay.

CHAIR MARCH-LEUBA: Okay.

MR. KREPEL: So the methodologies in PRIME to calculate the fission gas that's within the gap, but then it also does more work to then --

MR. PFEFFER: One second.

CHAIR MARCH-LEUBA: Okay. Why don't we propose this discussion to the proprietary section.

MR. KREPEL: Yeah, that's fine. I plan to discuss it later anyway.

Okay. The next section really describes how the actual analysis is performed once you've got the model and then what the actual process is that's done. It formulates basically the heart of the method.

There are a lot of steps, step-by-step description of what happens and how to specifically do the controlled run withdrawal sequence and different parameters that may affect the applicability of that order. Of course, you evaluate that against the acceptance criteria.

Next slide. The uncertainties. Again, GNF did not do a formal PIRT, but they did identify all of the important phenomena and addressed each one of those for the uncertainties in different ways.

There are three listed here, the three different approaches; the bounding analysis parameters, the sensitivity studies, and the analysis conservatism so seeing that conservatism in the analysis. I will discuss all of that later in more detail because most of is proprietary.

CHAIR MARCH-LEUBA: In 20 seconds or less would you describe the methodology as best estimate, best estimate plus uncertainties, or conservative? A, B, C?

MR. KREPEL: I would probably characterize it as conservative.

CHAIR MARCH-LEUBA: Okay. In LOCA terms would it be an Appendix K type calculation?

MR. KREPEL: Not exactly 100 percent Appendix K but, yeah, it is conservative.

CHAIR MARCH-LEUBA: Thank you.

MR. KREPEL: I mean, Appendix K is very conservative as you know.

Next slide. The final area was a little unique to this topical report because, as you may know, GNF has GESTAR II and they allowed the licensee to adopt new methodology right away. They provided updates to their GESTAR II to allow the licensee to adopt new methodology. There are documentation requirements that clarify how that methodology can be used.

Jose, do you have a question?

CHAIR MARCH-LEUBA: I didn't turn on my green light and he already could foresee my question. Yes, I would like for our education if you can give us

a one-minute primer on the GESTAR methodology.

How does it work? Specifically I'm interested in if I am making a minor update to an existing fuel; for example, I'm changing the inlet filter or a major upgrade like GNF 13 by 13, how does it propagate to a licensee? When does the licensee need an LAR?

MR. KREPEL: First, with GESTAR II that is the primary methodology that is documented and it describes all of the other methods that can be used to analyze the fuel. GNF does have a process for the new fuel design and they can assess their new fuel design and then document the details of what is called the fuel compliance document which the NRC can audit at any point. We did actually do an audit for GNF2 and GNF1 fuel design if I recall correctly.

CHAIR MARCH-LEUBA: So a licensee on the specifications have a reference to the GESTAR document?

MR. KREPEL: Yes.

CHAIR MARCH-LEUBA: And then --

MR. KREPEL: The tech specs reference GESTAR.

CHAIR MARCH-LEUBA: And then GE modifies GESTAR only once, gets it approved through you, and it

applies to all the licensees. Is that correct?

MR. KREPEL: More or less, yes. They do get approval and that includes all of the modifications which is easy, but typically they submit GESTAR amendment topical report that we also review to confirm that everything is A-okay.

CHAIR MARCH-LEUBA: Once you issued an SER Amendment 29, then every licensee that references GESTAR can use the fuel. Is that correct?

MR. KREPEL: Yes.

CHAIR MARCH-LEUBA: Okay. Thank you.

MR. KREPEL: One last point here on this final bullet point. As I mentioned, we'll talk about it more later but there were some specific situations where the requesting approval for the use of different ways or methods to do the analysis. Those will be subject to some limitations that we can discuss in more detail later because, again, I don't want to run into proprietary information.

Okay, next slide. So overall conclusions. The staff found NEDE-33885P provided good guidance for the use of GNF methodology to do CRDA analyses. We do have four additional limitations and conditions beyond those that already exist for the code that they're using.

I'll talk about those more in detail later, but really they are just affirming the key assumptions are met making sure that the method cannot extend beyond the area of applicability that is expected by the NRC staff when approving this method, or when we plan to approve this method, I should say, assuming that the ACRS is fine with it.

Yes.

MEMBER REMPE: I have a question. In your SE you talked about the sensitivity of the results to the high end of the enrichment spectrum. I assume that was something near 5 percent. Could you confirm that in the open session? Then how do I know that -- what would happen if GE came in with a higher enriched fuel?

MR. KREPEL: I expect that kind of situation would be addressed through their control rod worth that explicitly says that is part of their methodology for looking at whether they have higher enrichment. Then that would lead to more release, more heat release, and then that would be captured by the control rod worth.

MEMBER REMPE: Just so I know what we're approving if we approve this topical report, are we approving its application for higher enrichment than

5 percent?

MR. KREPEL: I'm not explicitly approving that but I'm not saying that it can't be used for that purpose.

MEMBER REMPE: So then, again, I'm not into how this process would work because I just know that -- I'm more into the technical details, but how does that get monitored and checked carefully if that happens because, as you know, it's in discussion right now.

MR. KREPEL: Probably the clearest answer is right now PRIME in that methodology has its limitation on burn-up and the applicability for that method.

MEMBER REMPE: So for burn-up. What about enrichment? Is it limited to 5 percent?

MR. KREPEL: Enrichment I can't recall exactly. I know that with PANACEA there is an assessment database that covers up to 5 percent but I can't recall exactly if there is an explicit limitation in there or not. Maybe GNF has an answer to that.

MS. LAMB: This is Shawn Lamb from DNF. We are looking it up right now.

CHAIR MARCH-LEUBA: Who was that? Sorry,

what's your name?

MS. LAMB: This is Shawn Lamb. I'm the Manager of Stability and Radiological Analysis Team. We are looking up if PRIME has an enrichment limitation right now. We'll get back to you very shortly.

CHAIR MARCH-LEUBA: Thank you.

MEMBER REMPE: I am interested in that. I started asking that question to GE or GNF or whoever we're talking to but also other --

MS. LAMB: Okay, thank you.

MEMBER REMPE: It sounds like the rules might change and I just want to know if we're missing something if the rules change. Thank you.

CHAIR MARCH-LEUBA: You know that ACRS only speaks through letters so what we're hearing here is subcommittee members opinions. I think even though ACRS has not written a letter, we have made our ideas very clear that if the enrichment is increased 5 percent, we would expect a very large review for everybody in this building.

It wouldn't be -- all the technical reports automatically apply. Even if you didn't say specifically to apply 5 percent, I think it would be a review of everything. That's what I would expect.

MEMBER REMPE: Expectations. I'm just curious so it's nice sometimes if someone can say, oh yeah, some other method would limit this. Thank you.

MR. KREPEL: Understood. Understood. That's a good statement.

CHAIR MARCH-LEUBA: We never made any topical reports that says enrichment has to be granted at 1 percent or 5, but if somebody comes up with a natural reactor with .7 and it doesn't apply, you'll have to review it if it's a big change.

MR. KREPEL: I know for the perspective on this topical report, I know that I specifically recognized and took a look that the way they approached the applicability in looking at the existing method that they used to analyze it and whether there were any limitations on the methodology would carry over into the new one for the CRDA analysis.

MEMBER REMPE: Thank you.

CHAIR MARCH-LEUBA: Okay. So we managed to recover all our technical difficulty time and we are ahead of schedule. I would like to propose to have a 10-minute break so we can switch to the closed session. You are free to sit in your original chairs. We are off the record --

MEMBER REMPE: Public comments.

CHAIR MARCH-LEUBA: We are not off the record because we need to ask for anybody in the room who wants to provide a comment because this is the opportunity in the public session.

Nobody in the room wants to make a comment. How about the phone? If anybody is on the phone line, could you please say hello to know that it's open?

MR. HECK: Hello. This is Charles Heck of GNF. We're hearing you. Can you hear me?

CHAIR MARCH-LEUBA: Yes, we can hear you. Does anybody on the phone line have a comment? If so, state your name and provide a comment. We waited a full three seconds and nobody said anything. We will assume we can close the public line now because we are going to go into closed session. You're dismissed. We're on a short recess.

(Whereupon, the above-entitled matter went off the record at 9:29 a.m. and resumed at 9:40 for the Closed Session.)

Global Nuclear Fuel

Control Rod Drop Accident (CRDA) Application Methodology

NEDE-33885P Review

December 3rd, 2019

Contents for Open Portion

Licensing Review

- Licensing Topical Report (LTR) Development Overview
  - Drivers
  - Approach
- Documentation Status
  - Request for Additional Information (RAI)
  - Limitations and Conditions (L&C)
  - Draft Safety Evaluation (SE)

LTR Development

Drivers

- Align with latest reactivity-initiated accident fuel damage guidelines
  - More thoroughly evaluate possible CRDA scenarios
- Improve plant operations
  - Allow for more flexibility during reactor startup
  - Prevent inadvertent subcriticality events
- Dose Improvements
  - Demonstrate zero fuel rod failures result from a CRDA

LTR Development (continued)

Approach

- Utilize previously approved methods
  - PANAC, PRIME, and TRACG
- Implement NRC guidance
  - Hydrogen and Fission Gas Release (FGR) models
  - Pellet Cladding Mechanical Interaction (PCMI) and High Temperature Cladding Failure (HTCF) thresholds
- Sources for NRC guidance
  - NRC Memoranda ML14188C423 (Reactivity-Initiated Accident Acceptance Criteria) and ML15133A306 (Hydrogen Uptake)
  - NUREG-0800, Sections 4.2, including Appendix B, and 15.4.9
  - DG-1327 (Control Rod Ejection and CRDA)

Current Status

Documentation

- CRDA LTR submitted for review February 2018
- NRC audit conducted October 2018
- All RAIs resolved March 2019
- L&C notification October 2019
- Draft SE issued October 2019
- Final SE anticipated January 2020
- Issue approved CRDA LTR expected February 2020
- Update GESTAR-II expected February 2020

Global Nuclear Fuel

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

NRC Review of GNF Control Rod Drop Accident (CRDA) Application Methodology, NEDE-33885P

Scott Krepel

Office of Nuclear Reactor Regulation, US NRC

Background

- NRC guidance for RIAs has evolved significantly in recent years
  - SRP 4.2 Appendix B
  - DG-1327
- Current GNF/GEH methods are based on BPWS
  - NEDE-33885P provides an approach better tailored to current guidance

Background

NEDE-33885P only covers an analysis procedure; all codes have previously been reviewed and approved by the NRC

- TGBLA (lattice physics)
- PANACEA (3D core physics)
- TRACG (thermal hydraulics)
- PRIME (fuel rod performance)

Additional validation performed to confirm applicability of codes to limiting CRDA events

Licensing Topical Report (LTR) Review Components

SRP 15.0.2 review areas (additional guidance in RG 1.203):

- Accident scenario
- Code assessment
- Evaluation methodology
- Uncertainty evaluation
- Documentation*
- Quality assurance*

*Implicitly addressed via GEH/GNF QA program and staff review of supporting documentation for this LTR

Regulatory Acceptance Criteria

Current regulatory requirements are defined in:

- 10 CFR 50.34 – general safety analysis reporting requirement
- GDC 13 – system parameters must be controlled adequately to bound design basis accidents
- GDC 28 – reactivity accidents must not damage reactor coolant pressure boundary or impede core cooling
- 10 CFR 100.11, 50.67 – radiation dose limits

Regulatory Acceptance Criteria

Current acceptance criteria to demonstrate regulatory compliance defined in SRP 15.4.9.II:

- Reactivity initiated accident criteria (SRP 4.2 App. B)
  - High temperature cladding failure
  - PCMI cladding failure
  - Core coolability
  - Fission product release inventory
- ASME reactor pressure vessel limit

Note: DG-1327 contains updated criteria that are intended to supplant the current criteria; second public comment period ended October 2019

CRDA Accident Scenario

Licensee characterized the CRDA scenario and relevant phenomena.

Critical output parameters are derived from acceptance criteria for CRDA event.

Identification of high importance phenomena is consistent with other available assessments for the CRDA or similar events.

CRDA Code Assessment

Assessments from code LTRs

- Code fidelity
- Thermal hydraulics models
- Global core neutron kinetics response

CRDA specific assessment

- SPERT III tests

CRDA Evaluation Methodology

Different aspects of the CRDA analysis methodology described in the LTR were reviewed.

- Modeling Guidance
- CRDA Analysis Procedure

CRDA Evaluation Methodology: Modeling Guidance

- TRACG Model Nodalization
- Reactivity Insertion
- Fission Gas Inventory
- Initial Parameters
- Doppler Coefficient
- Enthalpy Determination

CRDA Evaluation Methodology: Analysis Procedure

- At-Power & Cold Zero Power
- Analysis Parameters
- Control Rod Withdrawal Order
- Evaluation Against Acceptance Criteria

CRDA Uncertainties

Uncertainties were dispositioned for individual phenomena known to be important for the CRDA event:

- Bounding analysis parameters
- Sensitivity studies
- Analysis conservatism

GESTAR & Method Applicability

- GESTAR II updates to describe relevant documentation requirements (e.g., control rod withdrawal requirements)
- Clarifications regarding how methodology can be used
- New NRC approved models and codes can be used in lieu of those described in the LTR, subject to certain limitations

Conclusions

- The staff found NEDE-33885P to provide adequate guidance for use of PANACEA and TRACG to perform CRDA analyses.
  - Limitations and conditions associated with approved LTRs for individual codes remain applicable
  - Four additional limitations and conditions
    - Confirm key assumption (control rod drop speed)
    - Restrictions on extended applicability of methodology

Nomenclature

ASME – American Society of Mechanical Engineers
BPWS – Banked Position Withdrawal Sequence
CFR – Code of Federal Regulations
CRDA – Control Rod Drop Accident
DG – Draft Guide
FGR – Fission Gas Release
GDC – General Design Criteria
GEH – General Electric - Hitachi
GNF – Global Nuclear Fuel
LTR – Licensing Topical Report
NRC – Nuclear Regulatory Commission
NSRR – Nuclear Safety Research Reactor
PCMI – Pellet-Clad Mechanical Interaction
RIA – Reactivity Initiated Accident
RG – Regulatory Guide
SPERT – Special Power Excursion Reactor Test
SRP – Standard Review Plan

Backup Slides

Transient FGR Database

- Revised NSRR database shifted many data points and exposed a more prominent BU-dependence
- Large spread not unexpected, given spread in steady-state FGR data