From:	Sebrosky, Joseph
Sent:	Wednesday, January 12, 2022 12:46 PM
To:	Afzali, Amir; Cyril Draffin; HOLTZMAN, Benjamin
Cc:	NICHOL, Marcus; Shams, Mohamed; Segala, John; Bowen, Jeremy; Lynch, Steven; Hayes, Michelle; de Messieres, Candace; Jung, Ian; Oesterle, Eric; Bowman, Eric; Stutzke, Martin; Khan, Maryam; Hart, Michelle; Van Wert, Christopher; Cubbage, Amy; Steven Nesbit; Chisholm, Brandon Michael; AUSTGEN, Kati; Christopher P. Chwasz; 'Tom King'; Jim C. Kinsey Jr; Thomas Hicks; Vechioli Feliciano, Lucieann; Cuadrado de Jesus, Samuel
Subject:	Transmittal of NRC Staff Additional Considerations for Level of Information to be Provided in the Safety Analysis Report (SAR) for Anticipated Operational Occurrences (AOOs), Design Basis Events (DBEs) and Beyond Design Basis Events
Attachments:	Additional Discussion of Chapter 3 LBE Comment - final.docx

Amir Afzali
Southern Company Services
Licensing and Policy Director – Next Generation Reactors

Ben Holtzman
Program Advisor, New Reactors and Advanced Technology
Nuclear Energy Institute

Cyril Draffin
Senior Fellow, Advanced Nuclear
United States Nuclear Industry Council

Mr. Afzali, Mr. Holtzman, and Mr. Draffin,

The purpose of this email is to provide you with the attached document titled “Additional Considerations for Level of Information to be Provided in the Safety Analysis Report (SAR) for Anticipated Operational Occurrences (AOOs), Design Basis Events (DBEs) and Beyond Design Basis Events”. The attached document will be discussed during the January 18, 2022, technology inclusive content of application project (TICAP) public meeting (see: https://www.nrc.gov/pmns/mtg?do=details&Code=20211592)

This email will be captured in ADAMS and the email will be made publicly available so that interested stakeholders will have access to the information.

If you have questions regarding the attached documents please contact me or Eric Oesterle.

Sincerely,

Joe Sebrosky
Senior Project Manager
Advanced Reactor Policy Branch
Office of Nuclear Reactor Regulation
301-415-1132

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From: Sebrosky, Joseph

Created By: Joseph.Sebrosky@nrc.gov

Recipients:
"NICHOL, Marcus" <mrn@nei.org>
Tracking Status: None
"Shams, Mohamed" <Mohamed.Shams@nrc.gov>
Tracking Status: None
"Segala, John" <John.Segala@nrc.gov>
Tracking Status: None
"Bowen, Jeremy" <Jeremy.Bowen@nrc.gov>
Tracking Status: None
"Lynch, Steven" <Steven.Lynch@nrc.gov>
Tracking Status: None
"Hayes, Michelle" <Michelle.Hayes@nrc.gov>
Tracking Status:: Response: None : 1/6/2022 8:52:00 AM
"de Messieres, Candace" <candace.demessieres@nrc.gov>
Tracking Status: None
"Jung, Ian" <Ian.Jung@nrc.gov>
Tracking Status: None
"Oesterle, Eric" <Eric.Oesterle@nrc.gov>
Tracking Status: None
"Bowman, Eric" <Eric.Bowman@nrc.gov>
Tracking Status: None
"Stutzke, Martin" <Martin.Stutzke@nrc.gov>
Tracking Status: None
"Khan, Maryam" <Maryam.Khan@nrc.gov>
Tracking Status:: Response: None : 1/11/2022 9:00:00 AM
"Hart, Michelle" <Michelle.Hart@nrc.gov>
Tracking Status:: Response: None : 1/10/2022 8:48:00 AM
"Van Wert, Christopher" <Christopher.VanWert@nrc.gov>
Tracking Status: None
"Cubbage, Amy" <Amy.Cubbage@nrc.gov>
Tracking Status: None
"Steven Nesbit" <steve.nesbit@lmnt-consulting.com>
Tracking Status: None
"Chisholm, Brandon Michael" <BMCHISHO@SOUTHERNCO.COM>
Tracking Status: None
"AUSTGEN, Kati" <kra@nei.org>
Tracking Status: None
"Christopher P. Chwasz" <Christopher.Chwasz@inl.gov>
Tracking Status: None
'"Tom King'" <thomasking2993@gmail.com>

Tracking Status: None
"Jim C. Kinsey Jr" <jim.kinsey@inl.gov>
Tracking Status: None
"Thomas Hicks" <hickste@earthlink.net>
Tracking Status: None
"Vechioli Feliciano, Lucieann" <Lucieann.VechioliFeliciano@nrc.gov>
Tracking Status: None
"Cuadrado de Jesus, Samuel" <Samuel.CuadradoDeJesus@nrc.gov>
Tracking Status: None
"Afzali, Amir" <AAFZALI@southernco.com>
Tracking Status: None
"Cyril Draffin" <cyril.draffin@usnic.org>
Tracking Status: None
"HOLTZMAN, Benjamin" <bah@nei.org>
Tracking Status: None

Post Office: PH0PR09MB7436.namprd09.prod.outlook.com

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NRC Staff Additional Considerations for Level of Information to be Provided in the Safety Analysis Report (SAR) for Anticipated Operational Occurrences (AOOs), Design Basis Events (DBEs) and Beyond Design Basis Events

The NRC staff would like to understand industry's perspective in two areas regarding the level of information to be provided in the SAR for AOOs, DBEs, and BDBEs that follow guidance found in NEI 21-07, "Technology Inclusive Guidance for Non-Light Water Reactors Safety Analysis Report Content for Applicants Utilizing NEI 18-04 Methodology:"

1) Feedback regarding whether there is an inconsistency between the guidance provided in Chapter 2 of NEI 21-07, Revision 0 (ADAMS Accession No. ML21250A378) and NEI 21-07, Revision 0, Chapter 3

The current NEI 21-07, Revision 0, Chapter 3 states the following:

> "Details on the models, site characteristics, and supporting data associated with the calculation of mechanistic source terms and radiological consequences are part of the PRA [probabilistic risk assessment] documentation that is included in the plant records."

This chapter 3 wording appears to conflict with the following text in Chapter 2 since it implies that the type of information specified in Chapter 2 is to only be included in plant records.

The Rev 0-B NEI 21-07, Chapter 3 specifies that the following information be provided in the application for AOO, DBE, and BDBEs with releases:

- Identification of the reactors and non-reactor sources involved in the [AOO-DBE-BDBE]
- Plots of the responses of key plant parameters needed to characterize the plant response and the mechanistic source term, if there is a release
- Identification of common-cause failures between reactors, if applicable, and the reactors and sources impacted
- Tables to describe the mechanistic source term if there is a release
- The mean, 5th percentile, and 95th percentile values of the estimated frequency and dose
- Discussion of significant factors that influence any degradation of layers of defense (the staff notes that this bullet applies to NEI 21-07 AOO guidance but is missing from NEI 21-07 DBE and BDBE guidance)

The NRC staff has requested that the following additional information be provided in the application to the extent such information is not provided in methodologies and analyses discussions in Chapter 2, the event sequence summaries provided in Chapter 3, the functional or system descriptions in Chapters 5-7, or other sections of the SAR.

- Description of the models, site characteristics, and important supporting data associated with the calculation of the mechanistic source terms and radiological consequences.

It's also noted that Chapter 3 information may need to address a situation where a facility may have multiple mechanistic source terms and specific event sequences to address various systems that contain significant inventories of radioactive material.

The expectation here is nothing more than what NEI 21-07 Chapter 2 already specifies **provided the descriptions of the models and data extend to the associated event sequence consequence target instead of stopping at "the accessible environment."** NEI 21-07, Chapter 2 states (material highlighted

in yellow for emphasis – bracketed bold information identifies staff comments related to level of information in the SAR or an area that the staff would like to confirm):

> "[from Section 2.1.1]…Identification of the software and analytical tools that were used to perform the event sequence modeling and quantification, determine the mechanistic source terms, and perform radiological consequence evaluations…"
>
> [from Section 2.1.2]…there is information derived from the PRA provided for LBEs [licensing basis events] including the description of the plant response, human actions, relevant phenomena [**the staff would like industry to provide examples of relevant phenomena to which this guidance is referencing]**, and radiological consequences. The PRA results essential to the definition and evaluation of LBEs are included in Chapter 3 **[this could be considered important supporting data]** ….
>
> [from Section 2.2]…The applicant should address the transport of the radioactive material from its point of origin to the accessible environment. For light water reactors, this is typically done with computer codes such as LOCADOSE for design basis events or MAAP for beyond design basis events [**when extended to the associated event sequence consequence target the descriptions of models should include offsite dispersion models]**. The applicant should describe the available pathways for attenuation, retention, and transport of radionuclides. This includes the description of physical phenomena or empirical justification for the attenuation, retention, and transport of radionuclides through each barrier between the origin and the accessible environment **[this addresses important supporting data and when extended to the associated event sequence consequence target this should include the site characteristics]**."
>
> [from Section 2.4 Other Methodologies and Analyses]…Dispersion modeling…These analyses should be pertinent to the LMP [Licensing Modernization Project]-based affirmative safety case (i.e., to SR SSCs [safety-related structures, systems, and components] and/or associated special treatments). The applicant should describe the analytical methodology and the key inputs and assumptions used. The applicant should address the applicability of the analytical methodology to the specific analysis, including a discussion of supporting data. Details of the analyses should be in plant records and available for regulatory audits **[the staff would like clarity on how the discussion in NEI 21-07 Section 2.4 relates to the NEI 21-07 Section 2.2 and understand better what key information will be provided in the SAR. The staff is not looking for the same information to be captured in both Section 2.2 and Section 2.4. Rather, the staff is requesting an understanding of what key information will be provided in the SAR based on NEI 21-07 Section 2.2 and 2.4 guidance].**

In addressing the apparent discrepancy between Chapters 2 and 3, the staff would like industry to confirm that the guidance found in NEI 21-07 Chapter 2 would lead to important aspects of the AOO, DBE, and BDBE event sequence and source term information being captured in the SAR and not simply available in plant records.

In addition, NEI 21-07 Section 3.3 has in its italicized portion at the beginning: "*The technical adequacy of the non-DBA [design-basis accident] LBE analyses is therefore not based on the SAR documentation but on the PRA technical adequacy, established through conformance with the non-LWR [light water*

reactor] PRA Standard and substantiated by the associated peer review (see Chapter 2)." As written, it can be interpreted that no information regarding the technical adequacy of the non-DBA LBE analyses needs to be included in the SAR. Since NEI 21-07 Chapters 2 and 3 address information in the SAR that describes the adequacy of the non-DBA LBE analyses, it appears to be a conflict. The NRC staff therefore suggests a clarification of the sentence above.

2) The second area of interest to the staff is industry feedback on the following information that the staff believes is relevant to guidance for the NEI 21-07 Chapter 3 SAR content for AOOs, DBEs, and BDBEs. This information can be found in:

- guidance found in RG 1.203, "Transient and Accident Analysis Methods"
- an X-energy Xe-100 technology inclusive content of application project (TICAP) tabletop report
- a possible approach for reviewing mechanistic source terms through a topical report that is incorporated by reference into the SAR
- previous comments on TICAP guidance provided to industry
- guidance found in NEI 21-07
- RG 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, And Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors"

Regulatory Guide 1.203

Regarding description of LBE models, RG 1.203, *Transient And Accident Analysis Methods*, describes the level of documentation necessary to allow appraisal of the evaluation model (EM) application to the postulated scenario. The EM documentation should cover all elements of the evaluation model development and assessment process (EMDAP) process, and should include the following information:

- EM requirements
- EM methodology
- code description manuals
- user manuals and user guidelines
- scaling reports
- assessment reports
- uncertainty analysis reports

This information can be provided in a topical report.

X-energy Xe-100 TICAP Tabletop Exercise Report

A review of tabletop exercises (e.g., Xe-100) and Appendix B of NEI 21-07 did not identify instances where the type of information requested in NEI 21-07 Chapter 2 cited above was provided. However, the Xe-100 Tabletop Exercise Report dated August 2021 (ADAMS Accession No. ML21217A086) states the following in Section 4.1 of the report:

> "The descriptions of many general analysis methodologies and approaches were developed at a preliminary level of detail during the tabletop exercise, but it was recognized that Regulatory Guide 1.203 elements would be best placed in Chapter 2, including phenomena uncertainties,

evaluation model development, and sensitivity analyses and risk-significance discussion. Some of this content could be placed in subsequent chapters (i.e., LBE evaluations) as an alternative."

Mechanistic Source Term Topical Report Example

An example of an approach that the staff would like to discuss that might be consistent with the staff's recommendation above is the potential use of a mechanistic source term topical report being incorporated by reference into a SAR. For this example, the NRC staff notes that the NRC staff and the Advisory Committee on Reactor Safeguards (ACRS) are reviewing a Kairos Power Fluoride Salt Cooled High Temperature Reactor (KP-FHR) mechanistic source term methodology topical report Revision 1, dated August 19, 2021 (see: ADAMS Accession No. ML21231A289). The staff notes that the use of this example is for illustrative purposes and that because the Kairos topical report contains a methodology for development of source terms and consequence analysis, some input values are left to the implementation and would be reviewed in an application that uses the topical report. Another designer could potentially send a different topical report with a different scope and different information. The NRC staff would still expect the key analysis assumptions somewhere in the topical report that is incorporated into the SAR.

Regarding the Kairos example, the staff has issued a draft safety evaluation report on this topical report as noted in an email dated November 2, 2021 (see ADAMS Accession No. ML21307A043) and the ACRS has reviewed the topical report as noted in their letter report dated December 20, 2021 (see ADAMS Accession No. ML21342A179). This specific topical report describes a methodology to develop mechanistic source terms and radiological consequence analyses for DBAs to show compliance with the offsite dose criteria in 10 CFR 50.34(a)(1) for siting and safety analysis, and also source terms and consequences of AOOs and DBEs for use in the risk-informed process described in NEI 18-04, " Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development," as endorsed in RG 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content Of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors." While the review has not been completed on this topical report, and the tie to how source terms developed using the methodology in this topical report could be potentially used in the risk-informed LMP evaluation of LBEs with radiological consequences has not been established, the staff would like to discuss industry insights on whether incorporating the topical report in the SAR (assuming it is approved by the staff and ACRS, and the tie to how it is used in the LMP process is clearly established) would be consistent with the proposed TICAP guidance that the following information be captured in the SAR: Description of the models, site characteristics, and important supporting data associated with the calculation of the mechanistic source terms and radiological consequences.

Previous Staff Comments on DBE with Radiological Consequences Provided to Industry

Regarding the NRC staff previous comments in this area, the staff provided comments to industry on TICAP Revision E, in an email dated August 13, 2021 (ADAMS Accession No. ML21225A565). Industry's TICAP draft Revision E guidance included an Appendix B, "Example LBE Descriptions." One of the examples found in Appendix B with radiological consequences was a DBE description for a moisture in-leakage event for a modular high-temperature gas reactor. The staff provided comments/examples of

information that it would expect to be found in the proposed SAR Chapter 3 if such information was not included in other sections of the SAR. The staff comments included the following:

- expectation that the settings of protection system functions that were used in the evaluation, important assumptions, and SSC performance assumed in the analysis would be captured in the SAR.
- Discussion of how the Chapter 2 dose methodology was applied to the evaluation
- A basis for the statement that the one-time relief through the primary system relief valve causes a release of 15 percent of the circulating gases and particulates.

NEI 21-07 Guidance

As described above, Revision 0-B of NEI 21-07, Chapter 3 specifies that the following information be provided in the application for AOOs, DBEs, and BDBEs with releases (yellow highlighted material is for emphasis - bracketed bold information identifies staff comments related to level of information in the SAR) :

- Identification of the reactor and non-reactor sources involved in the [AOO-DBE-BDBE]
- Plots of the key plant parameters [**e.g., flow rates, temperatures, pressures, and trip setpoints]** needed to characterize the plant response and the mechanistic source term, if there is a release
- Identification of common-cause failures between reactors, if applicable, and the reactors and sources impacted
- Tables to describe the mechanistic source term if there is a release
- The mean, 5th percentile, and 95th percentile values of the estimated frequency and dose
- Discussion of significant factors that influence any degradation of layers of defense

Regulatory Guide 1.233

The NRC Regulatory Guide 1.233 describes the necessary level of information needed for non-DBA LBEs as follows (excerpt from Page 24):

> "The approach described in NEI 18-04 and this RG involves the assessment of event categories that extend from benign to severe. The analysis of AOOs, DBEs, and BDBEs plays an important role in defining safety functions, classifying SSCs, and assessing DID [defense-in-depth] for non-LWRs. The safety analysis report describes the analysis results for event sequences and related organization into event families. The PRA results are typically described in Chapter 19 of the safety analysis report, which could be expanded; a new section added to Chapter 15; or a new chapter created to include the analysis of AOOs, DBEs, and BDBEs. In addition to plant response information on SSC capabilities typically provided in deterministic evaluations, the description of AOOs, DBEs, and BDBEs needs to include or point to key information identified in NEI 18-04, such as uncertainties and measures to ensure assumed SSC availabilities."

This RG position supports the staff's comment that the analysis of AOOs, DBEs, and BDBEs (i.e., not just DBAs) plays an important role in defining safety functions, classifying SSCs, and assessing DID for non-LWRs.

NRC Staff Additional Considerations for Level of Information to be Provided in the Safety Analysis Report (SAR) for Anticipated Operational Occurrences (AOOs), Design Basis Events (DBEs) and Beyond Design Basis Events

Summary

1) There is an apparent discrepancy/conflict within NEI 21-07 Revision 0-B regarding the content expectations for Chapters 2 and 3. In conjunction with addressing this discrepancy, the NRC staff comment specifies that for LBEs with releases, the application contain level of detail information of the models and supporting data that is similar to that already specified to be included in the application describing releases to the accessible environment (i.e., outside the building) but extended to the associated event sequence consequence target (e.g., information regarding offsite dispersion models). This comment aligns with NEI 21-07's Chapter 2 content descriptions, does not impose an undue burden on the applicant, and would provide the necessary level of description of the event sequences.

2) Additional Chapter 3 detail regarding LBEs is needed, as reflected in the discussion above.