PUBLIC SUBMISSION

SUNI Review Complete
Template=ADM-013
E-RIDS=ADM-03

ADD: Jordan Hoellman, Mary Neely
Comment (2)
Publication Date: 6/30/2021
Citation: 86 FR 34794

As of: 8/31/21 2:24 PM
Received: August 30, 2021
Status: Pending_Post
Tracking No. ksz-3cu1-18fk
Comments Due: August 30, 2021
Submission Type: Web

Docket: NRC-2021-0112
Fuel Qualification for Advanced Reactors

Comment On: NRC-2021-0112-0001
Fuel Qualification for Advanced Reactors

Document: NRC-2021-0112-DRAFT-0003
Comment on FR Doc # 2021-13955

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General Comment

See attached file(s)

Attachments

08-30-21_NRC_Submittal of NEI comments on draft NUREG-2246 Fuel Qualification for Advanced Reactors

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NUCLEAR ENERGY INSTITUTE

August 30, 2021

Mr. John Segala
Chief, Advanced Reactor Policy Branch
Division of Advanced Reactors and Non-Power Production and Utilization Facilities
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Submittal of NEI comments on draft NUREG-2246, "Fuel Qualification for Advanced Reactors," 86 Federal Register 34794, 6/30/2021 (Docket ID: NRC-2021-0112)

Project Number: 689

Submitted via Regulations.gov

Dear Mr. Segala:

On behalf of the nuclear energy industry, the Nuclear Energy Institute (NEI)[1] appreciates the opportunity to provide comments on the U.S. Nuclear Regulatory Commission (NRC) draft NUREG on fuel qualification. Our comments below, and detailed in the attachment, are focused on achieving NRC's stated objective of providing clear criteria, derived from regulatory requirements, which when satisfied support regulatory findings for licensing.

Most notably, the specific purpose of the guidance is not clear throughout the document as it discusses criteria for both fuel qualification and how to prevent fuel damage during operation. The guidance should focus on what is needed for fuel qualification in a technology neutral method that can be applied to a variety of fuel types and therefore reactor designs. It is noted that fuel qualification is not specifically required for applicants to receive licensing approvals for design certification, combined licenses, manufacturing licenses, or standard design approvals. Rather fuel qualification is only necessary to meet the requirements referenced in NUREG-2246 Section 2.1 to the extent that the fuel is specifically relied upon as a safety feature, which some advanced reactor applicants may not pursue. The guidance should more explicitly consider that criteria

[1] The Nuclear Energy Institute (NEI) is responsible for establishing unified policy on behalf of its members relating to matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect and engineering firms, fuel cycle facilities, nuclear materials licensees, and other organizations involved in the nuclear energy industry.

for fuel qualification for advanced reactors may be much different than the criteria for large light-water reactors, because the role of fuel in performing safety functions for advanced reactors is expected to be different than the role fuel plays in large light-water reactors.

We appreciate the NRC's willingness to make the guidance as flexible as possible to enable the various approaches being considered by the numerous respective companies pursuing advanced reactors. Each advanced reactor design has its own unique challenges and advantages. Furthermore, we encourage the NRC to include as many examples for non-traditional LWR fuel designs in addition to the traditional LWR fuel design examples currently present in the draft guidance.

Similarly, many applicants will use data collected at the national laboratories that often do not use ASME NQA-1 to qualify their data and therefore the application of this standard for fuel data collected at national laboratories would not be possible. NRC has previously reviewed the quality assurance program plan (QAPP) for the U.S. Department of Energy's (DOE) Argonne National Laboratory (ANL). NRC staff determined that ANL's QAPP is based on the method provided in ASME's NQA-1-2008/2009 and satisfies the quality assurance requirements of Appendix B to 10 CFR Part 50 (ML20054A297). NRC should note in the NUREG that ANL and other DOE national laboratories use alternative and acceptable quality assurance methods for data collection that can be used for fuel qualification.

Another topic that we would like to see further clarified in the NUREG is the unique challenges associated with qualifying fuel for first core applications. The guidance focuses on existing programs such as the lead test specimens, which are valuable only when a prototypic reactor is available to test the fuel design. As such, lead test specimens would not be available as part of fuel qualification for a first core application before a prototypic reactor is operational. Including a pathway for licensing reactors to utilize a fuel design without a complete set of qualification data will be important for advanced reactors.

Thank you for your time and attention to this important matter. We would like to have a public meeting at some point to discuss the NUREG. If you have any questions or require additional information, please contact me.

Sincerely,

Ben Holtzman

Attachment

c: Timothy Drzewiecki, NRR, NRC
Jordan Hoellman, NRR, NRC

NEI Comments on draft NUREG-2246

Com #	Location	Comment	Proposed Change
1	General	There are numerous advanced reactor designs, with many different fuel designs, and each fuel design has its own unique challenges and advantages. This draft NUREG has a lot of guidance heavily based on existing LWR fuel designs, which may not be applicable to all advanced reactor designs. Please make the guidance more applicable to non-traditional fuel designs.	Please add examples for non-traditional LWR fuel designs.
2	General	Industry believes the draft NUREG allows for the flexibility for accelerated fuel qualification compared to the historical 20-year duration.	None
3	General	The term "safety case" appears to describe the safety function of the fuel independent of the definition from using risk-informed performance-based methodologies.	Please change "Safety Case" to "Fuel Safety Functions" in the document.
4	Page iii Line 4	The text states that "The purpose of this report is to identify criteria that will be useful for advanced reactor designs through an assessment framework that would support regulatory findings associated with nuclear fuel qualification." It is important to note that there is no specific regulatory requirement for the "qualification of fuel." The regulatory requirement referenced in this NUREG is 50.43, which requires the "performance of novel safety features be demonstrated through either analysis, appropriate test programs, experience, or a combination thereof." Fuel qualification is therefore only necessary to meet the requirements in Section 2.1 to the extent that the fuel is specifically relied upon as a safety feature.	The abstract section should be revised to clarify that fuel qualification is not a regulatory requirement and provide more context to how potentially applicable requirements would inform what is necessary for fuel qualification.
5	Page 1-1 Line 6	The NUREG primarily references the Crawford report when establishing the objective of fuel qualification and its corresponding basis. A technical paper (the Crawford report) does not establish a regulatory basis and is not appropriate to establish the regulatory need for fuel qualification. Furthermore, the noted economic operation in the Crawford report is not something that NRC should be regulating on.	Please replace the reference of a technical paper with a regulatory one (when identified as a means to do so) and remove reference to economics as a regulatory goal.

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6	Page 1-1 Line 14	The term "base goal" is confusing - even with the footnote.	Please add additional information regarding how the base goal meets high-level regulatory requirements.
7	Page 1-1 Lines 20-24	The text states "this framework relies on regulatory requirements that are applicable to applications for design certifications, combined licenses, manufacturing licenses, or standard design approvals." However, fuel qualification itself is not required for any of the mentioned licensing approvals. Fuel qualification is therefore only necessary to meet the requirements in Section 2.1 to the extent that the fuel is specifically relied upon as a safety feature.	Please clarify the connection of fuel qualification to the noted licensing approvals, or modify the text to more clearly denote more context to how potentially applicable requirements would inform what is necessary for fuel qualification.
8	Page 1-2 Lines 4-6	The following text is confusing because it is not consistent with the stated purpose of the document: "The scope of this report focuses on the identification and understanding of fuel life-limiting failure and degradation mechanisms due to irradiation during reactor operation." Therefore, it is unclear whether the purpose of the report is for the identification of safety functions of the fuel and its performance in a reactor, or for fuel performance in general.	Please clarify the regulatory basis of this NUREG and ensure alignment throughout the report.
9	Page 1-2 Lines 5-6 and Section 3.1.1	Fuel life-limiting failure and degradation mechanisms are not just due to irradiation during reactor operation. Other degradation mechanisms, chemical attacks, hydrogen pickup, high temperature, and time at temperature during AOOs or Design Basis Accidents also impact fuel performance.	Please remove "due to irradiation" to expand the applicability of the statement to include other failure mechanisms.
10	Section 2.1	The regulatory basis denoted is 50.43(e) and the design criteria (GDC and ARDC). However, the GDC and ARDC are not requirements for, and as guidance are not required to be met by, non-LWRs. Thus, non-LWRs may choose to develop PDCs through another method. The guidance should clarify that fuel qualification is only necessary if it is determined to be one of the PDCs for the design, based upon the fuel being relied upon as a safety feature.	Please clarify the text to indicate how fuel qualification could be used to demonstrate compliance to 50.43 but is not necessary if fuel is not relied upon as a safety feature. Additional context on how potentially applicable requirements would inform what is necessary for fuel qualification would be helpful.

Com #	Location	Comment	Proposed Change
11	Section 2.2.1	The specific purpose of the guidance is not clear throughout the document. The guidance discusses both fuel qualification and how to prevent mechanical damage of traditional LWR fuel - as noted in Section 2.2.1.	Please provide additional clarification regarding the intent of the guidance.
12	Page 2-3 Line 17	Section 3.2.2 refers to "fuel failures" rather than “fuel rod failures” as noted in this paragraph. Please consider using “fuel failures” as it is more generally applicable. NUREG-0800 appropriately uses the term “fuel rod failures.”	Please replace "fuel rod failures" with "fuel failures."
13	Section 2.2.2	While the information listed here relates to Accident Tolerant Fuel (ATF), which may only be applicable to some advanced reactor fuel designs, the intent of the section appears to be the potential of the PIRT process. It is therefore confusing to title the section as the ATF ISG.	Please revise this section to focus on the PIRT process as one acceptable method for identifying failure mechanisms and features of an evaluation model.
14	Page 2-4 Lines 18-20	The following text is misleading because fuel may have safety functions as noted in the text, but it is not required to. It is possible to not credit the fuel and instead credit other mechanisms outside of the fuel matrix. Fuel qualification is therefore only necessary to meet the requirements in Section 2.1 to the extent that the fuel is specifically relied upon as a safety feature. "Fuel qualification partially addresses the fundamental safety functions of control of reactivity, cooling of radioactive material, and confinement of radioactive material…"	Please clarify the role of fuel qualification and its necessity only if being relied upon and/or credited in the safety analysis as some designs may not. Additional context on how potentially applicable requirements would inform what is necessary for fuel qualification would be helpful.
15	Page 2-4 Lines 31-35	The text mentions work on fuel qualification for molten salt reactors, but does not mention the work on other fuel designs such as EPRI's Topical Report for TRISO fuel qualification.	Please add information for the TRISO fuel qualification and other relevant development work.

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16	Section 2.4 Page 2-5 and Section 3.4.2, Page 3-17, Lines 9-20	The text here on lead test specimen programs is applicable only if we had existing/operating advanced reactors. It does not discuss alternatives for fuel to be qualified for first core applications where lead test specimens are not possible.	Please add information on fuel qualification for first core applications.
17	Section 3.1.3	The TRISO SER allows for manufacturing independence as long as the final product has properties that fall within the specification range. Please note TRISO as an example of "insensitivity to manufacturing processes."	Please add text to denote that the TRISO is an example of fuel that has an insensitivity to manufacturing processes and instead measurable criteria can be used to justify predicted performance.
18	Figures 3-3 and 3-8, Section 3.2.3 and other locations	Criterion G2.3 includes a statement for the "ability to achieve and maintain safe shutdown can be assured." The NUREG further defines safe shutdown as "a state in which the reactor is subcritical, decay heat is being removed, and radionuclide inventory is contained." However, safe shutdown and safe state are not interchangeable. Not all reactors must be subcritical to be safe and therefore it is not necessary for all fuel types to be subcritical. Industry recommends aligning the NUREG with other documentation that use the phrase "a safe stable end-state" instead.	Please change criterion G2.3 to "Ability to achieve and maintain a safe, stable, end state" and revise the text throughout to be consistent with this revised criterion.
19	Page 3-4 Line 7	The text states that "This performance envelope informs the safety analysis and technical specifications for the design (i.e., limiting conditions for operation)." The use of LCO in this context is unclear. LCOs are typically defined for active systems in a facility, whereas design features are defined for fuel systems.	Please remove the reference to LCOs or clarify how this is intended to inform LCO development.

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20	Page 3-5 Line 20	The statement that "conditions to which the fuel is subjected during design-basis accidents may be specified independent of the reactor design…" is unclear and should be further justified.	Please clarify the text.
21	Page 3-6 Lines 1-2	The following text is vague. "To satisfy G2.2.1, the degree of radionuclide retention within the fuel system should be specified."	Please clarify the text regarding the quantification of retention.
22	Page 3-6 Lines 19-20	The text denoting the statistical confidence level example "(e.g., 95/95)" is one way to incorporate uncertainties. Another way is to bound it within the uncertainty quantification parameters.	None
23	Page 3-8 Lines 14-16	No specific criterion is set as to what the term "coolable geometry" means for non-traditional LWR fuel designs. For example, some advanced reactor fuel designs like the MSFR and the MCFR are planning on using liquid salt with fissile product as both their coolant and their fuel, which would require clarification/flexibility on the definition of "coolable geometry."	Please clarify what a coolable geometry criterion would be for fuel designs that do not have a containment (e.g., LWR fuel cladding) and how this will ensure ability to attain safe, stable, end state.
24	Page 3-9 Lines 2-8	Please include additional examples applicable for non-traditional LWR fuel designs (e.g., gas cooled reactors or solid core block reactor fuel designs). These designs may have fuel channels that are separate or away from control rods or drums. Noting diverse phenomena for such designs will make the NUREG more useful to industry applicants.	Please add examples for non-traditional LWR fuel designs.
25	Page 3-9 Line 24	“form” should be “from”	Please made editorial change as noted.
26	Page 3-10 Lines 5-9	For designs that do not have neutron control element insertion (e.g., control drums), having criteria to ensure control element insertion paths would not be necessary.	Please revise text to indicate criteria should be specified only for designs with neutron control elements whose insertion is credited in accident response models.

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27	Page 3-12 Lines 28-33	Some phenomena do not have a known explicit mechanistic physics code available. Please clarify whether evaluation physics models can be mechanistic or empirical in nature, so that phenomena that are known but do not have an explicit first-principles model can be covered. For example, a SiC layer degradation mechanism would not be explicitly modeled in fuel performance codes.	Please clarify the text regarding the modeling of phenomena.
28	Page 3-16 Line 18	"Data analytics" may be more applicable than "machine learning" as the latter implies the need for an artificial intelligence system, which may not be needed to perform the role noted.	Please replace "machine learning" with "data analytics."
29	Page 3-16, Lines 38-47	The text does not address methods for justifying when fuel can be used beyond its performance envelope when lead test specimens are not available.	Please add information on what adequate justification is needed to expand the performance envelope using experimental data without the use of lead test specimens.
30	Page 3-17 Line 34	ASME NQA-1 is not the only way to qualify fuel data. For data collected at national laboratories, the application of this standard may not be possible, despite the national laboratories using alternative and acceptable quality assurance methods. NRC should accept data from the technical experts at national laboratories if the data was collected under the lab's QA program as noted in ML20054A297, where NRC staff determined that Argonne National Lab's quality assurance program plan is based on the method provided in ASME's NQA-1-2008/2009 and satisfies the quality assurance requirements of Appendix B to 10 CFR Part 50.	Please either remove or modify the text to allow for data to also be qualified under the commercial grade dedication (CGD) process rather than stating data must be made compliant.