



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
WASHINGTON, D.C. 20555-0001

June 17, 2022

**X ENERGY, LLC – DRAFT SAFETY EVALUATION OF XE-100 LICENSING TOPICAL
REPORT: RISK-INFORMED PERFORMANCE-BASED LICENSING BASIS DEVELOPMENT,
REVISION NO. 2 (EPID L-2021-TOP-0019)**

SPONSOR AND SUBMITTAL INFORMATION

Sponsor: X Energy, LLC (X-energy)

Sponsor Address: X Energy, LLC
801 Thompson Ave
Rockville, MD 20852

Project No.: 99902071

Submittal Date: June 25, 2021 (Topical Report (TR) Revision 1)
March 15, 2022 (TR, Revision 2)

Submittals Agencywide Documents Access and Management System (ADAMS)

Accession Nos.: ML21196A069 (TR Revision 1); ML22074A288 (TR Revision 2)

Brief Description of the Topical Report: This topical report (TR) describes how the risk-informed performance-based methodology, contained in the Licensing Modernization Project (LMP), is being implemented by X-energy for design, analysis, and licensing of its Xe-100 reactor. The guidance regarding the LMP is contained in Nuclear Energy Institute (NEI) 18-04, Revision 1, "Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development" (Reference 1), and the U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (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, Certification, and Approvals for Non-Light-Water Reactors" (Reference 2). RG 1.233 endorses, with clarifications, NEI 18-04, Revision 1. X-energy requested that the NRC staff review the approach described in this TR to determine its acceptability in implementing the NEI 18-04 guidance for the selection of licensing basis events (LBEs); classification of structures, systems, and components (SSCs) and associated special treatments; determination of defense-in-depth (DID) adequacy for non-LWRs; and addressing the clarifications provided in RG 1.233. X-energy intends to use the TR to inform the content for future safety analysis reports to fulfill the regulatory requirements for prospective Xe-100 licensing applications under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities;" 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants"; and/or future 10 CFR Part 53.

For additional details regarding the submittals, please refer to the documents located under the ADAMS Accession Numbers identified above.

REGULATORY EVALUATION

Regulatory Basis: The regulations under 10 CFR 50.34, “Contents of applications; technical information;” 10 CFR 52.47, “Contents of applications; technical information;” 10 CFR 52.79, “Contents of applications; technical information in final safety analysis report;” 10 CFR 52.137, “Contents of applications; technical information;” and 10 CFR 52.157, “Contents of applications; technical information in final safety analysis report” contain the technical requirements for applications for a construction permit, operating license, standard design certification, combined license, standard design approval, and manufacturing license for nuclear power facilities.

RG 1.233 provides the NRC staff’s guidance regarding using a technology-inclusive, risk-informed, and performance-based methodology to inform the licensing basis and content of applications for non-light-water reactors (non-LWRs). It endorses, with clarifications, NEI 18-04, Revision 1, as one acceptable method for informing the licensing basis and determining the appropriate scope and level of detail for parts of applications for licenses, certifications, and approvals for non-LWRs.

NEI 18-04, Revision 1, presents a technology-inclusive, risk-informed, and performance-based process for selection of LBEs, classification of SSCs and associated special treatments, and determination of DID adequacy for non-LWRs. It provides applicants one acceptable method for informing the licensing basis and content of applications regarding the forementioned topics above.

TECHNICAL EVALUATION

Consistent with X-energy’s request, the NRC staff evaluated the approach described in this TR to determine its acceptability in implementing the NEI 18-04 guidance for selection of LBEs, classification of SSCs and associated special treatments, and determination of the DID adequacy, and in addressing the clarifications provided in RG 1.233. The NRC staff’s evaluation is based on TR, Revision 2, which has been updated from TR, Revision 1, to address the NRC staff’s preliminary questions (Reference 3). The meeting summary for the virtual public meeting held between the NRC staff and X-energy regarding the set of preliminary questions developed by the NRC staff to improve its understanding of the information provided in the TR can be located in ADAMS under Accession No. ML21347A947. In its evaluation, the NRC staff primarily used the guidance in RG 1.233, Revision 0 and NEI 18-04, Revision 1.

Section 1 of the TR summarizes the purpose, scope, interfacing references, and applicable regulations of this document. Section 2 outlines the applicability of the LMP approach outlined by RG 1.233 to licensing of the Xe-100 design.

Sections 3 through 5 of the TR, which correspond to Sections 3 through 5 of NEI 18-04, cover selection of LBEs, classification of SSCs and associated special treatments, and determination of the DID adequacy, respectively. Each section presents a discussion of how the Xe-100 approach (called the Xe-100 Program) adopts, or provides additional implementation descriptions to, the guidance in NEI 18-04. For example, Section 3 of the TR specifies that the current LBE frequency estimates are based on insights from previous high-temperature gas-cooled reactor technologies and will be refined further to incorporate new information from the Xe-100 design, safety analyses, and probabilistic risk assessment (PRA). These three TR sections also address the following eight clarifications identified in RG 1.233:

- Subsection 3.4, Clarification C.1.a through C.1.e (Selection of LBEs)

- Subsection 4.5, Clarification C.2.a, and C.2.b (Classification of SSCs)
- Subsection 5.10, Clarification C.3.a (Determination of the DID Adequacy)

The NRC staff confirmed that Sections 3 through 5 of the TR follow the guidelines provided by the corresponding sections of NEI 18-04 with no deviations, but it adds implementation descriptions for clarity. The NRC staff found that the added descriptions in the TR are minor and remain consistent with the principles and methodology in NEI 18-04. The TR also follows the NRC staff's clarifications (i.e., NRC Staff Positions) described in RG 1.233 but contains additional implementation descriptions to the clarifications. The NRC staff finds that the added descriptions to the RG 1.233 clarifications in the TR are minor and acceptable as they are within the guidelines provided by RG 1.233. For example, RG 1.233, Section C.1.c provides, in part, that if an applicant proposes a method for identifying a design-basis external hazard level (DBEHL) that the NRC staff has not previously reviewed and approved, the NRC staff will review such methodologies on a case-by-case basis. X-energy's additional implementation descriptions for this clarification states that while NEI 18-04, as endorsed by RG 1.233, uses the term DBEHL, X-energy instead uses the term DBHL to clarify that both external and internal hazards are considered. X-energy states that it expects to "use NRC reviewed and approved methods to identify DBHLs." However, it acknowledges that if it chooses to propose methods that have not been previously reviewed and approved, such methods would be reviewed by the NRC staff on a case-by-case basis. In all, the NRC staff determined that the approach, as described in the TR in implementing the NEI 18-04 guidance, is acceptable because the proposed approach meets the principles and methodology in NEI 18-04, and the clarifications provided in RG 1.233.

Since the TR is based on NEI 18-04 and guidance included in RG 1.233, statements from RG 1.233 regarding exemptions from NRC regulations apply. For example, the applicant's methodology, consistent with NEI 18-04, defines and uses some terms in a manner that differs from NRC regulations. Thus, consistent with RG 1.233, an applicant referencing this TR is expected to "identify exceptions to and exemptions needed from NRC regulations," as needed. Also, as stated in RG 1.233, "...system designs and safety evaluations may also demonstrate compliance with or justify exemptions from specific NRC regulations." The TR does not request approval of any exemptions and the NRC staff is not approving any exemptions in this safety evaluation (SE). Thus, the NRC staff is adding Item 1 of this SE, "Limitations and Conditions," to clarify that this SE is not approving any exemptions and that an applicant using this TR will need to address compliance with pertinent regulations and request exemptions, as needed.

Section 6 of the TR describes the X-energy's plan for implementing the risk-informed, performance-based licensing basis framework.

LIMITATIONS AND CONDITIONS

The NRC staff imposes the following limitations and conditions with regard to the subject TR:

- This SE does not approve any exemptions from NRC regulations, and an applicant using this TR will need to address compliance with pertinent regulations and request exemptions as needed.

CONCLUSION

Based on consistency with RG 1.233 and NEI 18-04, the NRC staff finds that X-energy TR, "Xe-100 Licensing Topical Report: Risk-Informed Performance-Based Licensing Basis

Development, Revision 2,” subject to the limitations and conditions discussed above, provides an approach acceptable to the NRC staff in the selection of LBEs, classification of SSCs and associated special treatments, and determination of the DID adequacy based on a risk-informed and performance-based process.

Accordingly, the NRC staff concludes that the X-energy TR can be used to inform the licensing basis of the Xe-100 reactor design that supports the compliance with the relevant regulatory requirements for the prospective Xe-100 reactor licensing applications under 10 CFR Parts 50 and 52.

REFERENCES

1. Nuclear Energy Institute, NEI 18-04, Revision 1, “Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development,” issued August 2019 (ADAMS Accession No. ML19241A472).
2. Regulatory Guide, 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,” Revision 0, issued June 2020 (ADAMS Accession No. ML20091L698).
3. NRC, “U.S. Nuclear Regulatory Commission Preliminary Questions regarding X Energy LLC Topical Report: Xe-100 Risk-Informed Performance-Based Licensing Basis Development,” Revision 2, issued November 2021 (ADAMS Accession No. ML21312A478).

Principal Contributor(s): Ian Jung
Hosung Ahn

Date: June 17, 2022