

REQUEST FOR ADDITIONAL INFORMATION
ON THE NRC ASSESSMENT OF
THE XE-100 LICENSING TOPICAL REPORT: "CONTROL ROOM STAFFING ANALYSIS
METHODOLOGY AND IMPLEMENTATION PLANS"
X ENERGY, LLC
EPID: L-2021-TOP-0028

Title 10 of the Code of Federal Regulations (10 CFR), Part 50.54(m), provides the current requirements for control room staffing at commercial nuclear reactor facilities licensed under 10 CFR, Part 50, as well as reactor designs certified under 10 CFR, Part 52.

Chapter 13 of the U.S. Nuclear Regulatory Commission (NRC) Standard Review Plan (SRP) (NUREG-0800) provides guidance in Sections 13.1.2 - 13.1.3, "Operating Organization," for the review of the operating organization for commercial nuclear reactor facilities. This guidance states that the NRC staff should use the procedures and criteria delineated in NUREG-1791, "Guidance for Assessing Exemption Requests from the Nuclear Power Plant Licensed Operator Staffing Requirements Specified in 10 CFR 50.54(m)," to evaluate requests for exemptions from the licensed operator staffing requirements specified in 10 CFR 50.54(m).

In accordance with 10 CFR 52.7 and 50.12, the NRC must determine, in part, that granting an exemption will not present an undue risk to the public health and safety. In reviewing exemption requests, the NRC staff must determine whether the staffing proposals provide adequate assurance that public health and safety will be maintained at a level that is comparable to compliance with the current regulations. The guidance in NUREG-1791 describes a technical basis that the NRC has determined to be adequate to demonstrate that a staffing proposal will maintain public health and safety at a level that is comparable to that afforded by compliance with 50.54(m).

By letter dated January 4, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22004A333), X Energy LLC (X-energy) submitted topical report XE00-R-R1ZZ-RDZZ-X-000714, "Xe-100 Licensing Topical Report: Control Room Staffing Analysis Methodology and Associated Implementation Plans," Revision 2 (the Topical Report), for U.S. Nuclear Regulatory Commission (NRC) staff review. By letter dated August 24, 2022 (ADAMS Accession No. ML22236A665), X-energy provided supplementary information regarding this topical report. This topical report discusses X-energy's proposed methodology for conducting control room staffing analyses for the Xe-100 reactor design. Analyses performed using this methodology are intended to provide the technical basis for the number, roles, and qualifications of the control room operators, which is intended to be used by prospective Xe-100 licensees to request exemptions from the staffing requirements of 10 CFR 50.54(m).

The Topical Report, Section 7, "NRC Topical Report Review Objectives," states the following:

This report has been prepared to provide the proposed methodology for the Xe-100 HFE Program, which will be used as the basis for developing the technical basis for control room staffing in accordance with the guidance in NUREG-1791, or in support of a future

10 CFR 52 Design Certification application. X-energy is requesting NRC review and acceptance of this approach as a means to conduct the HFE program methodologies to support approval of the Xe-100 control room staffing and develop a valid basis for licensees requesting exemptions from 10 CFR 50.54(m) or X-energy to use in support of a future Design Certification application.

Based on X-energy's stated review objectives, NRC staff are reviewing the Topical Report to determine whether control room staffing analyses performed using the proposed methodology can be reasonably expected to align with the criteria outlined in NUREG-1791. In conducting this review, the staff have identified areas where additional information or clarification is needed to complete the review.

1. NUREG-1791, Section 2, "Review the Concept of Operations," Subsection 2.3, "Review Criteria," states that the NRC staff reviewing the control room analysis should confirm that the applicant's description of the concept of operations for the plant or system is complete and that the applicant has addressed each of the aspects of operations and roles of the control personnel.

NUREG-1791, Subsection 2.2, states that the concept operations should include a description of operations during construction of additional units.

The Topical Report, Section 4.1, "Concept of Operations," states that the Xe-100 Concept of Operations "includes the starting premises for [...] aspects related to multi-unit operations during construction of additional units (as applicable)."

NRC staff reviewed X-energy's Xe-100 Concept of Operations, Revision 1 (not submitted on the docket, but made available for review by NRC staff), but did not identify a discussion of the operation of existing units during construction of additional units.

Please confirm that the operation of existing Xe-100 units during construction of additional units will be addressed in a future revision to the Xe-100 Concept of Operations.

2. NUREG-1791, Section 7, "Review the Job Definitions," states in part, "The reviewer should ensure that the applicant's job definitions appropriately prioritize the responsibilities of each position and do not incorporate role conflicts."

NUREG-1791, Section 7, further states in part:

A job that consists of interrelated responsibilities and authorities that do not conflict would be coherent. A classic example of conflicting responsibilities would be a Senior Operator in a traditional control room, who is charged with maintaining an overview of operational conditions. These additional responsibilities may compromise his or her ability to maintain "the big picture." Conflicting responsibilities, in the past, have included responsibilities for taking control actions or responding to information requests from personnel outside of the control room. The reviewer should ensure that the applicant's job definitions appropriately prioritize the responsibilities of each position and do not incorporate role conflicts.

The Topical Report, Section 4.5, "Task Analysis," states in part, "The task analysis provides information to identify task timing and workload issues, giving potential information to determine conflicts that would affect the staffing configuration." However, the Topical Report does not describe how job definitions will be reviewed for conflicting responsibilities, so that the job definition appropriately prioritizes the responsibilities and does not incorporate role conflicts.

Please confirm that the job definitions will be reviewed for role conflicts and that any potential conflicts will be evaluated and corrected if necessary. If not, please describe how the operators will have coherent responsibilities and authorities.

3. NUREG-1791, Section 10, "Review the Staffing Plan Validation," states the following:

The applicant should provide data or demonstrations that the control personnel specified in the staffing plan can satisfy the plant and human performance requirements identified in the functional requirements analysis, function allocation, and task analyses. These data or demonstrations may come from operating experience, human-in-the-loop simulations, human performance models, or a mix of these methods. The data or demonstrations should include the full range of operational conditions identified for the exemption request, as well as a reasonable representation of the human performance variability expected in the context of the operational conditions.

The Topical Report, Section 4.9, "Staffing Plan Validation," indicates the following:

The staffing plan validation (SPV) refers to an assessment using performance-based tests to determine whether the staffing plan meets performance requirements and acceptably supports safe operation of the plant.

The validation tests of the HFE Program will be performed during different phases of the design. In the beginning, this is done by early partial validations with portions of the HSI design. Finally, when the complete simulation environment is ready, the Integrated System Validation (ISV) is performed.

Additionally, Section 4.9 states, "The process and methodology for the human-in-the-loop simulations are described further in the Xe-100 Verification & Validation Implementation Plan."

The Topical Report, however, does not explicitly state whether the full scope of ISV testing is being credited for completion of the SPV.

Please confirm whether the full scope of integrated system validation (ISV) testing is being credited towards the completion of the staffing plan validation (SPV). If not, please indicate what subset of the validation activities being performed within the HFE Program is intended to fulfill the needs of the SPV program. (For example, completion of the SPV may only rely on specific operating conditions assessed as part of the ISV testing, in conjunction with additional tests, partial validations, and/or other validation activities.)

4. NUREG-1791, Section 10, "Review the Staffing Plan Validation," includes among the review criteria listed in Subsection 10.3.1, "Operational Conditions Sampling," the following:

- Scenarios relevant to the exemption request were used.
- Scenarios that challenge the personnel, plant, and system were used

The Topical Report, Section 4.9, "Staffing Plan Validation," states the following:

"Staffing baseline resulting from the [staffing and qualification] analysis is tested in the HFE Program during the Verification and Validation activities."

Additionally, Section 4.9 lists – among the fundamental characteristics for the staffing plan validation (SPV) – the following:

2. Testbed conditions. A description of the validation environment, providing:

- the scenarios to be tested,
- representative number of crews and scenario repetition,
- the state of the simulator,
- the simulation conditions, and
- the number and duties of the HFE observers."

Furthermore, Section 4.9 states the following:

"The process and methodology for the human-in-the-loop simulations are described further in the Xe-100 Verification & Validation Implementation Plan."

Within the submitted Human Factors Verification and Validation Implementation Plan, Section 3.2.3.1.5, "Selected scenarios," states the following regarding the testbed to be used during validation and verification (V&V) activities:

"The scenarios selected for the V&V may be adjusted for the fidelity of the test bed being used. The test bed may not have the functionality and fidelity to allow for the performance of all the scenarios. The specific ISV procedure will identify the characteristics of the test bed and what scenarios will be performed."

However, specific information is not provided within the topical report regarding testbed limitations anticipated during SPV testing and the potential impact of those limitations on SPV testing.

To determine whether the simulator, at the time that SPV testing is performed, will provide sufficient fidelity to simulate environmental conditions as needed to adequately test personnel performance in high-workload situations, additional clarification is needed.

Please explain how the proposed methodology will ensure that relevant scenarios that challenge the personnel, plant, and system are used for staffing plan validation (SPV) purposes, despite the potential need to make adjustments due to possible test bed functionality/fidelity limitations. At a minimum, please confirm explicitly that testbeds used to conduct SPV activities will be of sufficient fidelity to allow realistic simulation of high workload demands (e.g., during complex operational evolutions or off-normal/accident conditions).