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

December 20, 2021

MEMORANDUM TO: Matthew W. Sunseri, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Taylor, Robert signing on behalf of Veil, Andrea on 12/20/21

FROM: Andrea D. Veil, Director
Office of Nuclear Reactor Regulation

SUBJECT: STAFF RESPONSE TO ACRS LETTER DATED NOVEMBER 23, 2021, IN REGARD TO NUREG-2246, "FUEL QUALIFICATION FOR ADVANCED REACTORS: DRAFT REPORT FOR COMMENT"

The purpose of this memorandum is to provide the U.S. Nuclear Regulatory Commission (NRC) staff's response to the Advisory Committee on Reactor Safeguards (ACRS, the Committee) letter dated November 23, 2021, (Agencywide Document Access and Management System (ADAMS) Accession No. ML21319A350) on the draft NUREG-2246, "Fuel Qualification for Advanced Reactors: Draft Report for Comment."

During the 690th meeting of the Advisory Committee on Reactor Safeguards, November 2-5, 2021, ACRS reviewed draft NUREG-2246. Previously, the ACRS Future Plant Designs Subcommittee (SC) reviewed this matter on February 2, 2021. In the letter dated November 23, 2021, the ACRS provided conclusions and recommendations on the draft NUREG-2246. The NRC staff reviewed the conclusions and recommendations, and the NRC staff's responses are provided below:

ACRS Conclusion and Recommendation 1:

> *The draft NUREG report provides a logical approach to fuel qualification. The top-down approach is methodical and provides some assurance of completeness when a claim is made that a nuclear fuel is qualified. Key parts of the approach are identifying relevant experimental data and assessing associated safety margins.*

ACRS Conclusion and Recommendation 2:

> *After the comments provided in this letter are addressed, the draft NUREG report should be finalized.*

CONTACTS: Jordan Hoellman, NRR/DANU
301-415-5418

Timothy Drzewiecki, NRR/DANU
301-415-5481

ACRS Comment 2-1:

Addressing the misalignment in the safety functions in the draft NUREG with those being developed as part of draft 10 CFR [Title 10 of the Code of Federal Regulations] Part 53

NRC Staff Response 2-1:

The NRC staff appreciates the ACRS feedback and in response revised Section 2.2.3, "Regulatory Guide 1.233," Section 3.2.2.3, "Criteria for Barrier Degradation," and Section 3.3.1.3, "EM G1.3 - Physics Modeling," to clarify that safety functions may include chemical attack, temperature effects, and/or other phenomena specific to a particular fuel design. Because Title 10 of the *Code of Federal Regulations* (10 CFR) Part 53 is currently a preliminary proposed rule and is not a final rule, the NRC staff will continue to ensure alignment between guidance documents, including NUREG-2246, and the Part 53 rulemaking, as the rule develops.

ACRS Comment 2-2:

Rewording to accommodate other environmental degradation mechanisms beyond irradiation and discussing relevant chemical phenomena, as appropriate

NRC Staff Response 2-2:

The NRC staff appreciates the ACRS feedback and in response revised the phrase "due to irradiation" to "due to irradiation and exposure to the in-reactor environment," in Section 1.4, “Scope,” Section 2.1, “Regulatory Basis,” and Section 3.1.1, “G 1.1 - Dimensions.” Relevant chemical phenomena are addressed as part of the resolution to ACRS Comment 2-1 by revising Section 2.2.3, "Regulatory Guide 1.233," Section 3.2.2.3, "Criteria for Barrier Degradation," and Section 3.3.1.3, "EM G1.3 - Physics Modeling."

ACRS Comment 2-3:

Assuring empirical approaches are acceptable as an evaluation model

NRC Staff Response 2-3:

The NRC staff appreciates the ACRS feedback and in response updated Section 3.3, "Assessment Framework for Evaluation Models," to state that “empirical models, simplified mathematical expressions, or comparisons against data can serve as an evaluation model if sufficient evidence exists to support its use.”

ACRS Comment 2-4:

Expanding on the use of AFQ [accelerated fuel qualification] in the overall assessment framework

NRC Staff Response 2-4:

The NRC staff appreciates the ACRS feedback and in response expanded the discussion in Section 2.3, “Accelerated Fuel Qualification,” to (1) incorporate recent references from the accelerated fuel qualification (AFQ) community, and (2) add subsections 2.3.1, “Fission

Accelerated Testing," and 2.3.2, "Reduced Number of Integral Irradiation Tests," to provide further discussion on these key topics related to AFQ. These updates clarify and explain how the framework presented in Section 3, "Fuel Qualification Assessment Framework," of the report accommodates AFQ, and highlights areas where additional information may be needed to support the use of fission accelerated testing. The NRC staff also reviewed the framework in Section 3 of the report to confirm no additional updates were necessary.

ACRS Comment 2-5:

Applying appropriate quality standards to fuel qualification activities

NRC Staff Response 2-5:

The NRC staff appreciates the ACRS feedback and in response added Section 1.5, "Quality Assurance," to NUREG-2246 to (1) clarify that all fuel qualification activities are to be controlled consistent with their importance to demonstrating the safety functions performed by the fuel, and (2) explain why quality assurance was explicitly identified as a separate goal within the framework for experimental data.

ACRS Comment 2-6:

Assuring that the final integral effects tests should use fuel produced at pilot or production scale under prototypic fabrication conditions with prototypic procedures and trained staff

NRC Staff Response 2-6:

The NRC staff appreciates the ACRS feedback and agrees with the context for this comment. The NRC staff agrees that obtaining integral test data using fuel produced at pilot or production scale, under prototypic fabrication conditions with prototypic procedures and trained staff would demonstrate a high degree of maturity for a fuel technology and produce the highest degree of assurance for fuel qualification. NUREG-2246 provides a framework that is consistent with this objective:

- Section 3.1, "G1-Fuel Manufacturing Specification," requires a fuel manufacturing specification to control the key fabrication parameters that significantly affect fuel performance.
- Section 3.4.4, "ED G4-Test Conditions" requires that (1) test specimens are fabricated consistent with the fuel manufacturing specification, and (2) test distortions (i.e., differences between the test and actual conditions which the fuel is expected to perform) are justified and accounted for in the experimental data.

In addition to demonstrating necessary assurance for fuel qualification, the framework presented in the draft NUREG-2246 provides sufficient flexibility to accommodate (1) the development of less mature fuel technologies, and (2) changes in manufacturing technology that may occur over the life cycle of a fuel technology. The NRC staff attempted to capture the need for representative test data while also providing flexibility by (1) highlighting only specific attributes of the fuel production process that warrant inclusion in licensing documentation, and (2) highlighting specific attributes of the tests used to quality a fuel. Specifics such as control of

the fabrication procedure and training of staff are expected to be addressed by the quality assurance program maintained by the fuel producer and/or test facility.

The NRC staff appreciates the Committee’s effort to promptly and thoroughly evaluate the NRC staff's regulatory guidance presented in the draft NUREG-2246 and looks forward to future interactions with the Committee on advanced reactor activities.

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ADAMS Accession Nos: Package: ML21333A059, Memo: ML21341A567 NRR-106

OFFICE	NRR/DANU/UARP	NRR/DANU/UART	NRR/DANU/UARP	NRR/DANU/UART
NAME	JHoellman	TDrzewiecki	SLynch	MOrenak
DATE	12/8/2021	12/8/2021	12/15/2021	12/16/2021
OFFICE	NRR/DANU	NRR		
NAME	MShams (JBowen for)	AVeil (RTaylor for)		
DATE	12/16/21	12/20/2021		

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