AUDIT PLAN

ANP-10337P, REVISION 0, SUPPLEMENT 1P, REVISION 0

"DEFORMABLE SPACER GRID ELEMENT"

DOCKET NO. 99902041

EPID NO. L-2018-TOP-0037

1.0 INTRODUCTION

By letter dated September 21, 2018 (Agencywide Documents Access and Management System Accession No. ML18268A141), Framatome, Inc. (Framatome) submitted a supplement to a topical report (TR) which presents a methodology to analyze deformable spacer grid elements. This methodology is intended for use with ANP-10337P-A (henceforth referred to as the "base TR"), which describes a general methodology for analysis of the dynamic response of fuel assembly structures as a result of vibratory loads imposed by seismic and/or loss of coolant accident (LOCA) events. The TR supplement is entitled, "Deformable Spacer Grid Element," and can be identified under its TR supplement number, ANP-10337, Revision 0, Supplement 1P, Revision 0.

Seismic and LOCA events can result in external forces applied to the fuel assemblies (e.g., shaking and/or vibratory forces). Therefore, licensees must evaluate the fuel assembly structural response under these conditions to ensure that regulatory requirements are met with respect to control rod insertability and core coolability. In particular, the spacer grid performance is assessed to confirm that any permanent deformation of the grid remains within acceptable limits. The methodology described in the base TR is consistent with other similar analysis methodologies previously reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC) in that the acceptance criteria for spacer grid performance are based on the expectation that the spacer grid will essentially maintain its original shape, therefore, control rod insertability and core coolability will not be affected. The proposed methodology in the TR supplement would allow for analysis of spacer grid designs that may exhibit nonlinear impact responses and/or accumulate permanent deformation.

In summary, the existing NRC approved testing and analysis methodologies in the base TR will continue to be used for analysis of seismic and LOCA events. For fuel assembly designs with spacer grids that meet the criteria for modeling through the use of analysis elements described in the base TR, the existing methodologies will remain applicable. This TR supplement presents the necessary analysis elements for testing and analysis of deformable spacer grid elements that behave as specified in the **Applicability** section of the TR supplement. These analysis elements are intended to be plugged into the overall analysis methodology, along with any additional supplements to ensure that the overall methodology remains applicable.

The NRC staff has determined that an audit, following Office of Nuclear Reactor Regulation Office Instruction LIC-111, “Regulatory Audits,” will be beneficial in identifying additional information required to complete the review.

2.0 REGULATORY AUDIT BASES

The methodologies described in the base TR, and by extension, the proposed enhancement of these methodologies described in the TR supplement, were developed primarily to satisfy NRC regulatory guidelines to meet the regulatory requirements established in Title 10, “Energy,” of the *U.S. Code of Federal Regulations* (10 CFR) Part 50, “Domestic Licensing of Production and Utilization Facilities,” Section 46, “Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors,” and 10 CFR Part 50 Appendix S, “Earthquake Engineering Criteria for Nuclear Power Plants,” as well as 10 CFR Part 50 Appendix A, “General Design Criteria for Nuclear Power Plants,” Criterion 2, “Design bases for protection against natural phenomena,” Criterion 27, “Combined Reactivity Control Systems Capability,” and Criterion 35, “Emergency Core Cooling.” This requirement is met by acceptance criteria defined in Standard Review Plan (SRP) Section 4.2, Appendix A to demonstrate coolability of the fuel and to ensure insertability of the control rods.

The NRC staff will audit the TR supplement and supporting documentation, to identify appropriate additional information to request for submittal. Such information would be that required to determine (1) whether the proposed enhancement of the base TR methodologies described in the TR supplement is appropriate and technically justified, and (2) whether the overall testing and analysis methodologies, as described in the base TR and expanded by the TR supplement, are sufficient to meet the aforementioned regulatory requirements and NRC guidance.

3.0 REGULATORY AUDIT SCOPE/OBJECTIVES

The audit is planned to cover the topics listed below.

3.1. METHODOLOGY AREA OF APPLICABILITY DISCUSSION

Much of the first three sections of the TR supplement are devoted to a discussion of how the methodology outlined in the supplement are intended to be used with the methodology in the base TR. The NRC staff will seek further clarification on the various applicability statements made in these sections, as well as better understand how the proposed testing and criteria will ensure that specific grids are confirmed to remain within the area of applicability for the proposed methodology. Particular areas of interest include:

- The intended application of the TR supplement methodology within the methodology described in the base TR, including any limitations.
- The intended uses for the deformable grid element (DGE).
- Extent of testing required to confirm that the DGE will appropriately represent the physical behavior of a given spacer grid across the entire range of postulated scenarios associated with regulatory requirements (operating basis earthquake, safe shutdown earthquake, LOCA; as well as beginning of life and end of life conditions for spacer grids).

3.2. DEFORMABLE GRID ELEMENT MODELING

Section 4 of the TR supplement discusses how the DGE model is constructed, including input parameters and how different physical response characteristics are described through mathematical relationships. The NRC staff will seek greater clarity on the details of the DGE model, and how it captures the physical behavior of the spacer grids that it is intended to model particular areas of interest include:

- Correlation of different features of the DGE to observed grid impact behavior.
- An expanded discussion of the different parameters input to the model and how they are related to each other and the expected grid behavior.
- Elaboration of how different options are to be selected in the proposed DGE model.
- Explanation of how the model and its constituent parameters are tuned to match the spacer grid performance as determined by testing.

3.3. SEISMIC AND LOCA ANALYSES WITH THE DGE MODEL

Sections 5 and 6 of the TR supplement describe how the DGE model, in combination with the analysis methodology described in the base TR, will be used to demonstrate that regulatory requirements are met for seismic and LOCA events. The NRC staff will review the proposed approach for verification that regulatory requirements are met, when using the DGE model with the methodology described in the base TR. Particular areas of interest include:

- Use of analysis results to confirm that regulatory requirements are met.
- Sensitivity and/or uncertainty analyses that may need to be performed in order to provide reasonable assurance that regulatory requirements are met.
- Applicability of existing guidance in the NRC's SRP Section 4.2.
- Additional regulatory requirements that are not explicitly addressed in the TR supplement (e.g., guide tube or fuel rod buckling).

3.4. TESTING PROTOCOL

Appendix A to the TR supplement provides an example of how the testing protocol from the base TR is applied for an example deformable spacer grid in order to develop the necessary parameters for the DGE. The NRC staff will review the testing protocol and example results to verify that the spacer grid performance is consistent with its characterization elsewhere in the TR supplement, and to determine whether the protocol is sufficient for its intended purpose.

3.5. BENCHMARKING ANALYSIS FOR DGE ELEMENTS

Appendix B describes the benchmarking analyses performed to confirm and validate the DGE response relative to experimental data. The NRC staff will review the proposed analysis procedure to be used in order to validate a DGE model as being adequately representative of the spacer grid of interest. This will include any required tuning of model parameters, regression analyses, and statistical validation approaches.

3.6. SAMPLE PROBLEM ANALYSIS

Appendix C of the TR supplement provides a summary and results from a sample problem analyzed using a combination of the methodologies from the base TR and TR supplement.

This problem includes a mixed core configuration in which DGEs are combined with standard spacer grid elements as described in the base TR. The NRC staff will audit the documentation associated with this sample problem to better understand the proposed analysis approach.

3.7. MISCELLANEOUS EMERGENT QUESTIONS

The NRC staff is continuing to identify and review other documents and resources that may be helpful in forming a complete picture of the relevant technical issues. In the course of the continued review efforts of the TR supplement, the NRC staff may encounter new issues that would benefit from a discussion during the audit.

3.8. ADDITIONAL DISCUSSION AND EXIT MEETING

At the conclusion of the audit, an exit meeting will be held to summarize additional information, if any, that Framatome will be requested to submit to continue the review. Other appropriate next steps, including an update to the licensing TR review schedule, will be discussed, as well.

4.0 TEAM ASSIGNMENTS

The following personnel will be supporting the review:

NAME	AFFILIATION
Scott Krepel	Technical Reviewer, NRC/NRR/Division of Safety Systems
Nicholas Klymyshyn	Contractor, Pacific Northwest National Laboratories
Jonathan Rowley	Project Manager, NRC/NRR/Division of Licensing Processes

5.0 LOGISTICS AND SCHEDULE

The audit will take place on March 26-28, 2019. The audit is scheduled to occur between the hours of 9:00 a.m. and 5:00 p.m. on March 26 and 27, 2019, and from 9:00 a.m. to 11:00 a.m. on March 28, 2019. However, these hours may be adjusted as necessary (e.g., start earlier on specific days) to accommodate the amount of time required to cover the material. An exit meeting will tentatively be scheduled for 10:00 a.m. on March 28, 2019, however, this meeting may be moved to March 27, 2019, if the audit ends early. The location is the Framatome headquarters at 3315 Old Forest Road, Lynchburg, Virginia, 24501.