



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001**

October 25, 2019

The Honorable Kristine L. Svinicki  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT: SUMMARY REPORT – 666<sup>th</sup> MEETING OF THE ADVISORY COMMITTEE  
ON REACTOR SAFEGUARDS, SEPTEMBER 4-6, 2019**

Dear Chairman:

During its 666<sup>th</sup> meeting, September 4-6, 2019, the Advisory Committee on Reactor Safeguards (ACRS) discussed several matters and completed the following correspondence:

**LETTER REPORTS**

Letter Reports to Chairman Svinicki:

- Review of Draft SECY Paper, "Population - related Siting Considerations for Advanced Reactors," dated October 7, 2019, ADAMS Accession No. ML19277H031.
- Report on the Safety Aspects of the Subsequent License Renewal Application of the Turkey Point Nuclear Generating Units 3 and 4, dated October 7, 2019, ADAMS Accession No. ML19275E747.

**LETTERS**

Letters to Margaret M. Doane, Executive Director for Operations (EDO), NRC, from Peter C. Riccardella, Chairman, ACRS:

- Safety Evaluation of the NuScale Topical Report TR-0516-49417-P, Revision 0, "Evaluation Methodology for Stability Analysis of the NuScale Power Module," dated September 20, 2019, ADAMS Accession No. ML19266A463.
- Safety Evaluation of the NuScale Topical Report TR-0716-50351, Revision 0, "NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces," dated September 24, 2019, ADAMS Accession No. ML19268A109.

- Proposed Focus Area Review Approach of the Advanced Safety Evaluation Report with No Open Items for the Design Certification Application of the NuScale Small Modular Reactor, dated September 25, 2019, ADAMS Accession No. ML19269B682.
- Safety Evaluation of Westinghouse Topical Report WCAP-17794-NP, Revision 0, "10X10 SVEA Fuel Critical Power Experiments and New CPR Correlation: D5 for SVEA-96 Optima3," dated September 26, 2019, ADAMS Accession No. ML19269D514.

## MEMORANDA

Memoranda to Margaret M. Doane, Executive Director for Operations, NRC, from Scott W. Moore, Executive Director, ACRS:

- "Documentation of Receipt of Applicable Official NRC Notices to the Advisory Committee on Reactor Safeguards for September 2019," dated September 25, 2019, ADAMS Accession No. ML19268A179.
- "Regulatory Guides," dated September 25, 2019, ADAMS Accession No. ML19268A198, regarding no review of RG 1.151, Revision 2, "Instrument Sensing Lines," and RG 1.180, Revision 2, "Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference in Safety-Related Instrumentation and Control Systems." The memorandum also states no Committee review at this time for DG-3036, proposed revision of RG 3.15, "Standard Format and Content of License Applications for Receipt and Storage of Unirradiated Power Reactor Fuel at a Nuclear Power Plant," and no review on the proposed withdrawal of RG 3.53, Revision 1, "Applicability of Existing Regulatory Guides to the Design, Construction, and Operation of an Independent Spent Fuel Storage Installation."

## HIGHLIGHTS OF KEY ISSUES

### 1. Review of Draft SECY Paper, "Population - related Siting Considerations for Advanced Reactors"

The staff has identified the issue of siting decisions related to nearby populations as a matter that warrants early engagement with the Commission. During development of the draft SECY the staff considered possible changes to population-related siting considerations appropriate for advanced reactors, which can have substantially different design and accident characteristics than existing light water reactors (LWRs).

The draft SECY paper provides four options for revising siting considerations for advanced reactors. We agree that Option 3 is the most reasonable of these approaches. Implementing it will require substantial work in identifying licensing basis events for evaluation and in developing mechanistic source terms for dose calculations. The preferred approach is technology-inclusive and risk-informed. There appears to be nothing that is focused on non-LWR aspects of design, and we see nothing that should preclude its use for LWR-based designs. It provides design-specific results and should be preferred technically to the present one-size fits all approach.

### Committee Action

The Committee issued a report to the Chairman on October 7, 2019, with the following conclusion and recommendations:

- a. We agree that Option 3 is the most reasonable of these approaches. However, it is short on details of implementation that will determine its ultimate value.
  - b. While Option 3 is short on details, they should be provided for review in the revised Regulatory Guide (RG) 4.7 with appropriate illustrative example.
2. Report on the Safety Aspects of the Subsequent License Renewal Application of the Turkey Point Nuclear Generating Units 3 and 4

The staff reviewed the Florida Power & Light (FPL) License Amendment Request for Subsequent License Renewal (SLR) in accordance with the Generic Aging Lessons Learned (GALL)-SLR and the Standard Review Plan (SRP)-SLR guidance documents. Conformance with this guidance provides bases for a conclusion that an applicant for life extension of 20 additional years beyond 60 years will assure adequate protection to the public through the Subsequent Period of Extended Operation (SPEO).

The most significant generic issues challenging operation beyond 60 years are: reactor pressure vessel embrittlement; irradiation-assisted stress corrosion cracking of reactor internals; concrete structures and containment degradation; and electrical cable environmental qualification, condition monitoring, and assessment. Each of these items has been addressed by FPL and evaluated by the staff through the review process. We agree with the staff's safety evaluation report regarding these issues.

### Committee Action

The Committee issued a report to the Chairman on this topic via letter dated October 7, 2019, with the following conclusion and recommendations:

- a. The programs established and the commitments made by FPL to manage age-related degradation provide reasonable assurance that Turkey Point can be operated in accordance with its licensing basis for the subsequent period of extended operation without undue risk to the health and safety of the public.
  - b. The FPL application for subsequent license renewal of the operating license for Turkey Point should be approved.
3. Safety Evaluation of the NuScale Topical Report TR-0516-49417-P, Revision 0, "Evaluation Methodology for Stability Analysis of the NuScale Power Module"

The Committee met with representatives of the NRC staff and NuScale to review the subject NuScale Topical Report and associated safety evaluation.

The NuScale stability topical report presents a thorough review of the possible instability modes that may affect the NuScale Power Module (NPM). NuScale concludes that the dominant mode is the riser natural-circulation instability. The staff has reviewed the impact of these possible modes and agrees with this conclusion.

To properly model the unique features of the NPM and its stability response, NuScale developed a dedicated computer code. The PIM code models the core, riser, and steam generators (SGs) using numerical methods that, given the experience with boiling water reactor (BWR) instability modelling, are known to be accurate for instability calculations. The staff has reviewed the PIM code and found it acceptable.

In response to a request for additional information (RAI), NuScale presented results from the SIET-TF2 prototypical SG tests, which exhibited unstable two-phase density-wave flow oscillations in the secondary side; i.e., inside the tubes where boiling occurs. The NuScale SG configuration is unique because in most SGs boiling occurs outside the tubes, which results in lower pressure drops and tends to minimize flow oscillations. The SGs have tube-inlet flow restrictors designed to minimize the possibility of unstable oscillations; however, they were found to be effective for some, but not all, test conditions. NuScale has committed to resolve this issue to minimize the possible impact of thermal fatigue on the SG. If the design allows flow oscillations, movement of the boiling boundary would create temperature oscillations in the tubes, potentially inducing thermal fatigue. The staff reviewed the SIET-TF2 SG tests and performed scoping calculations with the current tube design. These indicate that the SG tube flow is likely to oscillate, potentially with large amplitude; NuScale stated that their calculations show different trends. This issue is under review. If this oscillatory behavior is confirmed, then the ASME Code calculations for the SG must account for it.

Tube-flow oscillations will affect the SG heat transfer and induce pulses of cold/hot water in the NPM core, which will result in power oscillations. However, oscillations in the secondary side are of relatively short period (3 to 10 seconds), which should have minor impact on the primary side, where oscillations have periods of 100 to 500 seconds. In addition, by the nature of the flow oscillation, each of the approximately 1000 SG tubes is expected to oscillate with a random phase; therefore, the cumulative impact on the primary side is greatly reduced by averaging over all the SG tubes.

A validated calculational tool to estimate the stability of the SG secondary-side flow stability is needed to increase confidence in reliable operation of the NuScale design. NuScale is in the process of developing a tube-flow stability map using NRELAP5, after further benchmarking against the TF-2 test results. The staff should review these new analyses, and we look forward to further discussion on this topic.

#### Committee Action

The Committee issued a report to the EDO on this Topical Report and associated staff safety evaluation via letter dated September 20, 2019, with the following conclusion and recommendations:

- a. When used in compliance with the 16 limitations imposed by the staff, the methods documented in this stability topical report are acceptable for performing stability analyses of the NuScale power module (NPM). The safety evaluation should be issued.
- b. Prototypical steam generator tests and scoping staff analyses show that two-phase density-wave flow oscillations inside the tubes are possible with the current design, which could challenge thermal fatigue limits. NuScale and the staff are aware of the issue and are committed to resolving it prior to completion of the review.

4. Safety Evaluation of the NuScale Topical Report TR-0716-50351, Revision 0, "NuScale Applicability of AREVA Method for the Evaluation of Fuel Assembly Structural Response to Externally Applied Forces"

The Committee met with representatives of the NRC staff, Framatome, and NuScale to review the subject NuScale Topical Report and associated safety evaluation.

NuScale submitted TR-0716-50351 on September 30, 2016, to be referenced as part of its design certification application. This topical report examines the applicability of the AREVA fuel assembly structural response analysis methodology. The NRC approved the Framatome (formerly AREVA) topical report ANP-10337P-A, "PWR Fuel Assembly Structural Response to Externally Applied Dynamic Excitations" for referencing in license applications for operating reactors on May 21, 2018. The methodology presented in ANP-10337P-A covers structural acceptance criteria, model architecture, model parameter and allowable limits definition, seismic and loss-of-coolant accident analysis, and non-grid component strength evaluation methodology.

The NuScale topical report evaluated the applicability of each section of the ANP-10337P-A report to the NuScale fuel assembly and plant design. Additionally, the report identified NuScale fuel design differences and potential analysis impacts.

Committee Action

The Committee issued a report to the EDO on this Topical Report and associated staff safety evaluation via letter dated September 24, 2019, with the following conclusion and recommendations:

- a. The fuel assembly structural response methodology described in TR-0716-50351 is acceptable for use in performing NuScale fuel system structural response analyses. The associated safety evaluation report should be issued.
- b. The modifications to the approved ANP-10337P-A methodology will ensure that the seismic analysis of the NuScale fuel will be in conformance with General Design Criterion 2; 10 CFR Part 50, Appendix S; and related staff guidance.

5. Proposed Focus Area Review Approach of the Advanced Safety Evaluation Report with No Open Items for the Design Certification Application of the NuScale Small Modular Reactor

With the objective of completing the ACRS' Phase 5 review by June 23, 2020, the Committee proposed in this letter an approach that includes focusing on several cross-cutting safety significant issues including: Emergency Core Cooling System and Valve Performance; Helical Tube Steam Generator Design; Boron Dilution and Return to Criticality; Source Term; and Probabilistic Risk Assessment. In addition, Committee chapter leads will conduct completeness reviews of the safety evaluation report chapters.

6. Safety Evaluation of Westinghouse Topical Report WCAP-17794-NP, Revision 0, "10X10 SVEA Fuel Critical Power Experiments and New CPR Correlation: D5 for SVEA-96 Optima3"

The D5 topical report documents a correlation to estimate the CP for SVEA-96 Optima3 fuel. Optima3 fuel introduces a few evolutionary changes to SVEA-96 Optima2 fuel. Spacer design is the main improvement that increases the margin to CP.

The staff has reviewed the topical report using the methodology described in NUREG/KM-0013, "Credibility Assessment Framework for Critical Boiling Transition Models." It provides a well-structured and logical approach to the review of data-driven models. This approach provides consistency and completeness to this and future reviews. We were pleased to see that the staff considered the suggestion in our June 15, 2018, letter and published this methodology in a publicly available document. Future submittals will benefit from the predictability that this methodology provides by defining all the information expected in the submittal.

The staff has imposed four limitations on the use of this correlation. These limit the range of its applicability and ensure appropriate conservatism in the unlikely event when bundles with high pin-power peaking become limiting.

Committee Action

The Committee issued a report to the EDO on this Topical Report and associated staff safety evaluation via letter dated September 26, 2019, with the following conclusion and recommendations:

- a. The D5 critical power (CP) correlation, when used in compliance with the four limitations imposed by the staff, is acceptable for application to SVEA-96 Optima3 fuel.
- b. The safety evaluation should be issued.

RECONCILIATION OF ACRS COMMENTS AND RECOMMENDATIONS

- The Committee considered the letter from the Director, Office of New Reactors, dated July 24, 2019, ADAMS Accession No. ML19183A409, in response to the Committee's letter dated June 19, 2019, ADAMS Accession No. ML 19170A381. The topic was Chapter 3, Section 3.9.2, and Chapters 14, 19, and 21 of the NRC staff's safety evaluation report with open items related to the design certification application (DCA) review of the NuScale small modular reactors (SMR). The Committee accepted the staff's response and looks forward to the Phase 5 review of the NuScale application.
- On the subject of the NuScale SMR DCA review of Chapters 2 and 17, the Committee considered the letter from the Director, Office of New Reactors, dated August 5, 2019, ADAMS Accession No. ML ML19204A094. This letter was sent in response to the Committee's letter dated June 27, 2019, ADAMS Accession No. ML19171A350. The Committee appreciates the staff's effort with respect to conducting its briefings, including a briefing on the topic of open design issues/unverified design assumptions. The Committee accepted the staff's response and looks forward to the Phase 5 review of the NuScale application.

SCHEDULED TOPICS FOR THE 667<sup>th</sup> ACRS MEETING

The following topics were placed on the agenda for the 667<sup>th</sup> ACRS meeting which was scheduled for October 2-5, 2019:

- ABWR Design Certification Renewal Application
- FRAMATOME's Topical Report, RAMONA5 for Anticipated Transient without Scram

Sincerely,

**/RA/**

Peter C. Riccardella,  
Chairman

October 25, 2019

SUBJECT: SUMMARY REPORT – 666<sup>th</sup> MEETING OF THE ADVISORY COMMITTEE  
ON REACTOR SAFEGUARDS, SEPTEMBER 4-6, 2019

Accession No: ML19302F281 Publicly Available (Y/N): \_Y\_\_\_ Sensitive (Y/N): N

If Sensitive, which category?

Viewing Rights:  NRC Users or  ACRS only or  See restricted distribution

<b>OFFICE</b>	ACRS	SUNSI Review	ACRS	ACRS
<b>NAME</b>	LBurkhart	LBurkhart	SMoore	PRiccardella (SMoore for)
<b>DATE</b>	10/15/19	10/15/19	10/25/19	10/25/19

**OFFICIAL RECORD COPY**