



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

December 14, 2021

The Honorable Christopher T. Hanson  
Chairman  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

**SUBJECT:           SUMMARY REPORT – 689<sup>th</sup> MEETING OF THE ADVISORY  
COMMITTEE ON REACTOR SAFEGUARDS, OCTOBER 5-7, 2021**

Dear Chairman Hanson:

During its 689<sup>th</sup> meeting, October 5-7, 2021, which was conducted virtually due to the Agency's expanded telework capacities employed in response to the COVID-19 pandemic, the Advisory Committee on Reactor Safeguards (ACRS) discussed several matters. The ACRS completed the following correspondence:

**LETTERS**

Letters to Daniel H. Dorman, Executive Director for Operations (EDO), NRC, from Matthew W. Sunseri, Chairman, ACRS

- Safety Evaluation for Framatome Inc., Topical Report, ANP-10349P, Revision 0, "GALILEO Implementation in LOCA Methods," dated October 26, 2021, ADAMS Accession No. ML21292A005
- Regulatory Guide 1.247, "Acceptability of Probabilistic Risk Assessment Results for Advanced Non-light Water Reactor Risk-informed Activities," dated October 26, 2021, ADAMS Accession No. ML21288A018

**MEMORANDA**

Memoranda to Daniel H. Dorman, EDO, NRC, from Scott W. Moore, Executive Director (ED), ACRS:

- Documentation of Receipt of Applicable Official NRC Notices to the Advisory Committee on Reactor Safeguards for October 2021, dated October 15, 2021, ADAMS Accession No. ML21286A005
- Regulatory Guide, dated October 14, 2021, ADAMS Accession No. ML21286A006

## HIGHLIGHTS OF KEY ISSUES

### 1. Safety Evaluation for Framatome Inc., Topical Report, ANP-10349P, Revision 0, "GALILEO Implementation in LOCA Methods"

Framatome requested that the NRC complete a review of ANP-10349P, Revision 0, "GALILEO Implementation in LOCA Methods," which presents a methodology for implementing the fuel performance code GALILEO into Framatome pressurized water reactor (PWR) loss of coolant accident (LOCA) methods. The methodology is applicable for Westinghouse and Combustion Engineering PWRs with recirculation (U tube) steam generators, fuel assembly lengths of 14-feet or less, and emergency injection in the cold legs.

The GALILEO methodology models the following coupled physical phenomena: heat production and conduction in the fuel rod; fission gas release; mechanical behavior of the pellet and cladding structures; and growth of a corrosion layer at the cladding external surface. GALILEO includes the following models: thermal conductivity degradation; hydrogen pickup in the cladding; enhanced fission gas release for a range of burnups; high burnup structure on pellet rim, and cladding ridge formation; fuel pellet cracking, creep, and pellet deformations like dish filling and hourglassing; and fuel pellet swelling. The staff completed a thorough review of the methodology implementation, including the convergence of the iterative steps between S-RELAP5 and GALILEO.

Framatome has calibrated and validated their models using extensive experimental data, enabling them to apply the GALILEO methodology to fuel types in the following bundle configurations: 14x14 Combustion Engineering; 15x15 Babcock & Wilcox; 17x17 Westinghouse; and 17x17 Framatome. The database includes both Zr-4 and M5™ cladding materials and high-burnup conditions. The staff review and comparisons were supplemented by confirmatory calculations performed with the independent NRC code FRAPCON. The Committee reviewed the staff evaluation of these data for licensing calculations and found it acceptable in its November 23, 2020, letter.

To validate their LOCA evaluation methods with the GALILEO fuel performance code, Framatome provided comparisons against Loss-of-Fluid Test (LOFT) experimental data. For large break LOCA, the L2-3, L2-5, LP-02-6 and LP-LB-1 LOFT tests were provided. For small break LOCA, the L3-6 and L8-1 LOFT tests were provided. The staff has reviewed these validations in their safety evaluation (SE) and their audit report; they concluded that the cladding temperatures, fuel centerline temperature trends, and rod internal pressure trends are consistent with experimental data and the results of the previously approved methods (COPERNIC and RODEX2). The Committee concurs with their evaluation. However, the staff SE should state the demonstrated range of applicability (e.g., burnup, enrichment, fuel and cladding types, etc.) for which GALILEO is approved. The staff should consider incorporating by reference the applicability ranges and limitations in the earlier GALILEO topical report (ANP-10323PA).

To supplement the experimental data validations, the applicant provided code-to-code comparisons of GALILEO versus COPERNIC and RODEX2 for sample problems representative of typical LOCA calculations. These code-to-code comparisons add significant value to the validation effort but cannot be used to replace direct validation against experimental data. The staff should ensure that, for future assessments, code-to-code comparisons are not used exclusively. This is especially relevant for fuels with limited experimental data.

Development and benchmarking of fuel performance codes, like GALILEO, have often depended heavily on real-time data from well-instrumented test rigs at the Halden reactor for a range of test conditions and fuel burnups. The Committee observed in its April 13, 2020, Biennial Research Review letter that, without a replacement for this lost capability, it will be difficult to confirm the adequacy of models simulating the performance of proposed accident tolerant fuels (ATFs) or evolutionary fuels for the existing fleet of light water reactors. The Committee also continues to be concerned that, as the temperature resistance of ATFs improve, a new class of accidents may be created where the control rods fail before the fuel, leading to a potential criticality event as the core refloods. This class of events needs to be considered as part of future ATF evaluations.

Prior to issuing the SE report, the staff should consider the following items:

1. State the demonstrated range of applicability of the methodology. The staff should consider incorporating by reference the applicability ranges and limitations in the earlier GALILEO topical report (ANP-10323PA).
2. State that the GALILEO methodology does not replace existing methodologies. COPERNIC and RODEX2 continue to be acceptable methodologies.
3. Emphasize that the approval is based primarily on direct comparisons against experimental LOFT data. Code-to-code comparisons are valuable to supplement experimental data benchmarks but cannot replace them completely in future submittals.

#### Committee Action

The Committee issued a letter on October 26, 2021, with the following conclusion and recommendation:

1. The methodology documented in ANP-10349P, Revision 0, is a technically sound approach for loss-of-coolant accident (LOCA) calculations for both large and small breaks within its demonstrated range of applicability.
2. The staff should issue the SE report after considering the items suggested in this letter.
2. Regulatory Guide 1.247, "Acceptability of Probabilistic Risk Assessment Results for Advanced Non-light Water Reactor Risk-informed Activities"

Over the past two decades ASME has published a series of light water reactor (LWR) probabilistic risk assessment (PRA) standards, starting with a standard for Level 1 PRA of internal events for plants at power. ASME also issued standards for plants in the low power and shutdown condition, for large early release frequency, for internal fire, and for external events such as seismic and wind. The staff issued RG 1.200 describing an approach for determining the acceptability of a PRA to be used for regulatory decisionmaking; it endorsed a PRA standard (the 2013 version of ASME/American Nuclear Society (ANS) "Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," ASME/ANS-RA-S-2008, 2019) with exceptions and clarifications. RG 1.200 was revised several times, with the current version being issued in December 2020.

The newest standard is the “Probabilistic Risk Assessment Standard for Advanced Non-Light Water Reactor Nuclear Power Plants” (the Non-LWR PRA standard or the standard). It was first issued for trial use in 2013 and was issued as a final standard in January of 2021. ASME also has committees looking at probabilistic methods in design and probabilistic evaluation models.

The staff has followed development of the non-LWR PRA standard and has briefed the Committee on their support for the standard over the past two years. RG 1.247 is being issued for trial use and endorses the standard with no objections or exceptions, but with 147 clarifications and qualifications. The Committee was initially concerned that this large number of specific issues indicated substantial unanticipated differences between the standard and the staff. After reviewing the regulatory guide, the Committee finds the clarifications and qualifications helpful. They help eliminate ambiguity for users of the standard. Further, the staff is endorsing the standard with no exceptions or objections. Some representatives from the Standards Committee disagreed with the staff on specific issues and suggested that the staff should rephrase its “Resolution” of the clarifications and qualifications in Appendix A of RG 1.247 as interpretations of the standard that are acceptable to the NRC staff, rather than as changes to the text of the standard. The Committee agrees. First, some of the resolutions go beyond acceptable language or positions for an American National Standard. More importantly, the staff should own its clarifications and qualifications and make it clear to users that adopting the clarifications and qualifications is one acceptable way to demonstrate they meet the standard.

#### Committee Action

The Committee issued a letter on September 21, 2021, with the following conclusions and recommendations:

1. RG 1.247 should be issued for trial use.
2. Before a final version of RG 1.247 is issued the staff should consider the following suggested changes, in addition to including lessons learned during review of trial applications of the standard.
  - a. Rephrase the “Resolution” column of Appendix A of RG 1.247, to show the clarifications and qualifications, as “Interpretations” of the standard that are acceptable to the NRC staff, rather than as changes to the text of the standard.
  - b. Include guidance that the initial search for initiating events and scenarios should be done without preconceptions or using existing lists.
3. Discussions at the Planning and Procedures (P&P) Session

Member Ballinger led a discussion of recent inspection findings at Seabrook station related to the Alkali-Silica Reaction Topic (Note that the Committee issued a letter on this issue on December 14, 2018, ADAMS Accession No. ML18348A951). Member Ballinger and the ACRS staff will coordinate with NRC staff regarding the technical information available on this issue and will arrange a Subcommittee meeting, as warranted.

The Committee discussed the Full Committee and Subcommittee schedules through February 2022 as well as the planned agenda items for Full Committee meetings.

The ACRS Executive Director also led a discussion of significant notices issued by the Agency since the last Full Committee meeting in September 2021 (this activity is documented in the memorandum dated October 15, 2021).

The Committee discussed recommendations on review of one draft regulatory guide, as documented in the memorandum mentioned above, dated October 14, 2021.

The ACRS ED and Chairman led a discussion of the planned re-entry of the Agency on November 7, 2021. The ACRS plans to hold an in-person (hybrid) Full Committee meeting in December. All Subcommittee meetings through February of the 2022 will be virtual. Holding of hybrid Subcommittee meetings will be based on lessons learned from conduct of the Full Committee meetings in December 2021 and February 2022.

The Committee discussed and approved the CY2023 calendar with Full Committee and Subcommittee dates identified. The approved calendar (along with the already approved CY2022 calendar) have been uploaded to the ACRS SharePoint site.

Member Rempe led a discussion of proposed guidance for Subcommittee meeting chairs that represents best practices for conducting Subcommittee meetings. This guidance will be attached to the Subcommittee structure matrix document.

The Committee discussed potential formation of a Subcommittee on Humans and Automation with Member Bier as the Chair. It was agreed that Member Bier would discuss the purpose of the Subcommittee with Member Bley and others who are interested in being members. Members should inform Members Bier and Bley (and copy Mike Snodderly) if they are interested in participating. Member Bier with support from the staff engineer will work on a description of the activities for the group, membership, etc. Some of the first interactions may be with personnel from the Halden Project.

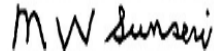
#### 4. Scheduled Topics for the 690<sup>th</sup> ACRS Meeting

The following topics were on the agenda for the 690th ACRS meeting which was held November 2-5, 2021:

- Draft Final Rule for Emergency Planning for Small Modular Reactors and Other New Technologies
- Interim Staff Guidance for Radiological Consequence Analyses Using Alternative Source Terms

- Draft Report on Molten Salt Reactor Fuel Qualification
- Biennial Report on Research Program
- Draft NUREG on Advanced Reactors Fuel Qualification

Sincerely,

A handwritten signature in black ink, appearing to read "M W Sunseri".

Signed by Sunseri, Matthew  
on 12/14/21

Matthew W. Sunseri  
Chairman

December 14, 2021

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**Accession No:** ML21323A040      **Publicly Available (Y/N):** Y      **Sensitive (Y/N):** N  
**If Sensitive, which category?**

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<b>OFFICE</b>	ACRS	SUNSI Review	ACRS	ACRS
<b>NAME</b>	LBurkhart	LBurkhart	SMoore (SWM)	MSunseri
<b>DATE</b>	11/19/21	11/19/21	12/13/21	12/14/21

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