U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NON-LIGHT-WATER REACTOR IMPLEMENTATION ACTION PLAN—PROGRESS SUMMARY AND FUTURE PLANS

Enclosure

CONTENTS

1.0 Introduction

This enclosure summarizes activities underway and planned by the staff of the U.S. Nuclear Regulatory Commission (NRC) to make the safe use of advanced nuclear technology possible. This enclosure covers progress made through December 31, 2020, in each of the six strategic areas:

(1) staff development and knowledge management
(2) analytical tools
(3) regulatory framework
(4) consensus codes and standards
(5) resolution of policy issues
(6) communications

Figure 1 shows the broad range of activities underway including many that have been completed. Checkmarks indicate completed activities. All other activities have been initiated and are under implementation progress.

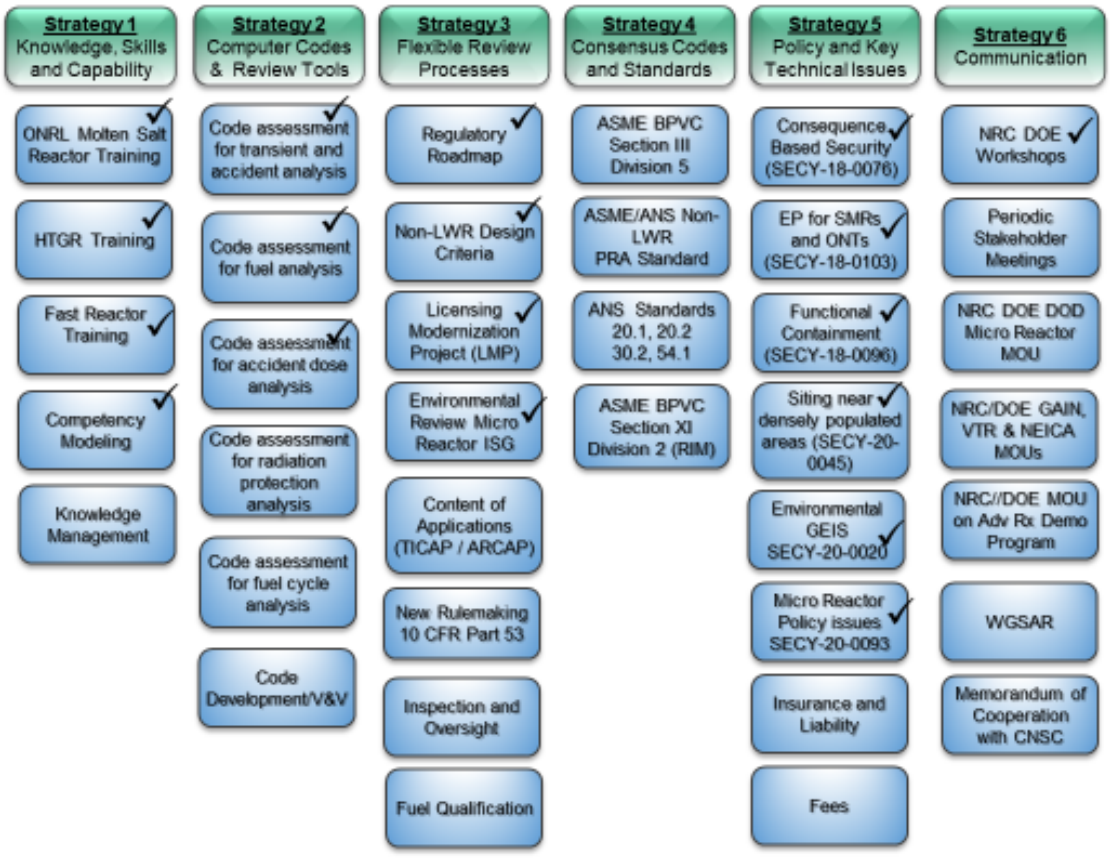

Figure 1: Implementation Action Plan Activities

The staff's significant accomplishments in calendar year (CY) 2020 include:

- issued SECY-20-0020, "Results of Exploratory Process for Developing a Generic Environmental Impact Statement for the Construction and Operation of Advanced Nuclear Reactors," on February 28, 2020
- issued SECY-20-0032 "Rulemaking Plan on 'Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (RIN-3150-AK31; NRC-2019-0062)," on April 13, 2020
- issued a notice of intent to develop an advanced nuclear reactor Generic Environmental Impact Statement (GEIS) and conduct scoping (85 FR 24040) on April 30, 2020, and later completed scoping process for development of a GEIS for the construction and operation of advanced nuclear reactors
- issued SECY-20-0045 "Population Related Siting Considerations for Advanced Reactors," on May 8, 2020
- published a proposed rule on emergency preparedness for small modular reactors (SMRs) and other new technologies (85 FR 28436) on May 12, 2020
- issued Draft Regulatory Guide (DG) 1350, "Performance Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, and Non-Power Production or Utilization Facilities" in May 2020
- issued Regulatory Guide 1.233, Revision 0, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Approach to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for NonLight-Water Reactors," in June 2020, endorsing Nuclear Energy Institute (NEI) 18-04 "Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development," Report Revision 1
- issued a draft white paper on proposed fuel qualification methodology to provide guidance on qualification for non-light water reactor (non-LWR) developers in September 2020
- issued SECY-20-0093 "Policy and Licensing Considerations Related to Micro-Reactors," on October 6, 2020
- published draft "Design Review Guide (DRG): Instrumentation and Controls for Non-Light-Water (Non-LWR) Reviews" on October 8, 2020
- published Interim Staff Guidance COL-ISG-029 on "Environmental Considerations Associated with Micro-reactors," in October 2020
- conducted stakeholder interactions to consider a performance-based approach for the content of applications regarding routine plant radiological effluents

- published a draft white paper on the analysis of the applicability of NRC regulations for non-LWRs applicants under Part 50 or Part 52[1] in September 2020

- provided training to the staff on the Licensing Modernization Project and research reactor licensing

- completed the safety evaluation for the Argonne National Laboratory quality assurance program plan for qualification of metallic fuel legacy data

- issued safety evaluation for topical report for uranium oxycarbide tristructural isotropic (TRISO)-coated particle fuel performance

- issued a draft white paper on recommended preapplication activities for non-LWR applicants in order to optimize application reviews[2] in October 2020

- collaborated with the Canadian Nuclear Safety Commission (CNSC) on the advanced reactor and SMR technical review approaches and preapplication activities under the memorandum of cooperation with the CNSC

- participated actively in the development of consensus codes and standards and developed plans for NRC endorsement of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Division 5 (BPVC-III-5), for high temperature materials, ASME Section XI, Division 2, for the reliability and integrity management (RIM) program, and the joint ASME/American Nuclear Society probabilistic risk assessment standard for advanced non-LWR plants

- continued to update computer codes and tools to strengthen technical bases for regulatory decisions, while increasing review agility

- conducted over 20 periodic public meetings to obtain stakeholder feedback on a variety of advanced reactor topics

- conducted several briefings of the Advisory Committee on Reactor Safeguards (ACRS) Future Plant Subcommittee and Full Committee on a variety of topics, including Title 10 of the *Code of Federal Regulations* (10 CFR) Part 53 (Licensing and Regulation of Advanced Nuclear Reactors), TRISO fuel qualification, Instrumentation & Controls Design Review Guide, and introductory meetings on specific non-LWR designs

- conducted the fourth annual NRC Standards Forum with this year's focus on the development and endorsement of codes and standards to support non-LWRs; chaired by the NRC's Standards Executive

- issued the NRC's non-LWR analytical code strategy

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[1] See Agencywide Documents Access and Management System (ADAMS) Accession No. ML20241A017.

[2] See ADAMS Accession No. ML20281A761.

- chaired the Nuclear Energy Agency's Working Group on the Safety of Advanced Reactors

- chaired the International Atomic Energy Agency SMR Regulators' Forum

In addition to the accomplishments summarized above, the NRC continues to implement flexible and multi-staged non-LWR regulatory review processes to engage with developers. The staff expects the level of preapplication engagement to increase in CY 2021. Figure 2 summarizes some of the diverse designs currently in various stages of development. Six of these non-LWR developers have formally notified the staff of their intent to begin regulatory interactions by responding to a regulatory issue summary. The figure does not include technologies such as fusion energy or accelerator-driven systems and may not include all companies actively developing designs even within the listed categories of micro-reactors, liquid-metal-cooled fast reactors, high-temperature gas-cooled reactors, and molten salt reactors.

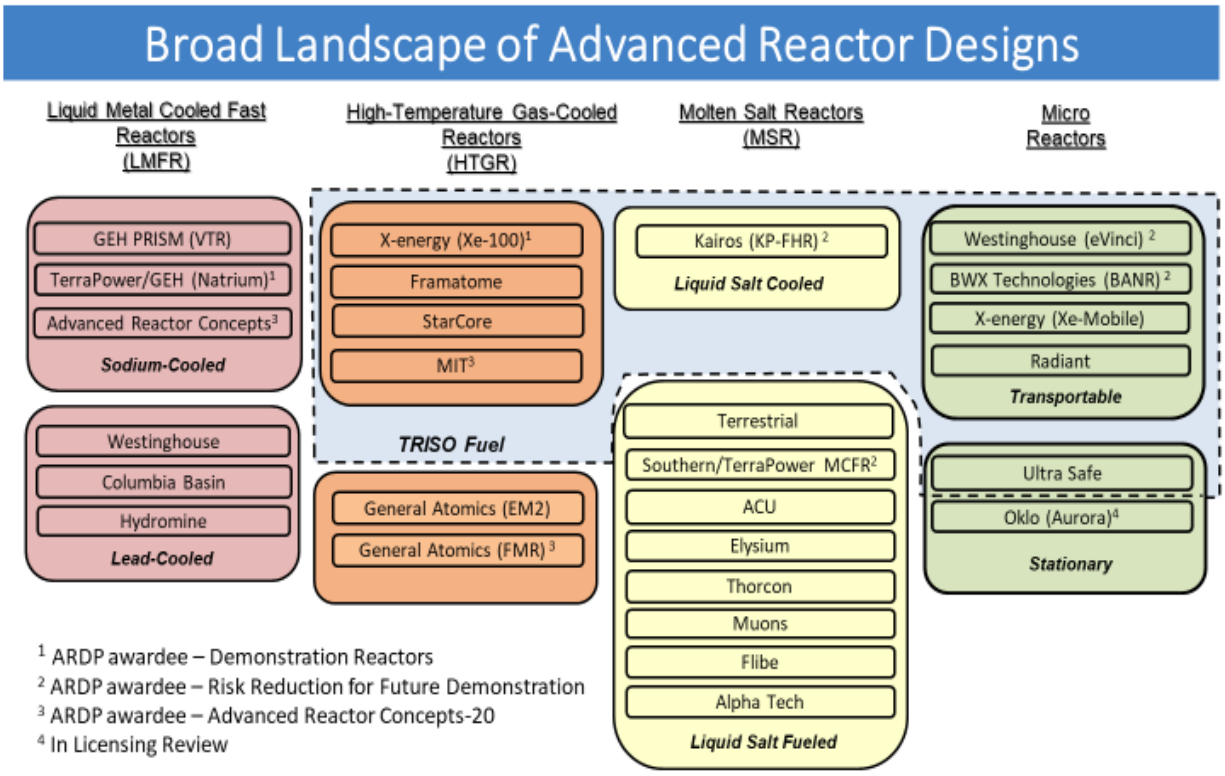

Figure 2: Companies developing non-LWR designs

2.0 Strategic Area No. 1: Staff Development and Knowledge Management

2.1 Overview

This strategic area supports the objective of enhancing non-LWR technical readiness. By investing in its people, the NRC can position itself to address the challenges of licensing new technologies. The near-term objectives in this area are to identify work requirements, identify critical skills and staff capacity requirements, assess the staff's current non-LWR technical readiness, and close gaps in technical readiness. Activities within Strategic Area No. 1 are informed by ongoing U.S. Department of Energy (DOE) and industry technology development.

The NRC also monitors the plans of prospective applicants so that it can assess future workload and appropriately prioritize its readiness in technology-specific areas.

In 2020, the NRC successfully increased staff knowledge of non-LWRs. In 2021, the staff's main objective in Strategic Area No. 1 is to continue to expand its capabilities and ensure preparedness to review the advanced reactor technology applications expected within the next few years.

2.2 Progress Summary

The staff has enhanced its advanced reactor technical readiness in accordance with Section 103(a)(5) of the Nuclear Innovation and Modernization Act (NEIMA). This section requires the NRC to provide for staff training or hiring of experts to support the activities specified in Section 103(a)(1)–(4) of the Act, as well as to support preparations for preapplication interactions and license application reviews for commercial advanced reactors.

In October 2019, when the Office of New Reactors (NRO) merged with the Office of Nuclear Reactor Regulation, NRO's Division of Advanced Reactors became the Division of Advanced Reactors and Non-Power Production and Utilization Facilities (DANU). The staff created the new division to increase focus on advanced reactor readiness activities and to increase staff capacity to support advanced reactor licensing. DANU has three branches that focus on advanced reactors: the Advanced Reactor Policy Branch, the Advanced Reactor Licensing Branch, and the Advanced Reactor Technical Branch. The inclusion of advanced reactor licensing in the same division as nonpower production and utilization facility licensing allows the staff to leverage synergies and experience in the licensing of novel technologies. To prepare for potential early mover advanced reactor applications, subject matter experts from critical disciplines were reassigned to DANU, forming a core review team that positioned the staff for success in conducting preapplication reviews, beginning the review of the Oklo Aurora combined license (COL) application, and continuing to develop the regulatory infrastructure for non-LWRs. In fiscal year 2021, the staff plans to utilize strategic workforce planning to identify and fill vacancies in DANU, so as to further increase organizational capacity to support the projected advanced reactor workload, which includes an anticipated construction permit application in late CY 2021.

The staff focused primarily on two activities in support of Strategic Area No. 1 in FY 2020.[3] (1) training and (2) knowledge management.

2.2.1 Training

During the year, the NRC staff took advantage of opportunities to learn about various technical topics related to advanced reactor technologies. The Advanced Reactor Technical Branch offered seminars on a variety of topics, including research reactor licensing process and its potential use as a model for micro-reactor licensing. Argonne National Laboratory (ANL) offered a presentation to the staff on the ASME BPVC-III-5, stress rupture factors for weldments. The staff and stakeholders involved in the Licensing Modernization Project (LMP) offered training to assist the staff reviewing the advanced non-LWR PRA standard in understanding background, licensing-basis events, safety classification and performance criteria, and defense in depth as

[3] This enclosure covers accomplishments through December 31, 2020, and discusses work currently planned for the remainder of FY 2021 with available budgeted resources.

related to the LMP. The staff attended many other training opportunities, as discussed in Section 7.2.4.

The staff developed and presented technical seminars on materials, chemistry, and component integrity for molten salt reactors (MSRs). Specific topics included the use of confirmatory tools to verify ASME BPVC-III-5 construction rules for high-temperature materials, salt chemistry control and purity, and corrosion and salt compatibility of reactor materials and components.

The staff participated in a 2-day virtual meeting of the Molten Salt Thermal Properties Working Group, whose members come from government, academia, industry, and international entities. The information presented included an overview of the DOE's efforts to develop a Molten Salt Thermodynamic Database, a collection of thermodynamic models pertaining to MSRs.

As part of an effort to develop staff competencies regarding MSRs, a Nuclear Regulatory Apprentice Network (NRAN) candidate in the Office of Nuclear Regulatory Research began studying molten salt chemistry and its impact on materials performance. The NRAN apprentice, along with other staff, attended an online MSR workshop hosted by Oak Ridge National Laboratory (ORNL).

For staff new to advanced reactors, recorded training is available in the NRC's Talent Management System on MSRs, sodium-cooled fast reactors (SFRs), micro-reactors, and high-temperature gas cooled reactors (HTGRs). There is also background reference material available, such as the report "NRC Regulatory History of Non-Light Water Reactors,"[4] which introduces relevant concepts and historical context to staff members unfamiliar with non-LWRs, to facilitate future reviews of non-LWR technologies.

Next steps: The staff will continue to assess training needs and develop additional training courses and other training opportunities, such as seminars on specific technical topics of importance for non-LWR technology.

2.2.2 Knowledge Management

Extensive information is available on technical, policy, and regulatory issues associated with licensing non-LWR designs. The goal of this activity is to consolidate existing documents and training materials to make them more easily accessible and searchable and to develop additional knowledge management resources as needed to support staff development.

One area of focus this year has been to reorganize the Advanced Reactor Web site to improve access to information, increasing both public and internal transparency. The staff routinely adds material to the Web site, including reports prepared for the NRC by the national laboratories. These contractor reports are posted to enhance awareness of and access to information that developers and other stakeholders may find useful.[5]

The staff has developed several Advanced Reactor pages in the NRC's Nuclepedia knowledge management platform. In 2020, the staff developed pages for sodium-cooled fast reactors and other non-LWR technologies.

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[4] See "NRC Regulatory History of Non-Light Water Reactors (1950–2019)," dated June 10, 2019 (ADAMS Accession No. ML19282B504).

[5] See https://www.nrc.gov/reactors/new reactors/advanced.html#advRxRef.

Next steps: In 2021, the staff will leverage the NRC's Nuclepedia knowledge management platform by continuing to add more content to make non-LWR information more readily accessible within the agency.

3.0 Strategic Area No. 2: Analytical Tools

3.1 Overview

This strategic area supports the objective of enhancing non-LWR technical and regulatory readiness. The NRC may use computer codes and tools to perform confirmatory, sensitivity, and uncertainty analyses to help investigate margins in the design, commensurate with the risk and safety significance of the phenomena applicable to each specific design.

The approach taken in this area is to (1) identify the tools, information, and data that the staff may need in reviewing non-LWR designs, (2) evaluate the existing computer codes, tools, and supporting information and identify gaps in both analytical capabilities and supporting information and data, and (3) interact with both domestic and international organizations working on non-LWR technologies to identify opportunities to collaborate and cooperate in closing the gaps, while avoiding conflicts of interest. These activities will also be used to develop the technical basis to resolve major materials related issues such as those related to chemistry, component integrity, and seismic safety.

The staff has continuing interactions with the DOE, the Electric Power Research Institute (EPRI), the national laboratories, reactor vendors, prospective licensees, and the international community related to computer codes and analytical tools. The main objective in this strategic area is to build a cooperative relationship with the DOE to coordinate funding activities, as appropriate, and reduce costs to the NRC and the U.S. Government. The next section summarizes the staff's activities in 2020.

3.2 Progress Summary

The staff has continued to develop knowledge, technical skills, and capacity to strengthen the technical bases for regulatory decisions, while increasing review agility. The staff continued to assess the information, experimental data, and analytical tools needed to support non-LWR reviews. The staff also completed its assessment of existing computer codes and tools that may be needed for non-LWR reviews and other regulatory applications. The assessment included overall life-cycle costs and development schedules; it considered NRC-developed codes, computer codes developed by the DOE under the Nuclear Energy Advanced Modeling and Simulation project, and international codes. The codes identified for non-LWR analysis are expected to be suitable for a broad range of hypothetical accidents, regardless of the applicant's choice of licensing approach, and can accommodate reviews using either the LMP or more traditional licensing approaches. As part of its assessment of analytical tools, knowledge and capability gaps have been identified. Based on these gaps, the staff has identified necessary code development tasks.

The staff has identified technical gaps associated with various non-LWR technologies, enhanced its knowledge of non-LWR designs, assessed the capabilities of candidate computer codes, and conducted code development activities. The staff has developed a comprehensive plan for developing computer code capabilities to support non-LWR reviews. This plan covers the overall code development approach, the codes, knowledge gaps, and necessary

development activities. Together with the supporting technical rationale and decision criteria, the plan provides a roadmap and priorities for ongoing and future computer code development and assessment.

In addition, the staff has identified and began to assess the performance needs and issues of seismic safety, materials, chemistry, and component integrity used in non-LWR designs. Through strong engagement with domestic and international partners, the staff has surveyed and collected information on non-LWR operating experience and is heavily involved with consensus standards and codes activities.

To improve understanding of the unique codes, experimental data, features, phenomena, and knowledge gaps related to non-LWR technologies, the staff has performed the following activities:

- The staff completed a series of six reports documenting the NRC's code development plans. These reports were shared internally to ensure alignment of priorities and next steps and were later publicly released for stakeholder input. The reports cover the follow topics:
  - The introduction gives an overview of the NRC's approach to code development in support of advanced reactor reviews.[6]
  - Volume 1 focuses on computer code readiness for systems analysis.[7]
  - Volume 2 focuses on computer code readiness for fuel performance analysis.[8]
  - Volume 3 focuses on computer code readiness for neutronics, source term, severe accident progression, and accident consequence analysis.[9]
  - Volume 4 focuses on computer code readiness for licensing and siting dose assessments.[10]
  - Volume 5 focuses on computer code readiness for criticality and shielding considerations for the front and back end of the fuel cycle.[11]
- In the area of systems analysis, the staff tested available reference plant models for near-term applicants. These models will be revised as applicant design information

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6 See "Approach for Code Development in Support of NRC's Regulatory Oversight of Non-Light Water Reactors," dated January 31, 2020 (ADAMS Accession No. ML20030A174).

7 See "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 1—Computer Code Suite for Non-LWR Plant Systems Analysis," dated January 31, 2020 (ADAMS Accession No. ML20030A176).

8 See "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 2—Fuel Performance Analysis for Non-LWRs," dated January 31, 2020 (ADAMS Accession No. ML20030A177).

9 See "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 3—Computer Code Development Plans for Severe Accident Progression, Source Term, and Consequence Analysis," dated January 31, 2020 (ADAMS Accession No. ML20030A178).

10 See "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 4—Licensing and Siting Dose Assessment Codes," issued August 2020 (ADAMS Accession No. ML20028F255).

11 See "NRC Non-Light Water Reactor (Non-LWR) Vision and Strategy, Volume 5—Radionuclide Characterization, Criticality, Shielding, and Transport in the Nuclear Fuel Cycle," dated November 3, 2020 (ADAMS Accession No. ML20308A744).

becomes available. Additionally, the staff has verified a suite of codes as being suitable for microreactor simulation.

- In the area of fuel performance analysis, the staff added material property correlations to the NRC's computer code Fuel Analysis under Steady-state and Transients (FAST) for TRISO modeling. Spherical solvers and TRISO mechanical failure modes were also added to FAST. The staff has completed an evaluation of metallic fuel models and identified potential improvements. Additionally, the staff completed training on the DOE's BISON fuel performance code. Staff members are collaborating with Idaho National Laboratory (INL) to assess FAST and BISON against Experimental Breeder Reactor data.

- In the areas of source term and severe accident progression analysis, the staff is studying non-LWR beyond-design-basis accident behavior. Reference plant models for near-term applicants are available and being tested.

- In the area of consequence analysis, the staff completed assessment of the MELCOR Accident Consequences Code System (MACCS) applicability for near-field consequence analysis and is currently updating MACCS to include near-field atmospheric transport and dispersion and dose calculation improvements.

- In the areas of licensing and siting dose assessment, Pacific Northwest National Laboratory completed "DRAFT Software Requirements Document for an Atmospheric Dispersion Engine" (PNNL-30355). The staff reviewed and provided comments for disposition of the final report.

- ANL's final report ANL-19/13, "Environmental Creep-Fatigue and Weld Creep Cracking: A Summary of Design and Fitness-For-Service Practices,"[12] documents best practices for the design of components for creep-fatigue. The staff received this report in April 2020. ANL initiated a follow-on task to evaluate effects of complex stress states on creep-fatigue life (notch effects). The staff also developed a software tool to execute the ASME BPVC-III-5 design rules, which was made publicly available on June 3, 2020, through the NRC public Web site.[13]

- The NRC placed a contract with Southwest Research Institute to develop a technology-inclusive, risk-informed, and performance-based (TI-RIPB) pathway for advanced non-light-water reactors (ANLWRs) to address seismic safety within the LMP framework. One part of the contract aims to (1) evaluate feasibility and adequacy of potential technical criteria through demonstration studies, (2) perform communication and outreach activities to help reach consensus with pertinent stakeholders on a viable and practical TI-RIPB approach for ANLWR seismic safety, (3) develop associated implementation guidance, and (4) identify potential regulatory improvements for future rulemaking activities. The other part of the contract aims to identify and evaluate technical criteria for regulatory guidance on the design and review of seismic isolation technologies included in commercial nuclear power plant licensing applications.

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[12] See ADAMS Accession No. ML20099A141.

[13] See "Transmittal of ASME Section III, Division 5 Design Tool for Advanced Non-Light Water Reactor High Temperature Metallic Components," dated June 3, 2020 (ADAMS Accession No. ML20153A360).

- The staff issued Research Information Letter (RIL) 2020-09, "International Workshop on Advanced Non-Light-Water Reactor—Materials and Component Integrity,"[14] related to a workshop held in December 2019 at NRC Headquarters. This RIL describes the current understanding and future research needs to support licensing readiness and safety assessments for advanced reactor materials and component integrity.

- Working with ORNL, the staff initiated work to provide confirmatory testing and analysis of various corrosion measurement techniques, so that confident assertions can be made about their validity.

- The NRC placed a contract with INL to provide technical support for graphite in ANLWRs. Under this contract, INL will (1) provide training to NRC staff on graphite degradation, aging, and failure mechanisms relevant to ANLWRS, and (2) identify existing DOE modeling tools that could be used for modeling graphite behavior in ANLWRs, provide training for them, or create a plan to develop such tools if none currently exist.

- The staff completed a technical letter report titled "Advanced Nonlight-Water Reactors Summary of Gap Identification and Recommendations on Consensus Codes and Computational Codes," (TLR-RES/DE/CIB-2019-04) issued in October 2020.[15] This report summarizes gap identification and makes recommendations on consensus codes and standards and computational codes relevant to the design and operation of ANLWRs. The report identifies potential gaps in the ASME BPVC Section XI, including high-temperature crack growth and fracture rules, residual stress relaxation cracking, and the use of advanced finite element procedures to evaluate buckling limits for time-independent conditions. The report also presents a summary of recent enhancements to the United Kingdom's R5 fitness-for-service procedure. R5 incorporates assessment procedures for high-temperature fracture mechanics that are not available in the current ASME BPVC.

Next steps: The staff plans to continue code development, focusing on technology-inclusive capabilities for NRC codes, and to enhance its understanding of and regulatory readiness to review the materials anticipated to be proposed for use in non-LWRs. Final issuance of Volumes 4 and 5 of the code assessment reports, on dose analysis and fuel cycle analysis, is scheduled for April 2021. For source term and severe accident progression analysis, public workshops are planned for summer 2021. For licensing and siting dose assessment, the next step is to develop the consolidated atmospheric dispersion engine computer code. The research plan and summary of accomplishments in materials, chemistry, and component integrity for advanced reactors are scheduled to be issued in March 2021.

[14] See ADAMS Accession No. ML20245E186.
[15] See ADAMS Accession No. ML20254A155.

4.0 Strategic Area No. 3: Regulatory Framework

4.1 Overview

This strategic area supports the objective of optimizing non-LWR regulatory readiness. One of the NRC's goals in Strategic Area No. 3 is to develop guidance for flexible non-LWR regulatory review processes, including conceptual design reviews and staged-review processes, within the bounds of existing regulations. In 2020, the staff prioritized activities supporting the development of technology-inclusive, risk-informed, and performance-based licensing approaches, in support of the NRC's goal of being a modern, risk-informed regulator.

4.2 Progress Summary

4.2.1 Non-Light-Water Reactor Licensing-Basis Development

On December 2, 2019, the staff submitted SECY-19-0117,[16] in which it requested that the Commission find the LMP methodology to be a reasonable approach for establishing key parts of the licensing basis for non-LWRs. The LMP was a cost-shared initiative led by Southern Company, coordinated by the NEI, and supported by the DOE. The industry LMP team generated the guidance document NEI 18-04, Revision 1, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development," issued in August 2019.[17] This document focuses on key areas of the design and licensing of advanced reactors, such as the selection of licensing-basis events, classification of structures, systems and components (SSCs), and assessment of defense in depth.

In a staff requirements memorandum (SRM) dated May 26, 2020, the Commission approved the LMP methodology as a reasonable approach for establishing key parts of the licensing basis and the content of applications for licenses, certifications, and approvals for non-LWRs. Subsequently, in June 2020, the staff issued a Regulatory Guide (RG) 1.233, Revision 0, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Approach to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors,"[18] which endorsed NEI 18-04, Revision 1.

The staff is continuing to work with stakeholders to create guidance for non-LWR developers on the content of applications that use the LMP methodology. This project is called the Technology-Inclusive Content of Applications Project (TICAP); it aims to provide guidance on the scope and level of detail for the final safety analysis report portion of an application based on the LMP methodology. The staff recognizes that some portions of an application are outside the scope of TICAP and its associated LMP methodology (for example, occupational dose and routine plant radiological effluents). Therefore, the staff is also working with stakeholders on the Advanced Reactor Content of Application Project (ARCAP), which encompasses TICAP and includes guidance for portions of applications outside of TICAP.

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16 See SECY-19-0117, "Technology-Inclusive, Risk-Informed, and Performance-Based Methodology To Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light Water Reactors," dated December 2, 2019 (ADAMS Accession No. ML18311A264).

17 See ADAMS Accession No. ML19241A472.

18 See ADAMS Accession No. ML20091L698.

The staff conducted nine public meetings during calendar year 2020 to discuss TICAP and ARCAP with stakeholders. The staff released preliminary guidance language which was discussed with stakeholders during these series of meetings. This draft guidance describes a performance--based approach for application content on routine plant radiological effluents. On November 5, 2020, the staff released ARCAP draft Chapter 2, "Site Information"[19] which covers geological and demography, seismological, hydrological, and meteorological characteristics of the site and the surrounding vicinity; and covers population distribution, land use and site activities and controls. This document also includes a proposal to limit the amount of material in Safety Analysis Report Chapter 2 to that which is necessary for establishing safety significant design parameters and performing the safety analysis, along with its supporting bases.

Next steps: The staff will continue ARCAP and TICAP efforts, with extensive stakeholder engagement to seek further input. These efforts are expected to be an important part of (1) the NRC's development and implementation of strategies for increased use of risk-informed, performance-based licensing evaluation techniques and guidance, and (2) the NRC's rulemaking to establish a technology-inclusive regulatory framework for advanced nuclear reactors as required by NEIMA.

4.2.2 Fuel Qualification Strategies

The designers of the various advanced reactors are considering several fuel types, including fuels based on TRISO particles, metallic uranium alloys, and liquid salt fuels. The staff is consulting with the DOE and the national laboratories on the qualification of each of the fuel types under consideration. The staff is also interacting with individual developers and other stakeholders.

Developers are proposing advanced reactor designs whose fuel designs and operating environments (e.g., neutron energy spectra, fuel temperatures, neighboring materials) are outside of the large experience base available for traditional LWR fuel. The type of fuel affects many aspects of the overall nuclear power plant design, and qualification of nuclear fuel has traditionally involved long development times. Recognizing these potential challenges for advanced nuclear fuel qualification, in early 2020, the staff began developing a white paper to establish a performance-based fuel qualification assessment framework that would satisfy regulatory requirements. This framework follows a top-down approach in which lower level objective goals support high-level regulatory requirements. In September 2020, the staff issued a draft white paper[20] that describes the bases for the identified goals and includes clarifying examples of the evidence needed to meet those goals. The staff discussed the draft white paper with stakeholders in a public meeting on October 1, 2020.

On May 31, 2019, EPRI submitted the topical report EPRI-AR-1 (NP), "Uranium Oxycarbide (UCO) TRISO Coated Particle Fuel Performance."[21] TRISO-coated particle fuel is foundational for many high-temperature reactor designs, including HTGRs and fluoride salt-cooled high temperature reactors (FHRs). EPRI and the DOE co-funded the report, with the involvement of developers of high-temperature reactors. In 2002, the DOE initiated the Advanced Gas Reactor Fuel Development and Qualification Program to establish the capability in the United States to

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19 See ADAMS Accession No. ML20316A013.

20 See "Fuel Qualification for Advanced Reactors (Draft)," issued September 2020 (ADAMS Accession No. ML20191A259).

21 See ADAMS Accession No. ML19155A173.

fabricate high-quality UCO TRISO fuel and to demonstrate its performance. Using the results of the Advanced Gas Reactor Program, the May 2019 EPRI report consolidates the technical basis for the functional performance of UCO TRISO-coated particles to support the use of UCO TRISO-coated particles by a variety of developers in their designs for high-temperature reactors. The NRC staff issued the final safety evaluation[22] for the EPRI topical report on August 11, 2020; the staff found that the topical report is acceptable for referencing in licensing applications, subject to certain limitations and conditions.

On May 30, 2019, ANL submitted the topical report ANL/NE 16/17, Revision 1, "Quality Assurance Program Plan for SFR Metallic Fuel Data Qualification,"[23] which describes the metal fuels legacy data quality assurance program. As part of its review of this report, the NRC audited the implementation process. The NRC staff determined that the quality assurance program plan satisfies the requirements in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities." The NRC issued the final safety evaluation[24] on April 29, 2020. The NRC is also working with stakeholders, including the DOE, to identify and resolve possible regulatory issues with the planned use of High-Assay Low-Enriched Uranium (HALEU) in some advanced reactor designs, including any needed licensing of fuel cycle facilities and transportation packages.

With ORNL support, the staff is developing fuel qualification criteria for liquid-fueled MSRs. As part of this effort, ORNL prepared ORNL/LTR-2018/1045, "Molten Salt Reactor Fuel Qualification Considerations and Challenges,"[25] issued in November 2018, and ORNL/TM-2020/1576, "MSR Fuel Salt Qualification Methodology,"[26] issued in July 2020.

Next steps: The staff plans to incorporate stakeholder feedback and convert the draft fuel qualification white paper into a formal regulatory guidance document, which will be issued for public comment in 2021. The staff has contracted with ORNL to develop a draft guidance document, expected in 2021, for the fuel qualification of liquid-fueled MSRs. The staff will evaluate the document for possible endorsement. The staff will continue generically applicable fuel qualification activities and will engage with advanced reactor developers on specific issues related to qualification of their fuel designs. For example, on November 19, 2020, the staff provided feedback on the TerraPower white paper titled "Advanced Fuel Qualification Methodology Report-Regulatory Guidance Development Report."[27] Advanced reactor developers have already begun to submit design specific- topical reports to the NRC for review and approval of their fuel qualification plans, and more are expected. The staff encourages developers to provide early engagement and feedback on key technical issues, in support of staged licensing approaches.

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22 See Final Safety Evaluation for "Uranium Oxycarbide (UCO) Tristructural Isotropic (TRISO) Coated Particle Fuel Performance: Topical Report EPRI-AR-1(NP)," dated August 11, 2020 (ADAMS Accession No. ML20216A323).

23 See ADAMS Accession No. ML19156A404.

24 See "Safety Evaluation regarding the Argonne National Laboratory Quality Assurance Program Plan for Sodium Fast Reactor Metallic Fuel Data Qualification," dated April 29, 2020 (ADAMS Accession No. ML20106F242).

25 See ADAMS Accession No. ML18347A303.

26 See ADAMS Accession No. ML20197A257.

27 See ADAMS Accession No. ML20310A278.

4.2.3 Additional Guidance Development Activities

In addition to the specific activities discussed in Section 4.2.1, the staff identified two broad regulatory framework development activities in support of Strategic Area No. 3:

(1) Establish criteria, as necessary, to reach safety, security, and environmental findings for non-LWR technologies.

(2) Identify and resolve gaps in the current regulatory framework for non-LWRs and the relevant fuel cycles.

The following specific activities support these two broad activities:

- The staff contracted with ORNL to develop a model of a material control and accounting (MC&A) program for pebble-bed reactors (PBRs) and a methodology for assessing MC&A performance at PBRs. ORNL issued a final report[28] that provides a model MC&A plan for PBRs, as well as the basis, methodology, and process for the development of the outline. The report discusses specific MC&A issues and challenges, as well as possible ways to address these challenges. The model is based on information in the draft of NUREG-2159, "Acceptable Standard Format and Content for the Material Control and Accounting Plan for Special Nuclear Material of Moderate Strategic Significance," issued in September 2013; Revision 2 of RG 5.29, "Special Nuclear Material Control and Accounting Systems for Nuclear Power Plants," issued in June 2013; and American National Standards Institute (ANSI) N15.8-2009 "Methods of Nuclear Material Control - Material Control Systems - Special Nuclear Material Control And Accounting Systems for Nuclear Power Plants."

- The staff is evaluating comments on the NRC's rulemaking on reprocessing. The rulemaking was initiated in 2013 but suspended in 2016 because of budgetary constraints and apparent lack of industry interest in constructing and operating reprocessing facilities. Consistent with SECY-15-0129 and the Commission's direction, the staff engaged with stakeholders several times in 2020 and is conducting an evaluation to determine whether to continue with the rulemaking. The staff intends to inform the Commission of its decision in early 2021.

- The staff developed the interim staff guidance COL-ISG-029, "Environmental Considerations Associated with Micro-reactors,"[29] issued in October 2020, to help staff members determine the appropriate scale and scope of the environmental documentation to be prepared for environmental reviews of micro-reactors. The staff developed this guidance based on the smaller size and expected design features of advanced micro-reactors (e.g., reduced radionuclide inventories and enhanced safety features). Micro-reactors have the potential for lower environmental impact than large light-water reactors (LWRs) and may therefore require less extensive environmental documentation.

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[28] See ORNL/SPR-2019/1329, "Model MC&A Plan for Pebble Bed Reactors," issued March 2020 (ADAMS Accession No. ML20112F355).

[29] See ADAMS Accession No. ML20290A519.

- On February 28, 2020, the staff submitted SECY-20-0020, "Results of Exploratory Process for Developing a Generic Environmental Impact Statement for the Construction and Operation of Advanced Nuclear Reactors."[30] The staff is currently developing a GEIS for the construction and operation of advanced nuclear reactors (ANRs). The purpose of a GEIS is to improve the efficiency of the environmental review process. On April 30, 2020, in Volume 85 of the *Federal Register*, page 24040 (85 FR 24040), the NRC issued a notice of intent to develop the ANR GEIS and conduct scoping. On May 28, 2020, the NRC held a public webinar to receive comments on the scope of the ANR GEIS. The ANR GEIS scoping summary report[31] documents the results of the scoping process. On September 21, 2020, in SRM-SECY-20-0020, the Commission directed the staff to initiate rulemaking to codify the GEIS. The staff is planning to conduct this rulemaking while continuing to prepare the GEIS.

- To modernize the instrumentation and controls (I&C) safety review of ANLWR applications, the staff developed a draft design review guide titled "Design Review Guide (DRG): Instrumentation and Controls for Non-Light-Water Reactor (Non-LWR) Reviews", which was published on October 8, 2020.[32] This DRG provides guidance for the staff to use when reviewing the I&C portions of applications for ANLWRs within the bounds of existing regulations. The guidance leverages the NuScale Design-Specific Review Standard Chapter 7 framework while factoring in the lessons learned from new reactor reviews.

- The staff anticipated the need to conduct Human Factors Engineering (HFE) reviews of application for facilities (e.g., small and micro non-LWRs) that differ substantially from the large LWRs for which NUREG-0711 "Human Factors Engineering Program Review Model" was developed. A scalable or graded process is needed to (1) assess the potential contribution of human performance to the risk that facilities which differ substantially from large LWR facilities present to public health and safety and, (2) assess, commensurate with that risk, whether the facility design or facility design process is adequate to identify and address the contribution of human performance to facility risk. The staff contracted with Brookhaven National Laboratory (BNL) to develop an HFE process and guidance for conducting non-design-specific technical reviews of small and micro non-LWRs. BNL developed a characterization of non-LWRs, and findings were documented in a technical letter report. BNL is currently reviewing existing NRC HFE guidance and determining suitability of existing guidance, and the findings will be documented in a technical letter report and submitted to the NRC in December 2020. A final report will be released publicly at the conclusion of the study.

- The staff contracted with ORNL to develop a report on proposed guidance for preparing and reviewing a molten salt non-power reactor application. This report was issued in July 2020 as ORNL/TM-2020/1478. On November 18, 2020,[33] the staff endorsed Appendix A to the report, with clarifications, as guidance for preparing applications for the licensing of non-power liquid fueled molten salt reactors.

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30 See ADAMS Accession No. ML20052D029.

31 See "Scoping Summary Report for the Generic Environmental Impact Statement for Advanced Nuclear Reactors," dated September 25, 2020 (ADAMS Accession No. ML20260H180).

32 See ADAMS Accession No. ML20238B936.

33 See ADAMS Accession No. ML20251A008.

Next steps: In 2021, the staff will proceed with guidance development activities including fuel qualification guidance for advanced reactors, ARCAP regulatory guidance, TICAP regulatory guidance, HFE guidance, a framework document for advanced reactor inspection and oversight, the final I&C DRG, and MC&A guidance for Category II facilities (NUREG-2159). The staff will provide the proposed rule for the GEIS for ANRs rulemaking to the Commission by February 1, 2022.

5.0 Strategic Area No. 4: Consensus Codes and Standards

5.1 Overview

This strategic area supports the objective of enhancing non-LWR technical and regulatory readiness. The staff intends to apply its established process for incorporating codes and standards into its regulatory framework. NRC Management Directive 6.5, "NRC Participation in the Development and Use of Consensus Standards," dated October 28, 2016, describes this process, which consists of three primary steps: (1) identifying and prioritizing needs for new and revised technical standards, (2) participating in development of codes and standards, and (3) endorsing codes and standards. The NRC is working with standards development organizations (SDOs), non-LWR designers, the DOE, and other stakeholders to identify and facilitate new codes needed for non-LWR development.

5.2 Progress Summary

5.2.1 The American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Division 5, for High-Temperature Reactors

The ASME BPVC provides NRC-accepted rules for the design, construction, testing, certification, and quality assurance of nuclear reactors with systems operating below 426 degrees Celsius (800 degrees Fahrenheit). However, non-LWR designs may incorporate novel materials or systems operating above 426 degrees Celsius. At these elevated temperatures, the structural capacity of systems and components will change as a function of time, temperature, and previously applied stress. BPVC-III-5 provides rules for the design, construction, testing, certification, and quality assurance of high-temperature reactors; it covers the use of metallic, graphite, and composite materials. ASME and the industry technology working groups for the major advanced reactor types (i.e., HTGRs, MSRs, and fast reactors) have requested that the NRC endorse the 2017 Edition of the ASME BPVC to improve the efficiency and effectiveness of the agency's review process, to provide non-LWR designers a stable set of rules for reactor development, and to facilitate the certification of non-LWR component vendors.

The NRC staff is actively participating in working groups and subgroups associated with the development of BPVC-III-5. Two joint ASME/NRC task groups, for metallics and non-metallics, have produced ASME reports identifying gaps and optimizations that need to be resolved in BPVC-III-5. These reports conclude that while the ASME BPVC committees should pursue further optimizations, there are no significant gaps in BPVC-III-5 that would prevent the NRC from endorsing the standard.

The ASME Qualification of Active Mechanical Equipment (QME) Committee has approached the NRC and the BPVC-III-5 committees seeking input on developing rules for active components operating at temperatures above 426 degrees Celsius. NRC staff representing the

agency on the QME Committee and BPVC-III-5 committees are supporting QME-1 development. The staff developed a draft Nonmandatory Appendix on Material Qualification for Active Mechanical Equipment in Advanced Reactors to be considered by ASME for incorporation into the ASME Standard QME-1, "Qualification of Active Mechanical Equipment Used in Nuclear Facilities." The QME Task Group on High-Temperature Reactors met on July 10, 2020 for an initial discussion of the draft nonmandatory appendix. The QME Task Group is reviewing the draft nonmandatory appendix for further discussion.

Next steps: The NRC has received final products from DOE national laboratories and draft products from commercial entities that have provided expert recommendations on endorsement of the code and its limitations. The NRC has reviewed these recommendations for quality and clarity. The agency is developing two documents for the endorsement effort: (1) a NUREG that documents the staff's technical evaluation, and (2) a regulatory guide that states the outcome of the NRC review and lists conditions to be applied to the use of BPVC-III-5. The NRC will make available to the public all documents that are important to the staff's evaluation. The staff began its technical review in January 2020 and plans to produce a draft RG by spring 2021. The staff has updated stakeholders and will continue to do so, at the ASME BPVC Week meetings, the NRC's Standards Forum, the advanced reactor stakeholder meetings, and other public venues. The staff will engage with the ACRS while developing the NUREG and draft RG.

5.2.2 The American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section XI, Division 2

The ASME BPVC, Section XI, Division 2, "Requirements for Reliability and Integrity Management (RIM) Programs for Nuclear Power Plants," provides the requirements for the creation of the RIM program for all types of nuclear power plants. The RIM program gives plant owners the flexibility to implement alternative strategies from Section XI, Division 1, for maintaining the reliability of SSCs in the plant. Section XI, Division 1, is incorporated by reference in 10 CFR 50.55(a), but the NRC's regulations and guidance currently do not reference Section XI, Division 2. ASME has requested NRC endorsement of the 2019 Edition of the ASME BPVC, Section XI, Division 2, in 10 CFR 50.55(a).

The NRC recognizes that non-LWR designers would benefit from a standardized set of requirements for design, construction, and inservice inspection. The staff has developed a project plan for review and potential endorsement of Section XI, Division 2, for non-LWR applications.

Next steps: The staff will review Section XI, Division 2, to determine whether it is acceptable for endorsement. Should the staff determine Section XI, Division 2, to be acceptable (with conditions, if necessary), the NRC will endorse it in a new RG rather than 10 CFR 50.55(a). The staff's technical review began in September 2020 with the goal of developing a draft RG by fall 2021. The staff has and will continue to update stakeholders at the ASME B&PV Code Week meetings, the NRC's Standards Forum, the Advanced Reactor Stakeholder meetings, and other public venues.

5.2.3 American Nuclear Society Standards

The NRC participates in several American Nuclear Society (ANS) standards development working groups and consensus committees. The table below shows the status of each.

Standard/Committee	Status
Research and Advanced Reactor Consensus Committee (RARCC).	Next meeting scheduled for November 2021.
Risk-Informed, Performance-Based Principles and Policy Committee.	No meetings scheduled at this time.
ANS 53.1, “Nuclear Safety Design Process for Modular Helium-Cooled Reactor Plants.”	Issued 2011, reaffirmed 2016. ANS plans to update this standard beginning in 2021.
ANS 54.1, “Nuclear Safety Criteria and Design Process for Liquid-Sodium-Cooled Nuclear Power Plants.”	Final standard issued March 27, 2020.
ANS 20.1, “Nuclear Safety Criteria and Design Process for Fluoride Salt-Cooled High-Temperature Reactor Nuclear Power Plants.”	Project Initiation Notification System (PINS) form submitted to ANSI on February 26, 2014. The development of this standard is on hold because of limited applicability to industry.
ANS 20.2, “Nuclear Safety Design Criteria and Functional Performance Requirements for Liquid-Fuel Molten-Salt Reactor Nuclear Power Plants.”	PINS form submitted to ANSI on July 7, 2016. The working group has held frequent meetings and conference calls in 2020. The goal is to issue the standard for ballot in late 2021.
ANS 30.1, “Integrating Risk and Performance Objectives into New Reactor Nuclear Safety Designs.” (Proposed)	Proposed; PINS form submitted to ANSI on July 31, 2016. The draft standard was given to the RARCC in February 2020 for comments. The goal is to resolve the comments and prepare Revision 3 of the standard by early 2021.
ANS 30.2, “Categorization and Classification of Structures, Systems, and Components for New Nuclear Power Plants.” (Proposed)	Proposed; PINS form submitted to ANSI on July 7, 2016. The working group has held frequent meetings and conference calls in 2020. Completion of the draft standard is targeted for spring 2021.

Next steps: The NRC will continue to participate in ANS committees and standards development working groups as appropriate to support standards for non-LWR technologies.

5.2.4 Development of the American Society of Mechanical Engineers/American Nuclear Society Non-Light-Water Reactor Probabilistic Risk Assessment Standard

The ASME/ANS Joint Committee on Nuclear Risk Management (JCNRM) issued ASME/ANS RA-S-1.4-2013, “Probabilistic Risk Assessment Standard for Advanced Non-LWR Nuclear Power Plants,” for trial use in 2013. The technical requirements for this standard were developed using source material from the existing ASME/ANS Level 1 full-power LWR probabilistic risk assessment (PRA) standard—namely, ASME/ANS RA-Sa-2009, as revised in 2013 in ASME/ANS RA-Sb-2013 (Addendum B)—as well as from draft LWR standards for low-power and shutdown PRA, Level 2 PRA, and Level 3 PRA. To support a variety of reactor

concepts, including HTGRs, SFRs, and MSRs, the JCNRM is updating the ASME/ANS non-LWR PRA standard on a reactor-technology-inclusive basis, using established technology-inclusive risk metrics common to existing LWR Level 3 PRAs. Such risk metrics include frequency of radiological consequences (e.g., dose, health effects, and property damage). To cover the wide range of applications defined by non-LWR stakeholders, this standard has a very broad scope, comparable to that of a full-scope Level 3 PRA for an LWR with a full range of plant operating states and hazards. Because the standard supports modular reactor concepts, it will address the evaluation of integrated risk for multireactor or multiunit plants, including concurrent accidents on two or more reactor units or modules.

Several national and international organizations are currently using the standard as they develop non-LWR PRAs. These organizations provided valuable feedback to the JCNRM writing group for incorporation into the final draft of the standard. The writing group also includes an NRC staff member, who provided numerous comments on the standard in May 2020. In September 2020, the JCNRM voted to approve the final draft. ASME/ANS RA-S-1.4 is now ready for publication as a consensus standard.

Next steps: ASME/ANS RA-S-1.4 is expected to be published as an ANSI standard in February 2021. The NRC staff is reviewing ASME/ANS RA-S-1.4 for endorsement upon publication. The staff expects to issue a Trial Use RG in 2021. Applicants may use this guidance on a trial basis and lessons learned from these piloted applications of the guidance and an expected revision to the ANSI standard will be incorporated before the regulatory guide is finalized.

5.2.5 The Standards Forum

The NRC Standards Forum aims to:

- identify needed standards within the nuclear industry that are not currently being addressed by SDOs, and to explore collaborations to accelerate their development
- identify process improvements for effective and timely standards development
- exchange information on standards for nuclear facilities across disciplines and stakeholders
- facilitate engagement and networking within the standards development community

On October 13, 2020, the staff held the fourth annual NRC Standards Forum, chaired by the NRC's Standards Executive. Approximately 270 attendees joined the event, including participants from the NRC; SDOs such as ANS, ASME, the American Concrete Institute, the American Society of Civil Engineers, and the Institute of Electrical and Electronics Engineers; NEI; EPRI; the DOE and DOE national laboratories, including ANL, INL, and ORNL; and academia. The NRC Web site offers a full summary and related documents.[34]

This year's event included six panel sessions and a DOE presentation. The focus was on codes and standards for advanced reactors, although this was not the entire scope of the event. Presentation topics included the following:

[34] See https://www.nrc.gov/about-nrc/regulatory/standards-dev/standards-forum/2020.html.

- needs and challenges for advanced reactor codes and standards
- efforts for coordination between new reactor technology developers and SDOs to identify and develop or update high-priority standards
- development of technology-neutral design and inspection standards for advanced reactors and non-LWRs
- ongoing regulatory review and endorsement efforts
- new materials and advanced construction techniques
- potential benefits of more harmonization across different SDOs
- ideas for expediting materials qualifications and associated challenges

Additionally, the DOE presentation highlighted opportunities to advance the development and applications of standards. It recommended the creation of a multiorganization working group to represent the stakeholder community, reach a consensus on priorities, and create a roadmap. The discussions contributed valuable ideas on how stakeholder groups, including the NRC, can more effectively develop and update codes and standards to meet advanced reactor needs.

Next steps: The staff expects to hold the next NRC Standards Forum in fall 2021.

6.0 Strategic Area No. 5: Resolution of Policy Issues

6.1 Overview

This strategic area supports the identification and resolution of policy issues within the purview of the NRC that contribute directly to regulatory predictability, effectiveness, and efficiency. Early identification and resolution of policy issues enhance technical and regulatory readiness and communications. Some policy issues are for the NRC staff to address, while others may require engagement with the Commission.

The NRC public Web site lists the policy issues the staff is considering in relation to the licensing of SMRs and non-LWRs. The list is routinely revised to reflect the latest updates on each policy issue. The staff has discussed these issues with stakeholders in several of its recurring public meetings. These discussions will continue, so that the NRC receives ongoing stakeholder input on identifying, prioritizing, and resolving policy issues.

6.2 Progress Summary

6.2.1 Part 53 Rulemaking

On January 14, 2019, the President signed NEIMA into law (Public Law 115-439). NEIMA directs the NRC to develop the regulatory infrastructure to support the development and commercialization of advanced nuclear reactors. As stated in NEIMA, the statute aims, in part, to provide “a program to develop the expertise and regulatory processes necessary to allow innovation and the commercialization of advanced nuclear reactors.” NEIMA Section 103(a)(4) directs the NRC to “complete a rulemaking to establish a technology-inclusive, regulatory

framework for optional use by commercial advanced nuclear reactor applicants for new reactor license applications" by December 31, 2027. Because NEIMA gave the NRC discretion on the content and scope of the rulemaking, the NRC staff sought Commission approval of the proposed scope in SECY-20-0032, "Rulemaking Plan on 'Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (RIN-3150-AK31; NRC-2019-0062)'" [35] dated April 13, 2020. The staff proposed a rulemaking that would establish a technology-inclusive regulatory framework for optional use by applicants for new commercial advanced nuclear reactors which would build on previous agency efforts in this area. This rulemaking would create 10 CFR Part 53, "Licensing and Regulation of Advanced Nuclear Reactors," in keeping with the NRC vision and strategy report and the statutory provisions in NEIMA Section 103(a)(4).

On October 2, 2020, the Commission issued SRM-SECY-20-0032, approving the staff's overall approach for the rulemaking but directing the staff to complete the rulemaking by 2024 instead of 2027 while still producing a high-quality, thoroughly vetted regulation. The Commission further directed the staff to provide a schedule with milestones and resource requirements to achieve publication of the final rule by October 2024 and to inform the Commission of key uncertainties that might affect publication by that date. Finally, the Commission directed the staff to consider the appropriate treatment of fusion reactor designs in the NRC's regulatory structure by developing options on licensing and regulating fusion energy systems for Commission consideration. In a memorandum dated November 2, 2020,[36] the staff provided the Commission with the requested schedule, including milestones and resource requirements, as well as the list of key uncertainties affecting publication by October 2024.

The staff is actively working on the Part 53rulemaking to develop an innovative, predictable, yet appropriately flexible framework with regulations encompassing various attributes of advanced reactor technologies, prioritizing risk-informed and performance-based licensing approaches to ensure public health and safety throughout the life of a facility. The staff istengaging stakeholders and the ACRS in developing a draft proposed rule for Commission consideration. The Part 53 rulemaking was discussed at several of the staff's recurring advanced reactor stakeholder public meetings in 2019 and 2020. Dedicated Part 53 public meetings in 2020 included discussion of preliminary rule language for the technology-inclusive safety requirements, which was released beforehand for stakeholder feedback. The staff has since released preliminary rule text on design and analysis requirements. The staff is routinely releasing preliminary rule language for discussion at public meetings and will document alternative perspectives in the proposed rulemaking package. The staff met with the ACRS in July and September 2020, and January 2021.

NEIMA defines "advanced nuclear reactor" as a nuclear fission or fusion reactor, including a prototype plant, with significant improvements compared to commercial nuclear reactors under construction as of the date of the Act. The NRC and the Fusion Energy Sciences program of the U.S. Department of Energy (DOE) Office of Science have initiated routine interactions to develop longer term strategies for the possible deployment of fusion reactors. Many of the regulatory changes being considered for non-LWRs will inform strategies for licensing fusion reactors. The NRC staff supported a DOE/NRC workshop on fusion technologies in October 2020.

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35 See ADAMS Accession No. ML19340A056.

36 See "Response to Staff Requirements—SECY-20-0032—Rulemaking Plan on 'Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (RIN-3150-AK31; NRC-2019-0062),'" dated November 2, 2020 (ADAMS Accession No. ML20288A240).

Next Steps: Consistent with the Commission-directed rulemaking schedule, the staff will continue to actively engage with stakeholders and the ACRS in developing a proposed rule for Commission consideration in October 2024. The staff is scheduled to release preliminary rule text on siting requirements by February 2021 and construction and manufacturing requirements by March 2021. The staff will continue to meet with ACRS every 1 to 2 months throughout 2021 to support providing the proposed rulemaking package to the Commission in 2022. In accordance with NEIMA Section 103(e), the staff will provide a SECY paper with a draft report to Congress on completing the Part 53 rulemaking to the Commission by June 4, 2021. This report will also address whether NRC has adequate expertise, modeling, and simulation capabilities, or access to those capabilities, to support the evaluation of commercial advanced reactor license applications. In 2021, the staff will engage stakeholders in dedicated public meetings on fusion technologies and will prepare a paper with options on licensing and regulating fusion energy systems to the Commission by January 3, 2023.

6.2.2 Siting for Small Modular Reactors and Non-Light-Water Reactors

In SECY-20-0045, "Population Related Siting Considerations for Advanced Reactors,"[37] dated May 8, 2020, the NRC staff presented the Commission with several options for addressing population-related siting questions for advanced reactors. The staff recommends revising NRC guidance to provide an alternative population density criterion that is directly related to the potential radiological consequences estimated from analyzing a range of possible design-specific events.

Next steps: The Commission is reviewing SECY-20-0045. The staff will implement the Commission's directions after issuance of the SRM.

6.2.3 Emergency Preparedness Requirements for Small Modular Reactors and Other New Technologies

Consistent with the Commission's direction in 2015, the NRC staff developed a proposed rule giving alternative emergency preparedness requirements for SMRs and other new technologies. The proposed alternative requirements would follow a consequence-oriented, risk-informed, and performance-based approach. This rulemaking would reduce potential requests for exemptions from the current emergency preparedness requirements and would promote regulatory stability, predictability, and clarity in the licensing process for future facilities. The NRC published the regulatory basis on November 15, 2017. The staff presented the proposed rule for Commission consideration in SECY-18-0103, "Proposed Rule: Emergency Preparedness for Small Modular Reactors and Other New Technologies," [38] dated October 12, 2018. On December 17, 2019, in SRM-SECY-18-0103, the Commission approved publication of the proposed rule. On May 12, 2020, the NRC published the proposed rule in the *Federal Register* for a 75-day public comment period. On June 24, 2020, the staff hosted a public meeting to answer questions about the proposed rule and guidance document, after which the public comment period was extended to September 25, 2020. Along with the proposed rule, the staff developed draft guidance in Draft Regulatory Guide (DG)-1350, "Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, and Non-Power Production or

[37] See ADAMS Accession No. ML19262H055.
[38] See ADAMS Accession No. ML18134A086.

Utilization Facilities," issued May 2020. This draft guidance provides a technology-inclusive, risk-informed, and performance-based approach to radiological dose assessment for emergency planning zone size evaluation.

Next steps: The staff is currently reviewing public comments and will make appropriate changes in the formulation of a proposed final rule to be provided to the Commission by September 30, 2021.

6.2.4 Appropriate Source Term and Dose Calculations for Small Modular Reactors and Non-Light-Water Reactors

In SECY-16-0012, "Accident Source Terms and Siting for Small Modular Reactors and Non-Light Water Reactors,"[39] dated February 7, 2016, the staff stated that evaluation of mechanistic methods would be important for application reviews, and that it did not note concerns or policy issues related to the implementation of mechanistic accident modeling of source terms. Specifically, the staff affirmed that although it has not yet developed source term tools and technical expertise for non-LWRs to the same level as for SMRs, it believes a mechanistic approach could also be applied to non-LWR designs, provided that adequate tools and analysis approaches are available.

The ACRS stated in a letter dated October 19, 2018, that the staff "should provide [mechanistic source term] guidance to evaluate the adequacy of the frequency of events considered and the duration over which such events must be analyzed," as well as guidance "on how source terms should be developed." In a response dated November 9, 2018, the staff informed the ACRS that it would continue to evaluate the need to further enhance its guidance on mechanistic source term (MST) development. Subsequently, NEIMA specified that the NRC should develop and implement guidance on the "use of mechanistic source terms" by January 2021.

The NRC contracted with INL to produce a report summarizing existing risk-informed, performance-based, and technology-inclusive approaches to developing source terms for dose-related assessments at advanced nuclear facilities, in support of the NRC's advanced reactor vision and strategy. The report outlines graded technical approaches to the development of design-specific MSTs, including previous approaches such as that of the Next Generation Nuclear Plant Project; it also describes how MSTs are used in the methodology described in NEI 18-04 and RG 1.233. The report does not provide MST methodologies or assumptions for the various advanced reactor technologies under development. The final report, titled "Technology-Inclusive Determination of Mechanistic Source Terms for Offsite Dose-Related Assessments for Advanced Nuclear Reactor Facilities," was issued in June 2020.[40]

The staff has continued interactions with potential non-LWR applicants on related MST methodologies that include accounting for the retention of radionuclides by barriers and the transport of radionuclides for all barriers and pathways to the environment. As previously discussed, the NRC supports the use of MST approaches, as evidenced by documents such as "Next Generation Nuclear Plant Licensing Strategy: A Report to Congress,"[41] issued in August 2008, and, more recently, the final safety evaluation report for the NuScale design certification.

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39 See ADAMS Accession No. ML15309A319

40 See ADAMS Accession No. ML20192A250.

41 See ADAMS Accession No. ML082290017.

Next steps: To support the use of MST approaches, the staff is conducting an endorsement review for the ASME/ANS non-LWR PRA standard. This standard provides a way to determine source terms and references the alternative source term calculation guidance in RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,"[42] which the NRC issued in July 2000 and is currently updating.

The staff also continues to interact with stakeholders and is engaging the national laboratories to support the use of MST approaches by advanced reactor developers. In 2020 and 2021, with support from ORNL and Sandia National Laboratories, the NRC is undertaking an effort to demonstrate the application of its modeling and simulation codes, MELCOR and SCALE, for non-LWRs. The NRC uses MELCOR and SCALE to model severe accident behavior, including the retention or attenuation of radionuclides by plant systems and structures, to resolve safety concerns and evaluate possible regulatory actions. The staff plans to conduct public workshops in 2021 to facilitate dialogue with stakeholders on the NRC's approach to assessing source terms for non-LWR technologies using MELCOR and SCALE.

6.2.5 Security and Safeguards Requirements for Small Modular Reactors and Non-Light-Water Reactors

On August 1, 2018, the staff issued SECY-18-0076, "Options and Recommendation for Physical Security for Advanced Reactors."[43] In its SRM dated November 19, 2018, the Commission directed the staff to initiate a limited-scope revision to regulations and guidance on physical security for advanced reactors; it also approved, subject to edits, a related rulemaking plan. The staff prepared a regulatory basis, which was published for public comment in the *Federal Register* on July 16, 2019. The staff released preliminary proposed rule language twice and held public meetings in 2020 to discuss the rule text and the staff's disposition of public comments on this rulemaking. The staff also reviewed a draft industry guidance document, NEI 20-05, "Methodology Approach and Considerations for a Technical Analysis to Demonstrate Compliance with the Performance Criteria of 10 CFR 73.55(a)(7)," prepared to support this rulemaking.

Next steps: The staff will continue to interact with stakeholders while preparing the proposed rule and related guidance. The staff will provide a draft proposed rule for the alternative physical security requirements for advanced reactors rulemaking to the Commission by September 27, 2021.

6.2.6 Insurance and Liability for Small Modular Reactors and Non-Light-Water Reactors

The NRC staff has engaged stakeholders on the issue of insurance and liability during several public meetings, most recently on November 5, 2020. On October 14, 2008, the Commission issued "Policy Statement on the Regulation of Advanced Reactors,"[44] which states:

> Consistent with its legislative mandate, the Commission's policy with respect to regulating nuclear power reactors is to ensure adequate protection of the environment and public health and safety and the common defense and security. Regarding advanced reactors, the Commission expects, as a minimum, at least

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42 See ADAMS Accession No. ML003716792.
43 See ADAMS Accession No. ML18052B032.
44 See 73 FR 60612 (ADAMS Accession No. ML082750370).

> the same degree of protection of the environment and public health and safety and the common defense and security that is required for current generation light-water reactors (LWRs). [In this context, current generation LWRs are those nuclear power plants licensed before 1997.] Furthermore, the Commission expects that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions.

Given that advanced reactors are expected to provide at least the same degree of protection as existing reactors, the question is whether (1) the risk profiles for advanced reactor facilities are comparable to those of existing facilities, for which the current insurance and liability requirements were established, or (2) the attributes of advanced reactor designs lead to reduced risk profiles, which might warrant changes to insurance and liability requirements. For the first question, the staff will document its assessments of the risks associated with advanced reactor facilities, including multimodule issues, as parts of developing a regulatory framework for advanced reactors and the licensing process for specific designs and facilities. For the second question, public meetings on this topic have shown that stakeholders, including designers and industry organizations, indicate that no immediate actions are called for to address the possibility that reduced risks posed by advanced reactors might warrant changes to current insurance and liability requirements. While the NRC does not envision a need for changes to the Price-Anderson Act, changes to guidance or through rulemaking may be needed to develop a financial protection framework for advanced reactors, including the licensing of multi-module or multi-unit designs and facilities.

Next steps: In accordance with the latest version of the Price-Anderson Act, by December 31, 2021, the NRC will prepare a report to Congress and an associated SECY paper that will address advanced reactors as well as other topics associated with continuation or modification of the provisions of the Price-Anderson Act.

6.2.7 Micro-reactors

Micro-reactors, which are generally small (on the order of one to tens of megawatts thermal), are envisioned to perform nontraditional roles for nuclear power, such as providing power for defense sites and remote areas. Micro-reactors are anticipated to rely less on complex safety systems and to use more inherent safety features; also, the potential consequences of any postulated accidents are expected to be less severe. The NRC staff has identified a number of potential policy and licensing issues to address for micro-reactors, including:

- security requirements
- emergency preparedness
- staffing requirements
- remote operation
- aircraft impact
- oversight
- annual fee structure
- manufacturing licenses
- transportable reactors
- siting
- environmental reviews

On October 6, 2020, the staff provided SECY-20-0093, "Policy and Licensing Considerations Related to Micro-Reactors,"[45] to the Commission. This paper (1) informs the Commission of licensing topics related to nuclear micro-reactors that may necessitate departures from current regulations, related guidance, and past precedents, (2) identifies potential policy issues related to licensing micro-reactors, and (3) describes the staff's approach to facilitating licensing submittals for near-term and future deployment and operation of micro-reactors.

Next steps: In the near term, the staff plans to license micro-reactors under the existing regulations for power reactor licenses in 10 CFR Part 50 and in 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants." Because of the significant differences between large LWRs and micro-reactors, the staff is receptive to requests for exemptions from the existing regulations in the areas above and would evaluate such exemptions on a case-by-case basis using existing agency processes. Proposals in some of these areas (such as fully autonomous operation) may encompass policy issues that warrant future Commission interaction.

In the longer term, the staff plans to incorporate the knowledge gained from the licensing and oversight of the first micro-reactors into a generic approach. The agency could codify such an approach in the rulemaking to establish the technology-inclusive regulatory framework required by NEIMA. The staff plans to address any policy issues that arise during the development of the approach through issue-specific Commission papers. The staff expects this rulemaking to include provisions addressing micro-reactors in a manner commensurate with the risks they pose. The NRC could also address issues such as annual fees in other planned rulemakings (e.g., the annual fee rule).

7.0 Strategic Area No. 6: Communication

7.1 Overview

This strategic area supports the objective of optimizing communications. The communications plan seeks to:

- Provide timely, clear, and consistent communication of NRC requirements, guidance, processes, and other regulatory topics, and provide multiple paths for external feedback to the NRC.

- Develop consistent NRC messaging suitable for a range of audiences.

- Promote the exchange of non-LWR technical and regulatory experience with the NRC's international counterparts and industry organizations.

7.2 Progress Summary

The NRC continues to proactively communicate with stakeholders and seek their feedback on all non-LWR readiness activities. The NRC also meets with potential applicants upon request and shares information with various international groups, including the Organization for Economic Co-operation and Development's (OECD's) Nuclear Energy Agency (NEA), the International Atomic Energy Agency (IAEA), the Generation IV International Forum (GIF), and the NRC's international regulatory counterparts. The sections below describe several key communications, accomplishments, and ongoing activities.

[45] See ADAMS Accession No. ML20254A363.

7.2.1 Stakeholder Engagement

The NRC conducts public meetings with stakeholders every 6–8 weeks. In early 2020, to maximize participation, stakeholders could participate either in person or virtually. Since March 2020, because of the coronavirus disease (COVID-19) pandemic, the NRC has been conducting these public meetings virtually. The NRC has conducted nine such meetings in 2020, in addition to topic-specific meetings on the following topics:

- Part 53 risk-informed, technology-inclusive regulatory framework
- advanced reactor content of application
- technology-inclusive content of application
- construction permit guidance

The NRC has also briefed the ACRS Future Plant Subcommittee and Full Committee on a variety of topics, including Part 53, TRISO fuel qualification, I&C DRG and introductions to specific non-LWR designs.

Next steps: The staff will continue to hold stakeholder meetings approximately every 6 weeks in 2021.

7.2.2 Coordination with the U.S. Department of Energy

The NRC continues to interact frequently with the DOE on regulatory development activities and in modernizing its regulatory framework to enhance the potential future licensing of advanced reactors. To support the DOE Advanced Reactor Demonstration Program (ARDP), the NRC staff is prepared to receive applications for multiple advanced reactor designs, including proposals to build two reactors and preapplication engagement to assist with risk reduction and the Advanced Reactor Concepts 20 awards. In October 2020, the DOE selected two teams, one led by TerraPower and the other led by X-Energy, LLC, to receive initial funding under the ARDP which will lead to applications within the next several years. In addition, in December 2020, the DOE selected five teams to receive initial funding under the risk reduction program and three U.S. based teams to receive funding under the Advanced Reactor Concepts 20 program. These awards will generate preapplication engagement for multiple advanced reactor designs. In 2020, the NRC and the DOE put in place an addendum to an existing memorandum of understanding (MOU) covering DOE and NRC roles and responsibilities in the ARDP. Additionally, the DOE has direction and funding to pursue regulatory development activities through the national laboratories and work with the NRC. In monthly calls, the NRC and the DOE discuss mutual areas of interest. They also hold periodic management meetings to share information about advanced reactor readiness activities.

An MOU is in place for the NRC and the DOE to collaborate on the DOE authorization process for the proposed Versatile Test Reactor (VTR). Under this MOU, the NRC and the DOE have discussed areas including the DOE's experience in implementing the NRC's guidance in RG 1.233 and the National Environmental Policy Act (NEPA) process for assessing the environmental impacts of the VTR. The NRC staff also participated in several workshops co-sponsored by the DOE's Gateway for Accelerated Innovation in Nuclear (GAIN) initiative. The specific workshops are listed in Section 7.2.4 of this enclosure.

Another MOU is in place to allow the NRC and the DOE to share technical expertise and knowledge as required by the Nuclear Energy Innovation Capability Act of 2017 (NEICA). The primary purpose of this MOU is to coordinate DOE and NRC technical readiness and to facilitate sharing of technical expertise and knowledge on advanced nuclear reactor technologies and nuclear energy innovation. This includes activities involving the National Reactor Innovation Center, which is a DOE program under NEICA designed to enable the testing and demonstration of reactor concepts to be proposed and funded, wholly or in part, by the private sector.

The NRC and the Fusion Energy Sciences program of the DOE Office of Science have initiated routine interactions to develop longer term strategies for the possible deployment of fusion reactors.

Next steps: The NRC staff will continue to interact frequently with the DOE to gather information relevant to the NRC's non-LWR readiness activities. The staff will also continue to support the DOE's GAIN initiative and attend GAIN workshops, as specified in the GAIN MOU. The staff will continue to work with the DOE to implement the regulatory development activities identified in the VTR and NEICA MOUs. The staff is outlining a new MOU addendum with DOE which will focus on cooperation in the characterization of radiological source terms and MELCOR code development activities. This effort is primarily centered around sharing of technical information and research activities to enhance the MELCOR capabilities and represents broad areas of collaboration between NRC and DOE's Office of Nuclear Energy that can enhance the technical bases for code models and their application to advanced nuclear energy technology assessments. Lastly, the staff is prepared to receive applications to support the DOE ARDP for multiple advanced reactor designs.

7.2.3 Coordination with the U.S. Department of Defense

The Strategic Capabilities Office (SCO) in the Department of Defense (DOD) is leading the mobile microreactor demonstration project, in collaboration with the DOE, the U.S. Army Corps of Engineers, and industry partners. In May 2019, the NRC, the DOE, and DOD SCO signed an MOU to coordinate technical readiness and the sharing of technical expertise and knowledge on micro-reactor technologies to support DOD's research and development of such reactors. The NRC's engagement in this project is designed to provide the NRC, consistent with its role as an independent safety and security regulator, with opportunities to enhance its understanding of advanced technologies and inform its approaches to licensing advanced reactors. Coordination is key to the rapid development of workable prototype designs that can support evaluation, safety analysis, and ultimately, construction and testing. The MOU specifically states that the DOE and its national laboratories will provide technical, environmental, siting, and safety-basis documentation support for the project. The NRC staff has been taking advantage of opportunities to enhance its understanding of advanced technology and inform its approaches to licensing advanced reactors. The NRC staff has also contributed explanations of the agency's requirements and guidance documents when needed.

Next steps: The staff will continue to cooperate, within the bounds of its statutory authority, with its counterparts at the DOD and the DOE to help resolve the technical and policy issues associated with the successful demonstration of a mobile reactor.

7.2.4 Meetings and Conferences

To facilitate non-LWR stakeholder outreach and communications, the NRC has actively participated in numerous workshops, conferences, and meetings, most of which were held virtually due to the COVID-19 public health emergency. These include the following events:

- EPRI's Advanced Reactor Stakeholder Forum
- ANS Annual Meetings
- U.S. Nuclear Infrastructure Council's Advanced Reactor Technical Summits
- ORNL's Molten Salt Reactor Workshops
- INL/NRC Metallic Fuel Workshop
- IAEA workshops on advanced reactors
- IAEA Consultancy Meeting: Safety Report on the Safety Assessment and Safety Analysis of Small Modular Reactors
- GAIN-EPRI-NEI Advanced Fuels Workshop
- GAIN-EPRI-NEI Sensor Technology for Advanced Reactors Workshop
- NRC/DOE/Fusion Industry Association Fusion Workshop
- 2020 ASME Section III Division 5 Virtual Workshop on High Temperature Reactors
- Quarterly ASME meetings
- NRC Codes and Standards Forum
- OECD/NEA Working Group on the Safety of Advanced Reactors
- Los Alamos National Laboratory Workshop on Heat Pipe Reactors
- NRC Virtual Public Workshop: Enhancing Risk-Informed and Performance-Based Seismic Safety for Advanced Non-Light Water Reactors
- University of Southern California, Berkeley Chemical Sensor Technologies for MSRs and FHRs
- National Academies of Sciences, Engineering, and Medicine's Committee: NRC staff briefed on Merits and Viability of Different Nuclear Fuel Cycles and Technology Options and the Waste Aspects of Advanced Nuclear Reactors which described the fuel cycle, transportation, storage, and disposal regulatory framework for advanced reactors

Next steps: The NRC will continue to participate in non-LWR meetings, conferences, and workshops as resources permit.

7.2.5 International Coordination

As part of the NRC's goal of being a modern risk-informed regulator and building strong partnerships, as well as optimizing resource use and leveraging experience, the staff continues extensive engagement and cooperation with international organizations, including the OECD/NEA, the IAEA, the Generation IV International Forum (GIF), and the NRC's international regulatory counterparts.

The NRC chairs NEA's working group for international regulators of non-LWRs, known as the Working Group on the Safety of Advanced Reactors (WGSAR). This group brings regulators together to discuss common interests, practices, and problems, addressing both regulatory and research needs. Currently, Belgium, Canada, China, France, Germany, Italy, Japan, Korea, Russia, the United Kingdom, and the United States are members of the WGSAR. Representatives from the European Union and the IAEA also participate in WGSAR meetings. WGSAR also interfaces with GIF. GIF representatives attend WGSAR meetings, and WGSAR comments on GIF documents such as SFR safety design guidelines. In 2020, WGSAR and GIF continued to cooperate on developing risk-informed and performance-based licensing approaches for non-LWRs and on WGSAR review of GIF safety design guidelines. On December 1, 2020, the Committee on Nuclear Regulatory Activities approved the WGSAR report on fuel qualification which leveraged the NRC's draft fuel qualification white paper.

The NRC also participates in and chairs the IAEA SMR Regulators' Forum in which regulators identify and address key regulatory challenges to SMR oversight. The Forum is hosted by the IAEA and comprises representatives from Canada, China, Finland, France, Korea, Russia, Saudi Arabia, the United Kingdom, and the United States. Japan and South Africa have also recently expressed interest in joining the Forum. In 2020, the Forum continued its work on reports related to licensing, safety analysis, and manufacturing oversight of SMRs, issued several interim reports on topics such as regulatory holdpoints and the multimodule aspects of SMRs, and formulated the new topics that will be addressed in the next phase of the Forum.

In August 2019, the NRC entered into a memorandum of cooperation (MOC) with the CNSC to expand interaction on activities associated with advanced reactor and SMR technologies, including the development of shared advanced reactor and SMR technical review approaches, preapplication activities, research, training, and the development of regulatory approaches addressing unique and novel technical considerations to ensure the safety of advanced reactors and SMRs. The NRC and the CNSC agreed that the MOC would be implemented under the existing NRC–CNSC Steering Committee, under which staff members from both agencies have already discussed these topics and the potential for future cooperation.

At the October 2019 Steering Committee meeting in Ottawa, Canada, the Steering Committee approved terms of reference for a new Subcommittee on Advanced Reactor Technologies and Small Modular Reactors (ART-SMR Subcommittee). The ART-SMR Subcommittee has held three formal meetings, in October 2019, March 2020, and September 2020, as well as over a dozen informal meetings. It has approved a work plan on developing common guidance for the contents of new build license applications for advanced reactor projects; a joint report resulting from the project will be issued in the spring of 2021. For this work plan, the LMP training NRC staff provided CNSC on June 25, 2020, was well received. In addition, the subcommittee has approved a work plan on sharing regulatory insights from the technical review of the NuScale SMR design certification review. The NRC staff has been meeting regularly with CNSC staff on topics of interest related to NuScale. The CNSC seeks to leverage the lessons learned and the

information forming the basis of the NRC's NuScale design certification review to inform the CNSC's vendor design review of the selected regulatory topics.

NRC and CNSC Subcommittee members have met with several other advanced reactor and SMR vendors that have activities underway at both the NRC and the CNSC and have approved work plans for cooperation in preapplication review activities on several designs. Working groups have been formed for these projects, and joint review activities on the selected topics are in progress. Common reports on two of these projects are expected in spring 2021. These common reports will contain statements and feedback from both the NRC and the CNSC, who will leverage them in their respective regulatory reviews and decision making, as appropriate.

The NRC and the United Kingdom's Office of Nuclear Regulation (ONR) have ongoing research activities on advanced reactor materials and component integrity. To minimize duplication and leverage expertise and experience, ONR and RES staff have continually exchanged valuable data and analytical modeling efforts for graphite aging. Both the NRC and the ONR have expressed interest in continued collaboration under the existing engagement agreement, to exchange insights on research and regulatory approaches for advanced reactor materials. The ONR hopes to gain insights to enhance its regulatory infrastructure for advanced reactor materials. The NRC hopes to gain insights to assist in its preparation to license ANLWRs, such as HTGRs, liquid-metal-cooled reactors, and fusion reactors.

Next steps: The NRC will continue to exchange information with international counterparts and to participate in NEA and IAEA working groups to foster international cooperation. The NRC will also continue frequent bilateral interactions with the CNSC under the NRC–CNSC MOC. The next meeting of the ART-SMR Subcommittee is planned for April 2021.