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 assure that the agency is ready to effectively and efficiently review potential applications for non-light-water reactor (non-LWR) technologies. The NRC staff has worked with various stakeholders to align the approach described in "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness," dated December 2, 2016,[1] with similar planning documents prepared by organizations such as the U.S. Department of Energy (DOE)[2] and the Nuclear Energy Institute (NEI).[3] The staff developed an implementation action plan to identify specific NRC near-term,[4] midterm, and long-term activities.[5] Many of the activities described in the plan involve interactions with stakeholders and the coordination of activities related to the development of advanced reactor technologies. The staff described background information and previous accomplishments in SECY-18-0011, "Advanced Reactor Program Status," Enclosure 1, "Non-Light Water Reactor Implementation Action Plan—Progress Summary and Future Plans," dated January 25, 2018.[6]

As described in the implementation action plan, the staff has organized its non-LWR readiness efforts into 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

The staff has made significant progress in activities related to all six of these areas. The staff has prioritized the advancement of risk-informed and performance-based approaches and the resolution of key policy issues. These activities support the goal of assuring NRC readiness to effectively, efficiently, and predictably review non-LWR applications. The NRC will continue to seek information from prospective applicants to ensure that technology-inclusive readiness activities will support the plans of near-term applicants.

This enclosure provides the status of each of the readiness strategies, with an emphasis on accomplishments achieved during calendar year 2018. This enclosure also describes next steps and planned activities for fiscal year (FY) 2019 and beyond. The NRC's plans for activities in FY 2019 have been informed by input received from stakeholders and reflect the available resources and staff members who have the necessary skills.

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1 See "NRC Vision and Strategy: Safely Achieving Effective and Efficient Non-Light Water Reactor Mission Readiness," dated December 2, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16356A670).

2 See DOE/NE-0147, "Vision and Strategy for the Development and Deployment of Advanced Reactors," DOE, Office of Nuclear Energy, issued January 2017.

3 See "Strategic Plan for Advanced Non-Light Water Reactor Development and Commercialization," NEI, issued May 2016.

4 See "NRC Non-Light Water Reactor Near-Term Implementation Action Plans," dated July 12, 2017 (ADAMS Accession No. ML17165A069).

5 See "NRC Non-Light Water Reactor Mid-Term and Long-Term Implementation Action Plans," dated July 12, 2017 (ADAMS Accession No. ML17164A173).

6 See SECY-18-0011, "Non-Light Water Reactor Implementation Action Plan—Progress Summary and Future Plans," dated on January 25, 2018 (ADAMS No. ML17334B217).

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

2.1 Overview

This strategy supports the non-LWR vision and strategy objective of enhancing non-LWR technical readiness. The near-term objectives for this strategy 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 DOE and industry technology development activities. The NRC also monitors the plans of prospective applicants to ensure that the staff prioritizes its readiness in technology-specific areas appropriately.

In 2018, the staff made progress in increasing staff knowledge of non-LWRs. The staff's main objective in 2019 under this strategy will be to expand the staff's capability and capacity in order to accelerate readiness activities and to prepare to review potential applications.

2.2 Progress Summary

The staff focused primarily on two activities in support of Strategic Area No. 1 in FY 2018: (1) training and (2) efforts in the area of knowledge management.

2.2.1 Training

To supplement the course on molten salt reactors (MSRs) developed in 2017 by Oak Ridge National Laboratory (ORNL), the staff has contracted with Argonne National Laboratory (ANL) to develop training curricula, including a self-study manual for sodium-cooled fast reactor (SFR), micro reactor, and high-temperature gas-cooled reactor (HTGR) technologies and to provide the course to the NRC staff. The knowledge gained from this training will assist the staff in understanding SFR, micro reactor, and HTGR technologies, and help enable the staff to perform regulatory reviews of designs using these technologies and to develop guidance for performing future application reviews, as needed. This initiative began in October 2018 and is scheduled to be completed in spring 2019.

Next Steps: The staff will receive SFR, micro reactor, and HTGR training in spring 2019. 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

Significant 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.

In 2018, the staff completed a report summarizing the available domestic and international operational experience for both power and research non-LWRs with regard to materials and structural performance. The report focuses on SFRs and HTGRs and will provide valuable knowledge to support staff development and readiness activities in this area.

In 2018, the staff contracted with Brookhaven National Laboratory to develop a report that comprehensively describes the NRC's history with non-LWR technology. This report, scheduled for completion by spring 2019, will assist the staff in understanding the history of non-LWR technologies and facilitate future reviews of these technologies. This report will introduce non-LWR concepts to NRC staff members who are not familiar with non-LWRs and will provide the associated historical context.

Next Steps: The NRC plans to leverage existing NRC knowledge management resources and data repositories to capture available non-LWR information in a manner that can be easily accessed and maintained. The NRC will also coordinate with DOE to leverage access to the non-LWR material on the DOE Gateway for Accelerated Innovation in Nuclear (GAIN) Web site.

Competency modelling for advanced reactor project managers and technical reviewers is part of a pilot project led by OCHCO. A competency model describes what people need to know and be able to do in order to do their job and serves as a tool to identify and help close any skill gaps. The first step in the modeling process is the Rapid Job Task Analysis (JTA). The JTA sessions identify the current job tasks and the required behaviors that are necessary to excel in these positions. In 2017, OCHCO completed the development of the competency model for advanced reactor project managers and advanced reactor technical reviewers and loaded these competency models into the Self-Directed Learning Engine system. In 2018, Project managers and technical reviewers began using the system to assess their skills against the model.

Next steps: Remaining staff will complete the skills assessment and supervisors will complete an independent assessment of their employees' skills. OCHCO also plans to develop more specific technical reviewer competency models to focus on specific technical review areas, such as reactor systems and containment systems.

3.0 Strategic Area No. 2: Analytical Tools

3.1 Overview

This strategy supports the non-LWR vision and strategy objective of enhancing non-LWR technical readiness and optimizing regulatory readiness. Currently, the staff has existing analytical codes that are applicable to current operating and new light-water reactors (LWRs), and some have limited non-LWR capabilities. The initial tasks for this strategy include evaluating existing analytical capabilities, identifying gaps for non-LWRs, and then selecting the analytical codes for use by the staff in performing confirmatory analyses and other regulatory activities.

The approach taken for this strategy is to (1) identify the tools, information, and data that may be needed to support the staff's review of non-LWR designs, (2) evaluate the existing computer codes 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 potential conflicts of interest. The staff's goal is to leverage, to the extent practicable, collaboration and cooperation with the domestic and international community interested in non-LWRs with the goal of establishing a set of tools and data that are commonly understood and accepted. That community may include the NRC, DOE, developers, utilities, and international regulatory partners. The NRC expects to use the codes 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 staff has a number of ongoing interactions and collaborative efforts with DOE, the Electric Power Research Institute (EPRI), the domestic research community, and the international community related to computer codes and analytical tools. The approach for this strategy will build on these existing interactions, with the goal of developing new cooperative-funded activities, as appropriate. For example, the NRC's Fuel Analysis under Steady-state and Transients (FAST) development team and DOE's BISON development team hold bimonthly calls to exchange information related to fuel performance modeling.

Across the various reactor designs, several fuel types are being considered, including tristructural isotropic (TRISO) particle, metallic, and liquid salt fuels. The TRISO fuel is a uranium oxy-carbide used in both HTGRs and one type of a fluoride-salt-cooled reactor, and the metallic fuel is a uranium-zirconium used in SFRs. Liquid salt fueled reactors have the nuclear fuel dissolved in the molten salt coolant. One of the challenges for computer code development is the limited experimental data on these fuel types.

In the near term, the plan for Strategic Area No. 2 addresses the functional areas of reactor kinetics and criticality, fuel performance, thermal-fluid phenomena, severe accident phenomena, offsite consequence analysis, materials and component integrity, and probabilistic risk assessment (PRA).

3.2 Progress Summary

During FY 2017 and FY 2018, the staff completed an initial assessment of the information, data, and tools needed to support non-LWR reviews. In addition, the staff also has performed a preliminary assessment of existing computer codes and tools that have the potential to meet non-LWR review and other regulatory application needs. The assessment included overall life cycle costs and development schedule and considered NRC computer codes, computer codes developed by DOE under the Nuclear Energy Advanced Modeling and Simulation (NEAMS) project, and international computer codes. Computer codes and tools are used by the staff for confirmatory analyses of both design-basis events (DBEs), in which little or no core damage is expected, and beyond-design-basis events (BDBEs), in which significant fission product release and dispersal may occur. For both DBEs and BDBEs, the staff anticipates that some code development will be necessary.

In FY 2018, the staff made significant progress in identifying technical information gaps associated with various non-LWR technologies; enhancing staff knowledge of non-LWR designs; assessing the capabilities of candidate NRC, NEAMS, and international computer codes; and expanding the technology-inclusive capabilities of NRC computer codes. The staff is using the information and insights derived from these activities to develop a coherent plan for providing needed DBE and BDBE computer code capabilities to support non-LWR reviews. This plan, along with the supporting technical rationale and decision criteria, will be documented in a report that will provide a roadmap and priorities for future computer code development activities. The following are examples of the significant work performed in support of these activities in FY 2018.

Identifying Technical Gaps for Non-LWR Technologies

The staff performed several activities to better understand the unique features and phenomena related to non-LWR technologies being considered by developers, including:

- The staff completed a phenomena identification and ranking table (PIRT)-related exercise for thermal-hydraulic and neutronic events in MSRs. The PIRT focused attention on fuel salt MSRs because of their novel and unique feature of fuel being part of the coolant of which three are many conceptual designs. Although the PIRT is considered preliminary because design specific details are not available, it has been useful in that several important phenomena requiring simulation were identified based on existing information.

- The staff completed a gap analysis on the most important materials and component integrity issues that should be considered for licensing MSRs. The report considered materials issues for both fluoride and chloride applications, with both fast and thermal neutron spectra.
- The staff completed a report summarizing the available domestic and international operational experience (OpE) for both power and research non-LWRs with regard to materials and structural performance. It is focused on sodium SFRs and HTGRs.
- The staff began work to assess source-dependent graphite properties, including degradation in the presence of molten salts. This work contributes to the review of high temperature graphitic components for MSRs and HTGRs.
- The staff initiated work in understanding the compatibility of reactor components with chloride and fluoride salt environments. This effort will leverage ongoing work at ORNL funded by DOE. This work will contribute to the development of corrosion criteria and guidance to facilitate the review of environmental effects on materials degradation in MSRs.
- The staff began work to assess the influence, if any, of thermal embrittlement upon structural alloys undergoing high-temperature creep and creep-fatigue behavior under operating conditions for non-LWRs.
- The staff began participation in an International Atomic Energy Agency (IAEA) international standard program that will provide unique code assessment data for a fast reactor. The NRC staff is planning to obtain experimental data for the Chinese Fast Reactor Experiment and use it to assess candidate neutronics codes. The data are considered highly important for fast reactor designs, including those micro reactors cooled by heat pipes.

Enhancing Staff Knowledge

In order to increase staff knowledge about ongoing DOE computer code development efforts, DOE sponsored staff “hands-on” training of some of the NEAMS codes. These training opportunities, most recently conducted during a workshop held on November 28-29, 2018, gave the staff insights about the NEAMS codes capabilities and applicability of the codes for NRC safety analyses. Staff participation in these training sessions as well as attendance at DOE- and NRC-sponsored workshops, technology working group (TWG) meetings, and developer “drop-in” meetings gave the staff a much better understanding of the non-LWR reactor systems under development.

Computer Code Capability Assessment

To better support the selection of computer codes for future non-LWR reviews and identify significant gaps, the staff has assessed the current capabilities of NRC and NEAMS computer codes. Activities performed during FY2018 include the following:

- Through a contract with ANL, a draft report was completed to assist the staff in the evaluation of one of the NEAMS codes. The System Analysis Module (SAM) is a modern systems analysis tool ANL is developing for non-LWR safety analysis. To assess SAM capabilities for advanced reactor safety analysis and licensing at the NRC, a series of verification and other standard tests were modeled in SAM, and code simulation results are

compared with available analytical results. Although relatively simple, these tests cover the basic equation models, basic component models, and basic system-level processes and phenomena that should be modeled for advanced reactor safety analyses.

- The staff completed a task to assess the capability of one of the DOE codes (PRONGHORN) with regard to pebble bed gas-cooled reactor analysis, with results showing good agreement between predicted and measured data. PRONGHORN is a thermal hydraulics analysis tool developed specifically for gas-cooled reactor analysis. Initial results provide confidence that the DOE code should be able to evaluate DBEs in a pebble bed gas-cooled reactor.
- To assess the readiness of the NRC's BDBE code for safety analyses, a draft report from Sandia National Laboratories on MELCOR severe accident modeling and source term characterization and application was completed. It describes the evaluation models for various non-LWR technologies and the modeling gaps. In preparation for licensing micro-reactors, work continued on the conceptual design phase and review of modeling strategies for simulation of a heat pipe. In addition, the staff improved the HTGR modeling in MELCOR to simplify the transfer of data and the calculation strategy.
- In order to leverage and assess models developed under the DOE NEAMS code development program, work was initiated to couple the NRC's FAST computer code with MOOSE. This enables FAST to couple to any MOOSE-based or MOOSE-wrapped computer code (including NEAMS computer codes). Additionally, the NRC and ORNL have begun coupling FAST and SCALE to calculate the power distribution inside of an example non-LWR metallic fuel element.
- The NRC and DOE began exploring the creation of a new multiphysics code suite, called the Comprehensive Reactor Analysis Bundle (CRAB). The suite is designed to integrate the NRC's analytical tools with codes developed under the DOE NEAMS program. The CRAB suite proposes to address design-basis events (DBEs), in which little or no core damage is expected, using the NRC's TRAC/RELAP Advanced Computational Engine (TRACE) code and several NEAMS codes. For beyond-design-basis events (BDBEs), in which significant fission product dispersal may occur, use of the NRC's MELCOR and MELCOR Accident Consequence Code System (MACCS) codes are being explored. To better assess the integrated capabilities of the CRAB suite, staff developed a new feature in TRACE, the NRC's thermal-hydraulic systems computer code, to communicate boundary conditions to and from the NEAMS suite of codes via a DOE framework of coupled solvers called the Multiphysics Object-Oriented Simulation Environment (MOOSE). The new capabilities in CRAB are being tested to predict several code validation scenarios in which data are transferred between TRACE and the DOE fuel performance code, BISON

Expanding NRC Computer Code Capability

Preliminary code development work has been initiated as described above. Additional code development activities focused on expanding the capabilities of current NRC computer codes to include more broadly applicable, technology inclusive, capabilities pertinent to non-LWR reactor designs are continuing and include the following:

- The staff updated its FAST fuel performance code to add finite-volume modeling capability, which enables the code to model any fuel geometry, including spherical and plate type fuel, under steady-state and transient conditions. A gap analysis of FAST for metallic fuels was initiated to support adding missing correlations to the code and expand validation and assessment of the code against available data. Additionally, the staff updated FAST with

properties for metallic fuels and assessed it against Experimental Breeder Reactor-II (EBR-II) data.[7]

- The staff made progress in evaluating different atmospheric transport and dispersion models for integrating into MACCS to address near-field phenomena that are of elevated importance for nuclear power plants like non-LWRs that may have smaller emergency planning zones and site boundaries relative to large LWRs. MACCS is used for probabilistic consequence calculations of dose, health, economic, and societal consequences. It is the only U.S. code that treats the range of protective actions and uncertainty of weather conditions.
- The staff has initiated several activities intended to build computer code infrastructure to support non-LWR reviews. This work includes technology inclusive activities such as development of neutron cross section and material property libraries and enhancement to computer code modeling capabilities (e.g., addition of heat pipe modeling and enhanced geometric capabilities).

The staff plans to continue to perform code development work focused on technology-inclusive capabilities for NRC codes. In parallel, the staff is developing plans and reports, as described below, to guide a broader spectrum of activities, including technology-specific code development.

Developing the Technical Basis for Non-LWR Code Capability Needs

The staff is developing a set of reports that will provide a plan to guide future computer code development activities to support non-LWR reviews and other regulatory activities. The reports will identify candidate computer codes, the decision criteria and technical rationale applied to the selection process, and specific development activities needed to address known gaps. Stakeholder feedback will be sought prior to finalizing these reports to ensure they reflect the best available information and an appropriate range of perspectives. During FY2018, the staff performed the following significant activities:

- The staff prepared two preliminary draft reports that describe computer code needs, current capabilities, and gaps relevant to non-LWR confirmatory and future (beyond initial licensing) safety analysis. These reports are currently going through internal review and are expected to be issued for stakeholder review in FY2019.
- On November 16, 2018, the staff briefed the Advisory Committee on Reactor Safeguards (ACRS) Thermal-Hydraulic Phenomena Subcommittee on the role of computer codes in regulatory activities and needs for advanced reactor reviews. The meeting also included presentations by several new and advanced reactor developers. The staff informed the ACRS sub-committee of the intention to seek feedback on the non-LWR computer code reports in FY2019.

Next Steps: In FY 2019, the staff plans to complete the DBE and BDBE planning reports. These reports will provide a coherent basis and technical rationale for the selection of computer codes, and related development activities, in support of safety reviews of non-LWR designs. The reports will describe the factors used to select the codes, the work necessary to achieve readiness to support the safety reviews and the approach that will be taken in prioritizing resources for code development activities. The staff plans to seek feedback on its code development plans and the reports through public meetings with stakeholders including the

[7] See K.J. Geelhood, I.E. Porter, "Modeling and Assessment of EBR-II Fuel with the US NRC's FAST Fuel Performance Code," Proceedings of TopFuel 2018, Czech Republic, September 30–October 4, 2018

ACRS, DOE, national labs, non-LWR developers and the public. The code development plans will be modified to reflect consideration of the feedback received. Code gap closure activities in FY 2019 will focus on those activities that support early staff interactions with non-LWR vendors, code development work broadly applicable for multiple reactor technologies, and maximal synergy with DOE programs. Additionally, in FY 2019, the staff will assess the readiness of radiation protection and health physics codes along with codes used to support probabilistic risk assessments and materials and component performance to support safety analyses of non-LWR designs.

4.0 Strategic Area No. 3: Regulatory Framework

4.1 Overview

This strategy supports the objective of optimizing non-LWR regulatory readiness. One of the objectives of Strategic Area No. 3 is to develop guidance for flexible non-LWR regulatory review processes within the bounds of existing regulations, including the use of conceptual design reviews and staged-review processes. This flexibility will accommodate potential applicants having a range of financial, technical, and regulatory maturity and application readiness. In 2018, the staff placed the priority on activities to support the development of technology-inclusive, risk-informed, and performance-based licensing approaches.

4.2 Progress Summary

4.2.1 Non-Light-Water Reactor Design Criteria

Developing design criteria for non-LWRs is an important first step in providing stakeholders with insights on how the NRC staff views the unique characteristics of non-LWR technology. In 2013, the NRC, in coordination with DOE, began work on the initiative to develop guidance for principal design criteria (PDC) for non-LWRs. The purpose of the initiative was to assess the general design criteria (GDC) in the current regulations to determine whether they apply to non-LWR designs and, if not, to propose PDC that address non-LWR design features while recognizing that the underlying safety objective of each applicable GDC still applies.

After reviewing a proposal prepared by DOE, the NRC developed design criteria for non-LWRs and issued Draft Regulatory Guide (DG)-1330, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors,"[8] for public comment on February 3, 2017. After significant stakeholder interaction, the staff published final Regulatory Guide (RG) 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors," on April 3, 2018.[9] RG 1.232 provides guidance to reactor designers, applicants, and licensees of non-LWR designs on developing PDC for any non-LWR design subject to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants." The non-LWR design criteria included in Appendices A–C to RG 1.232 are intended to provide stakeholders with insight into the staff's views on how the GDC could be interpreted to address non-LWR design features. These are not considered to be final or binding requirements for a non-LWR applicant. Because the GDC are considered guidance for non-

[8] See DG-1330, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors," dated February 3, 2017 (ADAMS Accession No. ML16301A307).

[9] See RG 1.232, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors," dated April 3, 2018 (ADAMS Accession No. ML17325A611).

LWRs, non-LWR applicants would not need to request an exemption from the GDC in 10 CFR Part 50 when proposing PDC for a specific design. They may use RG 1.232 to develop all or part of the PDC and are free to choose among the advanced reactor, SFR, or HTGR design criteria provided in RG 1.232 to develop their PDC.

Next Steps: The staff is considering a future revision of RG 1.232 to address the Commission's recent decision on functional containment (i.e. SRM SECY-18-0096).

4.2.2 Non-Light-Water Reactor Licensing-Basis Development

The NRC is continuing to interact with industry initiatives such as the Licensing Modernization Project (LMP) being led by Southern Company, coordinated by NEI, and cost shared by DOE. The LMP generated a draft guidance document, NEI Working Draft 18-04, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development," dated September 28, 20018.[10] The NRC plans to issue DG-1353, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Approach to Inform the Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," proposing to endorse NEI 18-04. These guidance documents focus 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; and assessing defense in depth. The staff is gaining experience with the application of the LMP methodology through observation of the LMP tabletop exercise for the GE-Hitachi PRISM sodium-cooled reactor and the review of an LMP pilot report submitted by Oklo, Inc., for its compact fast reactor design.

The current efforts resulting in the preparation of NEI 18-04 and DG-1353 continue activities that have been carried out over many years. Although recent activities are consistent with past Commission decisions, the development of NEI 18-04 and DG-1353 provides an opportunity to demonstrate the integration of past decisions and to request Commission approval of the resultant methodology supporting the design and licensing of non-LWRs. The staff is preparing a paper describing the methodology, relationship to previous Commission decisions, and remaining policy issues for submittal to the Commission for review and approval.

Next Steps: The staff is continuing to interact with stakeholders, including potential joint industry-DOE projects like the LMP, to provide additional guidance to non-LWR developers in areas such as the content (scope and level of detail) for applications and the assessment of potential radiological releases using design-specific mechanistic source term (MST) models. The staff will also interact with developers as the LMP guidance is piloted for other non-LWR designs, such as the Westinghouse eVinci micro reactor and the Kairos Power fluoride-salt-cooled, high-temperature reactor. The staff will issue DG-1353 for public comment and the SECY paper on LMP by early spring 2019. After addressing public comments on DG-1353, the staff plans to issue a final regulatory guide in late 2019.

4.2.3 Additional Guidance Development Activities Planned for Fiscal Year 2019

In addition to the specific activities discussed in Sections 4.2.1–4.2.2 of this enclosure, the staff identified two broad regulatory framework development activities in support of Strategic Area No. 3:

[10] See NEI Working Draft 18-04, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development," dated September 28, 2018 (ADAMS Accession No. ML18271A172).

(1) Establish criteria, as necessary, to reach a safety, security, or environmental finding for non-LWR technologies.
(2) Identify and resolve gaps in the current regulatory framework associated with non-LWR reactors and the relevant fuel cycle.

The following specific activities performed in FY 2018 support these two-broad regulatory framework development activities:

- The staff visited the X-Energy, LLC, fuel fabrication pilot facility at ORNL in April 2018. X-Energy submitted a regulatory engagement plan for its fuel fabrication facility and had an initial preapplication meeting on its planned pebble bed tristructural isotropic (TRISO) fuel fabrication facility in August 2018. Another meeting was held in December 2018, and additional preapplication meetings are planned to continue during 2019 and 2020. These meetings will help identify any regulatory or guidance gaps for this specific advanced reactor fuel cycle.

- The staff contracted with ORNL to develop a model material control and accounting (MC&A) program for pebble bed reactors and a methodology for assessing MC&A performance at pebble bed reactors. This will help the staff to establish MC&A review guidance for this type of non-LWR.

- The staff has also contracted with DOE national laboratories to provide information that will support the future development of licensing review guides for metal fuel fabrication operations and fuel salt processing operations for advanced reactors. This will help the staff establish safety review guidance for non-LWR fuel cycles that use these fuel materials.

- The Center for Nuclear Waste Regulatory Analysis is assisting the NRC staff with identifying and assessing the significance of potential challenges associated with the safe transportation, storage, and disposal of advanced reactor fuel. This will help the staff in establishing transportation, storage, and disposal review guidance for non-LWR fuel cycles.

- In FY 2018, the staff initiated work on fuel qualification and fuel cycle issues related to high-assay, low-enriched uranium (HALEU).

- In May 2018, ORNL issued ORNL/TM-2018/834, “Proposed Guidance for Preparing and Reviewing Molten Salt Non-Power Reactor License Applications (NUREG-1537),” under the sponsorship of DOE and NEI. This document proposed chapter adaptations for NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” issued February 1996, to address the preparation and review of MSR non-power reactor license applications. This document is intended as industry input to the NRC for consideration in the development of generic MSR interim staff guidance similar to that created for aqueous homogenous reactors. The staff has a contract with ORNL to continue this work.

- On November 2, 2017, NEI presented[11] some potential challenges associated with the non-LWR fuel cycle, specifically with regard to proposed reactors that would use HALEU. NEI submitted a draft white paper on this topic on December 1, 2017,[12] and a final version in January 2018.[13] The staff has followed DOE and industry efforts to identify sources of HALEU for advanced reactor fuel and discussed the value of preapplication meetings for facility licensing and transportation certificate applications. The NRC met with interested stakeholders on regulatory issues associated with the production or use of HALEU on December 13, 2018, and discussed how to proceed, if appropriate, with guidance development activities.

- The NRC has had several discussions with DOE on the quality assurance of metal fuel legacy data. Generic NRC approval of the quality assurance of these data would benefit several of the designers of non-LWR fast reactors seeking to use these legacy data as part of the safety case for their fuels.

Next Steps: The NRC anticipates that DOE will submit a topical report describing the metal fuels legacy data quality assurance program in FY 2019. As part of its review of the topical report, the NRC plans to perform an inspection of the implementation process. The NRC also anticipates reviewing pending industry submittals on fuel qualification for TRISO fuel. In addition, the NRC will continue to engage with interested stakeholders on regulatory issues associated with their production or use of HALEU and, if appropriate, proceed with guidance development activities.

5.0 Strategic Area No. 4: Consensus Codes and Standards

5.1 Overview

This strategy supports the objective of enhancing non-LWR technical readiness and optimizing regulatory readiness. The staff intends to enhance the NRC's technical readiness for possible non-LWR designs by applying its established process for incorporating codes and standards into its regulatory framework. NRC Management Directive (MD) 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 the need for new and revised technical standards, (2) participating in codes and standards development, and (3) endorsing codes and standards. The NRC works with standards development organizations (SDOs), non-LWR designers, 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

[11] See NEI slides, "Meeting the Challenge Providing Fuel for Advanced Reactors," dated November 2, 2017 (ADAMS Accession No. ML17310B495).

[12] See draft NEI white paper, "Addressing the Challenges with Establishing the Infrastructure for the front-end of the Fuel Cycle for Advanced Reactors," dated December 1, 2017 (ADAMS Accession No. ML17341A604).

[13] See NEI white paper, "Addressing the Challenges with Establishing the Infrastructure for the front-end of the Fuel Cycle for Advanced Reactors," dated January 31, 2018 (ADAMS Accession No. ML18103A250).

The American Society of Mechanical Engineers (ASME) B&PV Code provides NRC-accepted rules for the design, construction, testing, certification, and quality assurance of nuclear reactors with systems operating below 426 degrees Celsius. However, non-LWR designs may incorporate novel materials or systems operating above 426 degrees Celsius (800 Fahrenheit).

ASME B&PV Code, Section III, Division 5, provides rules for the design, construction, testing, certification, and quality assurance of high-temperature reactors. The scope of the rules in ASME B&PV Code, Section III, Division 5, covers the use of metallic, graphite, and composite materials. The TWGs for the major advanced reactor types (i.e., HTGRs, MSRs, and fast reactors) and ASME have requested NRC endorsement of the 2017 Edition of the ASME B&PV Code in order to improve the efficiency and effectiveness of the agency's review process, to provide the 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 subgroups and working groups associated with the development of ASME B&PV Code, Section III, Division 5. The NRC staff is also participating in two joint ASME/NRC task groups for Division 5 related to metallics and nonmetallics, which are identifying gaps in ASME B&PV Code, Section III, Division 5, that need to be resolved. ASME is publishing an updated edition of ASME B&PV Code, Section III, Division 5, in 2019. Currently, ASME is not working on an equivalent of ASME B&PV Code, Section XI, or the ASME Operation and Maintenance Code for high-temperature reactors.

Next Steps: The NRC has initiated efforts to review and endorse the 2017 Edition of ASME B&PV Code, Section III, Division 5, for high-temperature reactors. The NRC created a working group to manage the effort and coordinate the independent technical review with cognizant NRC staff, contractors from DOE national laboratories, and commercial entities. The working group has completed an historical review of licensing actions using ASME Code Cases for high-temperature reactors, DOE supplements to the ASME Code Cases, and ASME B&PV Code, Section III-NH. The historical review will inform the scope of the endorsement effort to ensure an efficient review of Division 5. The NRC has awarded contracts to commercial entities and DOE national laboratories, and the NRC working group is developing a final, fine-detailed scope of review for each commercial entity and DOE laboratory.

The expected outcome of the endorsement effort is a RG that will not be incorporated by reference into 10 CFR 50.55a, "Codes and Standards." One reason for this decision is that the NRC staff expects that ASME will continue to make significant revisions to Division 5 between editions. Because there are a variety of advanced reactor designers that use different technologies, the NRC staff currently does not want to make the use of ASME B&PV Code, Section III, Division 5, a requirement through 10 CFR 50.55a. NRC reviews of future editions of ASME B&PV Code, Section III, Division 5, may take a different approach to endorsement.

5.2.2 American Nuclear Society Standards

The NRC provides representation on several American Nuclear Society (ANS) standards working groups and consensus committees, shown on the table below with the status of each.

Standard/Committee	Status
Research and Advanced Reactor Consensus Committee	Next meeting scheduled November 2019
Risk-Informed, Performance-Based, Principles and Policy Committee	Next meeting scheduled June 2019
ANS 53.1, “Nuclear Safety Design Process for Modular Helium-Cooled Reactor Plants”	Issued 2011, reaffirmed 2016
ANS 54.1, “Nuclear Safety Criteria and Design Process for Liquid-Sodium-Cooled Nuclear Power Plants”	Draft standard submitted to the Research and Advanced Reactor Consensus Committee, Advanced Initiatives Subcommittee
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 the American National Standards Institute (ANSI) on February 26, 2014. The development of this standard has been put 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 several meetings and conference calls, and the draft standard is in development.
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
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

Next Steps: The NRC will continue its membership and participation on ANS committees and standards development working groups to support standards for non-LWR technologies, where appropriate.

5.2.3 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. Source material from the existing ASME/ANS Level 1, full power, LWR PRA standard, ASME/ANS RA-Sa-2009, as revised in 2013 in ASME/ANS RA-Sb-2013 (Addendum B), as well as draft LWR PRA standards for low-power and shutdown PRA, Level 2 PRA, and Level 3 PRA, have been used, where appropriate, in developing the technical requirements for this standard. ASME and ANS are developing a new edition of the Level 1, full power, LWR PRA standard, which they expect to issue in 2020. To support a diverse mixture of reactor concepts, including HTGRs, SFRs, and MSRs, the ASME/ANS non-LWR PRA standard is being developed 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 impacts). To support a wide range of applications defined by the non-LWR stakeholders, the scope of this standard is very broad and comparable to a full-scope Level 3 PRA for an LWR with a full range of plant operating states and hazards. Because some of the non-LWR designs supported by this standard include modular reactor concepts, this standard will contain guidance for evaluating the integrated risk of multireactor or multiunit plants, including accidents on two or more reactor units or modules concurrently.

A number of national and international organizations currently use the standard as they develop non-LWR PRAs and are providing valuable feedback to the JCNRM writing group for incorporation into the final draft of the standard. This writing group, which includes a member of the NRC staff, met on October 9, 2018, and revised the plan for updating the current version of the non-LWR PRA standard to be consistent with current draft versions of supporting LWR standards and to reflect lessons learned from the LMP (NEI 18-04) tabletops and the activities associated with the trial use of the non-LWR PRA standard.

Next Steps: The writing group is scheduled to meet in February 2019 to review the updated version, but the final version is not expected to be issued until after publication of the new edition of the LWR PRA standard. When it is available, the NRC staff will review the issued version for possible endorsement.

5.2.4 The Standards Forum

The purpose of the Standards Forum is to help identify needed standards within the nuclear industry that SDOs are not currently addressing and to collaboratively accelerate their development. On September 11, 2018, the staff held the third annual NRC Standards Forum, chaired by the NRC's Standards Executive. Approximately 70 attendees participated, representing SDOs such as ASME, ANS, the American Society for Testing and Materials, and the Institute of Electrical and Electronics Engineers; representatives from industry; and the Electric Power Research Institute (EPRI). Several representatives from DOE and DOE national laboratories also participated. A full summary and related documents can be found at https://www.nrc.gov/about-nrc/regulatory/standards-dev/standards-forum/2018.html.

This year, the forum continued the theme of "Collaborate to Accelerate" by addressing topics on standards development and process improvements. The presentations provided an overview of NRC standards activities, offered updates on completed topics from previous forums, and provided the processes for identifying and prioritizing standards across stakeholder groups. The discussions were valuable to understanding how the stakeholder groups, including the NRC, can be more effective in developing standards. The primary outcome of the Standards Forum was the identification of process improvements such as the following for standards development:

- Under the auspices of the Standards Forum, the NRC would facilitate requests by SDOs to change proprietary EPRI reports to nonproprietary so that the SDOs can use the information in these reports for standards development.

- NEI volunteered to survey its members to identify and prioritize standards of interest, thus providing an industry "demand signal" for standards developers and the NRC.

- SDOs proposed formalizing partnerships and liaisons to the extent needed to ensure that collaboration and effective standards development are taking place. The NRC staff agreed to facilitate initial engagements between different SDOs and other stakeholders such as EPRI.

- DOE offered to assist stakeholders in the nuclear power industry to find information to support standards development, particularly for non-LWRs, by accessing the DOE GAIN program. The DOE Office of Nuclear Energy supports industry codes and standards development through focused research and committee participation by subject matter experts.

As an action item from the 2017 Standards Forum, ANS and the NRC held a workshop on May 2, 2018, for industry stakeholders to develop a strategic vision for advanced reactors standards. A full summary and related documents from the 2017 Standards Forum can be found at https://www.nrc.gov/about-nrc/regulatory/standards-dev/standards-forum/2017.html. The TWGs for the major advanced reactor types (HTGRs, MSRs, and fast reactors) were represented at the workshop. The TWG representatives presented an overview of the technologies and identified potential needs for future standards. Generally, the TWGs recognized the benefit of standards, particularly endorsed standards. However, the lack of an existing standard was not expected to delay the development of advanced reactors, in that if standards were not available, designers could develop guidance. The TWGs emphasized that the NRC should place a high priority on the endorsement of ASME B&PV Code, Section III, Division 5, and the non-LWR PRA standard. The workshop summary provides additional details.[14]

Next Steps: Participants will complete the action items agreed upon during the forum. The staff anticipates that the next NRC Standards Forum will take place in September 2019.

6.0 Strategic Area No. 5: Resolution of Policy Issues

6.1 Overview

This strategy 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 help to achieve the objective of enhanced technical and regulatory readiness and communications.

The list of policy issues the staff is considering with regard to the licensing of SMRs and non-LWRs is available on the NRC public Web site and is routinely revised to reflect the latest updates on each policy issue. The policy issues have been discussed in several of the recurrent public stakeholder meetings. These discussions will continue in order for the NRC to obtain stakeholder input on the identification and resolution of policy issues and to help prioritize these issues.

[14] See "Summary of Advanced Non-Light Water Reactors Workshop Held with the American Nuclear Society," dated June 11, 2018 (ADAMS Accession No. ML18152B668).

6.2 Progress Summary

6.2.1 Appropriate Source Term, Dose Calculations, and Siting for Small Modular Reactors and Non-Light-Water Reactors

In SECY-10-0034, "Potential Policy, Licensing, and Key Technical Issues for Small Modular Nuclear Reactor Designs," dated March 28, 2010,[15] the staff noted that regulatory issues related to source term, site suitability, and risk evaluations could relate to policy, which would require Commission consideration. In the memorandum to the Commission dated December 29, 2011,[16] the staff stated that it would remain engaged with SMR stakeholders on the applications of MST methods, review preapplication white papers and topical reports about source term issues it would receive from potential SMR applicants, discuss design-specific proposals to address MST, and consider research and development in this area.

In Commission memoranda dated May 30, 2013,[17] and June 20, 2014,[18] the staff provided updates on interactions with DOE and nuclear industry organizations about MST. The staff developed SECY-16-0012, "Accident Source Terms and Siting for Small Modular Reactors and Non-Light Water Reactors," dated February 7, 2016,[19] which concluded that (1) SMR and non-LWR applicants can employ modern analysis tools to demonstrate quantitatively the safety features of those designs, and (2) applicants can also use MST analysis methods to demonstrate the ability of the enhanced safety features of plant designs to mitigate accident releases.

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

As discussed in SECY-16-0012, the staff will engage with interested stakeholders on the siting proximity issue. This paper indicated that using MST analysis methods would also allow future combined license applicants to consider reduced distances to exclusion area boundaries and low-population zones, as well as potentially increased proximity of SMRs and non-LWRs to population centers.

The NRC staff developed a draft white paper[20] summarizing the assessment of current siting regulations, Commission policy, and staff guidance and discussed it in a public meeting on December 14, 2017. The NEI Advanced Reactor Working Group is evaluating the NRC staff's white paper and coordinating discussions with developers and potential licensees.

The staff is working with ORNL to develop a draft technical report designed to identify potential alternative siting criteria for SMRs and non-LWRs that recognizes the possible reduced offsite releases for advanced reactors designs. The report will provide insights to the staff for

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15 See SECY-10-0034, "Potential Policy, Licensing, and Key Technical Issues for Small Modular Nuclear Reactor Designs," dated March 28, 2010 ((ADAMS Accession No. ML093290268).

16 See memorandum to the Commission, "Status of Staff Activities to Address Mechanistic Source Term Methodology and Its Application to Small Modular Reactors," dated December 29, 2011 (ADAMS Accession No. ML113410366).

17 See memorandum to the Commission, "Current Status of the Source Term and Emergency Preparedness Policy Issues for Small Modular Reactors," dated May 30, 2013 (ADAMS Accession No. ML13107A052).

18 See memorandum to the Commission, "Status of Mechanistic Source Term Policy Issue for Small Modular Reactors," dated June 20, 2014 (ADAMS Accession No. ML14135A482).

19 See SECY-16-0012, "Accident Source Terms and Siting for Small Modular Reactors and Non-Light Water Reactors," dated February 7, 2016 (ADAMS Accession No. ML15309A319).

20 See NRC draft white paper, "Siting Considerations Related to Population for Small Modular and Non-Light Water Reactors," issued November 2017 (ADAMS Accession No. ML17333B158).

informing its plans to develop additional regulatory guidance, as appropriate, for non-LWR siting. The paper is scheduled to be finalized by mid-2019.

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

In SECY-16-0012, the staff stated that the evaluation of the mechanistic methods would be important for application reviews and did not note concerns or policy issues about the implementation of mechanistic accident modeling of source terms. Specifically, the staff recognized that although it "has not yet developed source term tools and technical expertise for non-LWRs to the same level as that for SMRs, the staff believes a mechanistic approach could also be applied to non-LWR designs, subject to the availability of adequate tools and analysis approaches."

Subsequent to the staff's briefing of the Advisory Committee on Reactor Safeguards (ACRS) Full Committee on October 4, 2018, on a draft proposed rule on emergency preparedness (EP) for SMRs and other new technologies (ONTs), the ACRS Chairman stated in a letter dated October 19, 2018,[21] that the staff "should provide [MST] guidance to evaluate the adequacy of the frequency of events considered and the duration over which such events must be analyzed" and "on how source terms should be developed." By response dated November 9, 2018, the staff informed the ACRS that it will continue to evaluate the need to further enhance our guidance on mechanistic source term development.[22] Next Steps: The staff will consider insights obtained from stakeholder discussions and determine whether clarifications to siting guidance or other actions would be beneficial to address siting criteria for SMRs and non-LWRs. As appropriate and as the agency gains experience in these areas, the staff would then report to the Commission on proposed actions, such as the ones described in SECY-16-0012.

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

On May 29, 2015, the NRC staff issued SECY-15-0077, "Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies,"[23] which provided options for EP for SMRs and non-LWRs. The Commission issued the associated staff requirements memorandum (SRM) on August 4, 2015, which approved the staff's recommendation to initiate a rulemaking.[24] The staff developed a notation vote paper as SECY-16-0069, "Rulemaking Plan on Emergency Preparedness for Small Modular Reactors and Other New Technologies," dated May 31, 2016,[25] which discussed the rulemaking plan and schedule. In an SRM dated June 22, 2016, the Commission approved the staff's plan and schedule for the rulemaking

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21 See letter from ACRS Chairman Corradini to NRC Chairman Svinicki, "Draft Proposed Rule, 'Emergency Preparedness for Small Modular Reactors and Other New Technologies,'" dated October 19, 2018 (ADAMS Accession No. ML18291B248).

22 See NRC staff response to ACRS, "Response to Advisory Committee on Reactor Safeguards on the Draft Proposed Rule, "Emergency Preparedness for Small Modular Reactors and Other New Technologies,"" dated November 9, 2018 (ADAMS Accession No. ML18305B312).

23 See SECY-15-0077, "Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies," dated May 29, 2015 (ADAMS Accession No. ML15037A176).

24 See staff requirements – SECY-15-0077 – "Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies" (ADAMS Accession No. ML15216A492)

25 See SECY-16-0069, "Rulemaking Plan on Emergency Preparedness for Small Modular Reactors and Other New Technologies," dated May 31, 2016 (ADAMS Accession No. ML16020A388).

pertaining to EP for SMRs and ONTs (such as non-LWRs and medical isotope production facilities).

The rulemaking will address EP issues for future SMRs, non-LWRs, and ONTs. The Commission directed the staff to consider exemptions in the interim (e.g., for the ongoing early site permit application from the Tennessee Valley Authority) until completion of the EP rulemaking. The NRC published the draft regulatory basis for EP for SMRs and ONTs for public comment in the *Federal Register* on April 13, 2017.[26] The staff held a public meeting May 10, 2017, to facilitate the development of public comments on the draft regulatory basis. The public comment period closed on June 27, 2017, and the staff considered all stakeholder comments in the final regulatory basis,[27] published on October 16, 2017.

The staff released the draft proposed rule language and associated draft guidance[28] on August 1, 2018, to support ACRS briefings on August 22, 2018 and October 4, 2018. The Commission received the proposed rule on October 12, 2018, for its consideration. The NRC has posted these documents to Regulations.gov (Reference: NRC-2015-0225).

Next Steps: If the Commission approves the proposed rule, the staff will issue it for public comment and schedule a meeting to publicly discuss it and the associated draft guidance.

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

On December 14, 2016, NEI submitted a white paper, "Proposed Physical Security Requirements for Advanced Reactors Technologies."[29] This paper proposed "an approach to security that appropriately considers the enhanced safety and security incorporated into these designs and provides a more effective and efficient means to protect the public health and safety." The staff reviewed NEI's white paper and prepared a draft white paper to facilitate stakeholder interactions.[30] The staff discussed this white paper with NEI and other stakeholders on December 13, 2017.

After consideration of stakeholder input, the staff prepared SECY-18-0076, "Options and Recommendation for Physical Security for Advanced Reactors," dated August 1, 2018,[31] to provide the Commission with options on possible changes to regulations and guidance related to physical security for advanced reactors, including light-water SMRs and non-LWRs. In the

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26 See "Emergency Preparedness for Small Modular Reactors and Other New Technologies," Volume 82 of the *Federal Register*, page 17768 (82 FR 17768), April 13, 2017.

27 See "Rulemaking for Emergency Preparedness for Small Modular Reactors and Other New Technologies; Regulatory Basis," issued September 2017 (ADAMS Accession No. ML17206A265).

28 See DG-1350, "Performance-Based Emergency Preparedness for Small Modular Reactors, Non Light Water Reactors, and Non-Power Production or Utilization Facilities," dated October 12, 2018 (ADAMS Accession No. ML18082A044).

29 See NEI white paper, "Proposed Physical Security Requirements for Advanced Reactors Technologies," dated December 14, 2016 (ADAMS Accession No. ML17026A440).

30 See "Draft White Paper on Potential Changes to Physical Security Requirements for Small Modular and Advanced Reactors," dated November 29, 2017 (ADAMS Accession No. ML17333A524).

31 See SECY-18-0076, "Options and Recommendation for Physical Security for Advanced Reactors," dated August 1, 2018 (ADAMS Accession No. ML18052B032).

related SRM dated November 19, 2018,[32] the Commission directed the staff to initiate a limited-scope revision to regulations governing physical security for advanced reactors and approved, subject to edits, a related rulemaking plan.[33]

Next Steps: The staff is interacting with stakeholders and preparing a draft regulatory basis to issue for public comment as described in the rulemaking plan.

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

In SECY-11-0178, "Insurance and Liability Regulatory Requirements for Small Modular Reactor Facilities," dated December 22, 2011,[34] the staff identified a potential inequity between the insurance and liability regulatory requirements for facilities with power reactors that produce electrical power equal to or greater than 100 megawatts electric (MWe) per unit and multi-module facilities with SMR designs that individually produce less than 100 MWe, but, in combination, produce more than 100 MWe. For example, the staff raised the question of whether, under the current Price-Anderson Act and associated regulatory language, insurance and indemnity coverage would be sufficient to pay all public claims in the case of an insurable event at a multi-module facility with SMRs where an individual module is sized at less than 100 MWe.

Since completing that paper, the staff has prepared a comparative analysis of different SMR designs to further explore the potential inequity. The staff is using this analysis and other inputs to identify whether to recommend any changes to the Price-Anderson Act for SMRs and non-LWRs. The staff is also evaluating the differences in potential consequences for postulated accidents for non-LWR designs in relation to insurance and liability requirements. The NRC staff engaged stakeholders on this topic during a November 2, 2017, public meeting and is awaiting industry feedback.

Next Steps: In accordance with the latest version of the Price-Anderson Act, the NRC will prepare a report to Congress, and an associated SECY paper, recommending the need for continuation or modification of the provisions of the Price-Anderson Act by December 31, 2021. This report and SECY paper will address any changes that the staff recommends for non-LWRs and SMRs.

6.2.5 Containment Functional Performance for Non-Light-Water Reactors

The staff has engaged stakeholders on this topic at several public meetings. The staff prepared a draft white paper on functional containment performance[35] to facilitate stakeholder interactions. The staff discussed this white paper with stakeholders on December 14, 2017, and February 1, 2018. The staff also briefed the ACRS on April 5, 2018. The staff developed SECY-18-0096, "Functional Containment Performance Criteria for Non-Light-Water-Reactors,"

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32 See SRM-SECY-18-0076, "Staff Requirements—SECY-18-0076—Options and Recommendation for Physical Security for Advanced Reactors," dated November 19, 2018 (ADAMS Accession No. ML18324A478).

33 See SRM-SECY-18-0076, Enclosure 1, "Options and Recommendation for Physical Security for Advanced Reactors—Rulemaking Plan," dated November 19, 2018 (ADAMS Accession No. ML18324A477).

34 See SECY-11-0178, "Insurance and Liability Regulatory Requirements for Small Modular Reactor Facilities," dated December 22, 2011 (ADAMS Accession No. ML113340133).

35 See "Draft White Paper, 'Functional Containment' Performance Criteria," dated November 30, 2017 (ADAMS Accession No. ML17334A155).

dated September 28, 2018.[36] In SECY-18-0096, the staff proposed a methodology for establishing functional containment performance criteria for non-LWRs. The staff developed this proposed methodology following interactions with stakeholders and the ACRS. Designers can use the methodology to define design-specific functional containment performance criteria, relying heavily on the identification and analyses of licensing-basis events. In SRM-SECY-18-0096, dated December 4, 2018,[37] the Commission approved the proposed methodology.

Next Steps: The staff is incorporating the methodology for functional containment performance criteria in ongoing activities, such as the preparation of DG-1353, future revisions of RG 1.232, and interactions with specific designers.

7.0 Strategic Area No. 6: Communication

7.1 Overview

This strategy supports the non-LWR vision and strategy objective of optimizing communications. The plan for addressing communications consists of the following contributing activities:

- Provide timely, clear, and consistent communication of the 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 has developed an internal communications strategy to guide activities in this area. The NRC has also proactively communicated with stakeholders and sought stakeholder feedback on all of its non-LWR readiness activities, starting with development of its vision and strategy document and implementation action plan. The sections below describe several key communications accomplishments and ongoing activities.

7.2.1 Stakeholder Engagement

The NRC holds frequent public stakeholder meetings to discuss non-LWR topics of interest. To maximize participation, stakeholders can participate in person or by phone and Webinar. The NRC has conducted ten such meetings, beginning in 2018. The NRC has also conducted seven briefings of the Advisory Committee on Reactor Safeguards (ACRS) Future Plant Subcommittee and four briefings of the ACRS Full Committee.

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[36] See SECY-18-0096, "Functional Containment Performance Criteria for Non-Light-Water-Reactors," dated September 28, 2018 (ADAMS Accession No. ML18115A157).

[37] See SRM-SECY-18-0096, "Staff Requirements—SECY-18-0096—Functional Containment Performance Criteria for Non-Light-Water-Reactors," dated December 4, 2018 (ADAMS Accession No. ML18338A502).

Next Steps: The staff will continue to plan stakeholder meetings to take place approximately every 6 weeks in 2019.

7.2.2 Coordination with the U.S. Department of Energy

On November 10, 2016, the NRC and DOE signed a memorandum of understanding (MOU)[38] describing the roles, responsibilities, and processes related to the implementation of the DOE GAIN initiative. GAIN is intended to provide the nuclear energy community with increased access to the technical, regulatory, and financial support necessary to move new or advanced nuclear reactor designs toward commercialization while ensuring the continued safe, reliable, and economic operation of the existing nuclear fleet. As described in the MOU, the NRC is responsible for providing DOE and the nuclear energy community with accurate and current information on the NRC's regulations and licensing processes. DOE is responsible for then sharing that information with the prospective applicants, as appropriate. The NRC and DOE conduct monthly calls to discuss mutual areas of interest related to the GAIN initiative.

In addition to the specific activities identified in the GAIN MOU, the NRC actively participates in GAIN-sponsored non-LWR workshops to provide an opportunity for the NRC to gather information, develop technical expertise, and discuss NRC requirements and non-LWR readiness activities.

The NRC and DOE also conduct quarterly management meetings to share information about advanced reactor readiness activities. For example, at the most recent of these meetings in fall 2018, the NRC and DOE discussed areas of future cooperation, such as DOE piloting RG 1.232 and DG-1353 during the authorization process for the proposed versatile test reactor. The NRC and DOE also discussed opportunities for the NRC to observe or participate in the authorization process to gain knowledge about non-LWR technology and to build staff capability for future NRC licensing activities for non-LWR designs. The NRC and DOE are developing an MOU to outline these future interactions.

Next Steps: The NRC will continue to interact with DOE to gather information to inform the NRC's non-LWR readiness activities. The NRC will also continue to support the GAIN initiative, as specified in the GAIN MOU, and attend GAIN workshops. The staff will continue to conduct periodic coordination calls with DOE and representatives from Idaho National Laboratory who are managing the GAIN initiative.

7.2.3 Meetings and Conferences

In addition to the GAIN workshops discussed above, the NRC has actively participated in numerous workshops, conferences, and meetings to facilitate stakeholder outreach and communications related to non-LWRs. For example, the NRC has participated in the following non-LWR events:

- EPRI Advanced Reactor Technical Advisory Group meetings
- EPRI Workshop on Process Hazards Analysis to PRA for Advanced Reactors
- ANS annual meetings
- NRC Regulatory Information Conference

[38] See "Memorandum of Understanding Between U.S. Nuclear Regulatory Commission and U.S. Department of Energy on Gateway for Accelerated Innovation in Nuclear Initiative," dated November 10, 2016 (ADAMS Accession No. ML16215A382).

- U.S. Nuclear Infrastructure Council's Advanced Reactor Technical Summits
- ORNL's Molten Salt Reactor Workshops
- IAEA and Nuclear Energy Agency (NEA) workshops related to advanced reactors
- GAIN Advanced Manufacturing for Nuclear Workshop (ORNL)
- NEI advanced reactor working group meeting

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

7.2.4 International Coordination

The NRC shares information and engages with various international groups, including the Organization for Economic Co-operation and Development's NEA, IAEA, the Generation IV International Forum, 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). The purpose of the group is to bring interested regulators together to discuss common interests, practices, and problems and to address both regulatory interests and research needs. Currently, Canada, China, France, Germany, Italy, Japan, Korea, Russia, the United Kingdom, and the United States are members of WGSAR. Representatives from the European Union and IAEA also attend WGSAR meetings. Initially, WGSAR focused on SFR reactor safety and regulatory issues, such as severe accident prevention and mitigation and fuel qualification. However, WGSAR plans to expand its scope to other types of non-LWR designs. WGSAR also interfaces with the Generation 4 International Forum (GIF). GIF representatives attend WGSAR meetings and WGSAR comments on GIF documents, such as SFR safety design guidelines. In 2019, WGSAR and GIF plan to cooperate on the development of risk-informed and performance-based licensing approaches for non-LWRs (e.g., through the LMP).

The NRC also participates in and chairs the IAEA SMR Regulators' Forum, which is hosted by the IAEA and comprises representatives from Canada, China, Finland, France, Korea, Russia, Saudi Arabia, United Kingdom and the United States. In this forum, interested regulators identify and address key regulatory challenges that may emerge in future SMR regulatory discussions. This forum focuses on issues that are applicable to both light-water-cooled and non-LWR reactors, such as licensing, safety analysis and oversight of manufacturing.

Next Steps: The NRC will continue to exchange information with international counterparts and participate in NEA and IAEA working groups to foster international cooperation. The NRC also has frequent bilateral interactions with regulatory bodies such as the Canadian Nuclear Safety Commission (CNSC), which is considering some of the same or similar designs (such as the Terrestrial MSR design) for licensing. The NRC and CNSC are collaborating in areas such as staff training, risk-informed licensing approaches, fuel qualification, materials issues, and molten salt chemistry.