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Non-LWR Regulatory Framework Modernization

Fiscal Year 2024

JANUARY 2025

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INL/RPT-25-82952

Advanced Reactor Technologies



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January 2025

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INL Advanced Reactor Technologies Program
Non-LWR Regulatory Framework Modernization

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SUMMARY

This report provides an updated end-of-FY24 summary that reflects the progress and status of Idaho National Laboratory's activities concerning the development of an advanced reactor regulatory framework and its implementation in the United States. The report also provides recommendations for work to be performed in Fiscal Year 2025 and beyond. This work was completed in Fiscal Year 2024 and was supported by the U.S. Department of Energy Regulatory Development subprogram. These activities are managed by Idaho National Laboratory on behalf of the Department of Energy.

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CONTENTS

SUMMARY	vii
ACRONYMS.....	xi
1. PURPOSE	1
2. OBJECTIVES	1
3. SUMMARY OF COMPLETED ACTIVITIES	1
3.1. Meetings and Interactions	1
3.2. Industry Engagement	2
3.2.1. NEI New Reactor Regulatory Working Group.....	2
3.2.2. Technology Working Groups.....	5
3.2.3. Example of Industry Interface Success	6
3.3. ADVANCE Act of 2024.....	6
3.4. Physical Security.....	7
4. RECOMMENDATIONS FOR FUTURE ACTIVITIES	7
4.1. Multi-Lab Regulatory Coordination and Integration Group	7
4.2. Continued Interface with Industry Stakeholders.....	7
4.3. Performance-Based Physical Security Analysis	8
4.4. Advanced Materials and Manufacturing Technologies Support.....	8
5. CONCLUSIONS.....	8
6. REFERENCES.....	8

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ACRONYMS

ADVANCE	Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy
AMMT	Advanced Materials and Manufacturing Technologies
AR	advanced reactor
DOE	U.S. Department of Energy
EPZ	emergency planning zone
FY	fiscal year
INL	Idaho National Laboratory
LWR	light-water reactor
NEI	Nuclear Energy Institute
NGO	nongovernmental organization
NRC	Nuclear Regulatory Commission
NRRWG	New Reactor Regulatory Working Group
NTD	national technical director
TWG	technical working group

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Non-LWR Regulatory Framework Modernization

Fiscal Year 2024

1. PURPOSE

This report provides an end-of-year summary that reflects the progress and status of the Idaho National Laboratory (INL) Regulatory Development Group activities concerning advanced reactor (AR) (i.e., non-light-water reactors [non-LWRs]) regulatory framework development and implementation. This report addresses and satisfies the U.S. Department of Energy (DOE) milestone M3RD-24IN0702014, “Provide recommendations for R&D needed to establish licensing technical requirements and provide a summary of FY24 regulatory framework development outcomes,” under INL work package RD-24IN070201, “Non-LWR Regulatory Framework Modernization.”

2. OBJECTIVES

Non-LWR regulatory framework modernization activities are intended to establish a clearly defined regulatory structure for the non-LWR community and help implement regulatory and licensing strategies for newly emerging commercial nuclear power technologies. Additionally, these activities were initiated to engage in the progress of regulatory actions conducted by industry and government agencies and to interact with stakeholders on matters important to licensing in support of commercial deployments.

This activity coordinates DOE regulatory efforts with industry, nongovernmental organizations (NGOs), and Nuclear Regulatory Commission (NRC) staff and stakeholders, ensuring that DOE research and development (R&D) activities are appropriately aligned and adequately address aspects of licensing technical requirements that are incompatible or add uncertainty in an evolving regulatory environment.

3. SUMMARY OF COMPLETED ACTIVITIES

Non-LWR regulatory framework modernization activities encompassed work performed by DOE and INL researchers to plan and develop new R&D activities, participate in industry and government interactions associated with AR development and near-term deployment, and coordinate interactions with DOE and the NRC. The following subsections of Section 3 summarize the work performed by INL’s Regulatory Development Group in Fiscal Year (FY) 2024.

3.1. Meetings and Interactions

Throughout FY-24, INL Regulatory Development Group staff regularly participated in a variety of meetings that supported AR development and deployment. Members of the group researched, attended, and participated in the hybrid AR stakeholder meetings that the NRC held approximately every 6 weeks, which are typically attended virtually by NRC staff. Additionally, some INL staff attended and participated in the AR regulatory taskforce meetings, which were usually held virtually by the Nuclear Energy Institute (NEI) a day before the NRC AR stakeholder meetings.

The engagement in and impact of these meetings proved essential to INL staff for maintaining currency in the nuclear industry and remaining knowledgeable about its state—especially in regard to ARs—thus allowing staff to assist industry as it moves forward on regulatory activities. INL’s Regulatory Development group frequently communicated directly with NEI, NRC, DOE, individual applicants, and other national laboratories to engage and actively participate in development and near-term deployment activities related to regulatory development.

3.2. Industry Engagement

3.2.1. NEI New Reactor Regulatory Working Group

3.2.1.1. Background

The established mission of the NEI New Reactor Regulatory Working Group (NRRWG) is to provide industry coordination and strategic guidance on key generic licensing and regulatory issues for new reactors to achieve a modern and efficient regulatory framework. The desired outcomes resulting from the group's activities include:

- Promote the industry needs for cost, timing, and predictability of the NRC's regulatory framework for new reactors
- Streamline regulatory processes needed to support the timely and efficient review and oversight of new reactors
- Resolve key generic technical or policy topics needed to support the review and approval of new reactor applications
- Effect changes to the regulations that are needed to achieve a more modern and efficient regulatory framework.

The scope of NRRWG work is focused on:

- New Reactors—Any new reactor technology, including a large LWR, small modular reactor, non-LWR, and microreactors
- Licensing and Regulatory Framework—Regulations applicable to licensing new reactors (e.g., Part 50, 52, and 53), other regulations as applicable to new reactors (e.g., Part 51, 73), and guidance associated with these regulations
- International Regulatory Efficiency—International regulatory harmonization initiatives, bilateral cooperation with NRC, international codes and standards, and NRC support for regulatory authorities in other countries.

The NRRWG establishes the goals, strategies, priorities, and principles for industry's positions for the NRC regulatory framework for new reactors. The group provides direction, oversight, and leadership support (as necessary) to NEI and new reactor taskforces responsible for developing the details of industry's positions and achieving resolution with the NRC. This includes direction for the NEI Advanced Reactor Regulatory Taskforce, which INL directly supports through the Regulatory Framework Modernization Program.

NRRWG membership consists of an industry chair, NEI, advanced reactor developers, and owners and operators that have informed the NRC of their intent to submit a new reactor application. In addition, an INL representative was invited and has been participating in an advisory role since the group's inception, representing DOE and its national laboratory system.

3.2.1.2. INL Participation and Support of NRRWG FY24 Meetings and Activities

3.2.1.2.1. NRRWG January 17, 2024 Meeting (Virtual)

The primary topic of the agenda for this meeting was discussing the pending update to the industry's regulatory priorities for new and ARs. NEI last provided those priorities and requested focused action in a letter to the NRC in June 2022.

These industry-identified priorities are a key source of information for the scoping of work within the DOE Regulatory Framework Modernization Program. The outcomes from this meeting provided early input and insights into the integrated priorities listing for the program going forward into the next FY and DOE funding cycle.

3.2.1.2.2. NRRWG March 14, 2024 Meeting (in Person)

This was a shorter virtual meeting. It included a review and discussion of industry and NEI progress in addressing the industry actions identified in the January meeting, with a primary focus on updating and finalizing the listing of regulatory priorities. This effort was further supplemented by an in-person discussion with the NRC’s director of their Division of Advanced Reactors and Non-Power Production and Utilization Facilities.

3.2.1.2.3. NRRWG May 22, 2024 Meeting (Virtual)

The agenda for that meeting included:

- An update on NEI efforts to develop a white paper for NRC review addressing a methodology for identifying and selecting a seismic event when evaluating nuclear facility emergency planning zones (EPZs)
- A discussion of U.S. industry and NEI engagement with the International Atomic Energy Agency’s emerging Nuclear Harmonization and Standardization Initiative
- An overview discussion of the broad range of topics and supporting summaries to be included in NEI’s submittal to the NRC to facilitate “Rapid and Large-Scale Nuclear Reactor Deployments for Remote Industrial Applications”
- A presentation of the scope of the DOE Regulatory Framework Modernization Program.

The overview discussion resulted in a significant NEI submittal to NRC in late July 2024 with numerous recommendations for more streamlined and faster deployments, with a focus on microreactor technologies. The draft content of this submittal was reviewed by the DOE’s multi-lab Regulatory Integration and Coordination Group, with comments and inputs being provided back to NEI on selected items prior to the NRC submittal.

The fourth agenda item included a presentation by the technical area lead of DOE’s Regulatory Framework Modernization Program summarizing the scope and current activities within the DOE’s regulatory development programs. This presentation concluded with a request for follow-on discussion in the next NRRWG meeting to identify and confirm current industry regulatory needs and priorities that could be addressed through those programs, pending available DOE funding for FY-25.

3.2.1.2.4. NRRWG July 29, 2024 Meeting (Virtual)

Agenda topics included:

- The finalization of supporting summaries and specific requests being included in NEI’s submittal to NRC to facilitate “Rapid and Large-Scale Nuclear Reactor Deployments for Remote Industrial Applications”
- A follow-on presentation by the technical area lead of DOE’s Regulatory Framework Modernization Program and industry roundtable discussion to finalize program scope to be prioritized and proposed to DOE for support in FY-25.

The NEI’s requested actions for supporting rapid and large-scale deployments was formally submitted to the NRC for action on July 31, 2024.

The industry representatives confirmed the planned DOE program activities, including these highest priority items for continued work in FY-25:

- Interactions with the NRC supporting formal endorsement of NEI’s DOE-funded effort to establish the EPZ based on a risk-informed approach
- Interactions with the NRC supporting formal endorsement of the technology-inclusive risk-informed change evaluation approach

- Development of an NRRWG consensus approach for risk assessment change control during the plant operations phase to be submitted to NRC for formal endorsement
- Development of guidance for a performance-based physical security analysis
- Support for the development of a sodium fast reactor consensus standard addressing fire protection.

3.2.1.2.5. NRRWG September 9, 2024 Meeting (in Person)

This meeting was an NRRWG meeting combined with the New and Advanced Reactor Steering Group meeting held in Philadelphia, PA, just prior to NEI’s annual Nuclear Energy Assembly. Agenda topics included:

- NRC Agency and Schedule Updates
 - Kairos Power Hermes Unit 2 Construction Permit application is a redline strikeout version of the Hermes Test Reactor application. Kairos Power was allowed to utilize an Environmental Assessment rather than develop an entire Environmental Impact Statement.
 - Staffing changes.
 - The Tennessee Valley Authority’s Clinch River 1 application was for an LWR and was sent to the Division of New and Renewed Licensing, which differs from other applications and reports to this point.
- Regulatory Development in Digital Instrumentation and Control
The three steps of digital instrumentation and control are:
 - Remote monitoring
 - Remote operation
 - Autonomous operation.

The near-term goal is to achieve remote operations, and there is a potential NEI project in FY25 to propose a regulatory approach that would justify the use of remote operations.

- Kairos Power Licensing Experience on the Hermes Reactor(s)
The Hermes reactor development and licensing processes were run by Kairos with a commercial milestones approach similar to SpaceX’s initial projects. The contract was pre-negotiated and developed with a cost-per-milestone technique. For example, one milestone was to submit a construction permit application to the NRC.
 - This worked extremely effectively and allowed Kairos to minimize company staffing size.
 - Kairos and DOE were both extremely pleased with the progress and outcomes of the project to date.
- The Accelerating Reliable Capacity Act
This act is proposed to incentivize early development in nuclear by minimizing and insuring cost overruns for companies. It also provides expanded financing options for qualifying projects (\$2.5 billion or more).
- FY-25 Federal Budget Appropriations
 - The House budget for the DOE Office of Nuclear Energy (DOE-NE) is \$1.79 billion with \$8.98 billion to the Advanced Reactor Demonstration Program awardees. This supports two awardees and up to two Generation III+ (Gen-III+) nuclear reactors.
 - The Senate budget for DOE-NE is \$1.67 billion and replaces the term “Gen-III+” with “advanced,” which is inclusive to both Gen-III+ and current “advanced” reactor technologies.
- White House Project Management
The White House staff is setting up a Nuclear Project Management Working Group, which held its

first workshop on September 10, 2024. The goals of this workshop are unknown, but it is looking to focus on the risk management of projects for public utility commissions, utility boards of directors, the finance community, and DOE.

- Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act of 2024

The ADVANCE Act was passed in July 2024 with significant bipartisan support in Congress and significant support from the White House. Current NEI items of significance include:

- Section 208, which NEI is targeting with the “Regulations of Rapid High-Volume Deployable Reactors in Remote Applications (RHDRA) and Other Advanced Reactors” package. NRC has received the package and is currently reviewing it.
- Section 506, which discusses the National Environmental Policy Act of 1969 requirements. An NRC meeting will be held on September 25, 2024, on this subject.

The ADVANCE Act also addresses putting licensing costs for ARs in an “off the fee base” setup that would assist developers and utilities with funding for licensing activities.

- 10 CFR Part 53 Rulemaking

The NRC is preparing to release the revised rulemaking for 10 CFR Part 53 for its 60 day public comment period. The release was expected in early September 2024; however, it did not get published to the Federal Register until October 31, 2024. NEI drafted a letter to request a formal extension of the comment period to 120 days. This extension was granted, and the final comment period was extended until February 28, 2025.

- Physical Security for ARs

NRC published the “Alternate Physical Security for Advanced Reactors” proposed rule on August 9, 2024. The public comment period deadline was set for October 23, 2024. This rulemaking applies to all non-LWR reactors and LWR small modular reactors under 1,000 MW_{th}.

- Population Center Distances for ARs

NEI Goal: Modify NRC Regulatory Guide 4.7 Appendix A to appropriately address advanced reactor characteristics in population-related siting requirements.

- Example: Almost 80% of coal-fired power plants that would be suitable for ARs in coal-to-nuclear transitions are located close to population centers containing more than 25,000 people.

3.2.2. Technology Working Groups

The national technical directors (NTDs) and other key regulatory development subprogram staff have previously worked to maintain a regular and open dialogue with established industry-led technical working groups (TWGs) for high-temperature gas-cooled reactors, fast reactors, and molten-salt reactors. These interactions were critical to ensuring that high-priority, high-impact regulatory framework issues were clearly understood, efficiently integrated, and appropriately prioritized within the associated areas of the regulatory development initiatives in direct support of the timely commercial deployment of these technology types. While the NTDs are maintaining good dialogue with the developers, meetings of these TWGs have become rare and were virtually non-existent in FY-24, and INL regulatory development staff have had to pursue alternate means to determine industry needs. These alternate means include attending events held by NEI and other NGOs, direct communication with reactor developers, and increased interaction with the NRC.

3.2.3. Example of Industry Interface Success

Starting in FY-23, the Regulatory Development Program began funding work to review and make recommendations for redeveloping the ANS-54 series of consensus standards, which specifically pertain to sodium fast reactors. Most of these standards were withdrawn in 2000 after there was little need for them. Today, the need for these standards has returned, and in FY-24, the Regulatory Development Program funded work to revive ANS-54.8, “Liquid Metal Fire Protection in LMR Plants.” Stakeholders identified this specific standard as necessary to AR design and construction. To revive the standard, Argonne National Laboratory engaged the ANS-54.8 Working Group to expedite the revival process. Argonne provided significant historical information to the committee and became participants of the group. Work on reviving this standard will continue into FY-25 through funding from the Regulatory Development Program. The main goal for FY-25 will be to reissue the consensus standard, which will include addressing comments and suggestions for ANS-54.8. Full approval and implementation of this standard is expected to be completed in September 2025.

3.3. ADVANCE Act of 2024

The ADVANCE Act of 2024 was passed in July 2024 with bipartisan support in Congress and the Biden Administration. The purpose of the ADVANCE Act is to drive the NRC to take swift, significant actions to address the licensing of new reactors and fuels while maintaining the NRC’s core mission to protect public health and safety. The act requires NRC to “update its mission statement to specify that licensing and regulation of the civilian use of radioactive materials and nuclear energy will be conducted in a manner that is efficient and does not unnecessarily limit the civilian use of radioactive materials and deployment of nuclear energy or the benefits of civilian use of radioactive materials and nuclear energy technology to society.” Congress requires the NRC to meet the various deadlines identified in the act and provide reports on the completion of revisions of agency regulations and guidance.

The act has impacts on many of the NRC’s activities, including:

- The recruitment and retention of the NRC workforce
- The increase of flexibility in the NRC’s budgeting process
- The enhancement of the NRC’s regulatory framework to support advanced reactor development and deployment
- The development of a regulatory framework to support fusion technology
- The requirement to develop initiatives that support the efficient, timely, and predictable reviews of license applications by the NRC.

NRC staff have developed a database to track the implementation status of the ADVANCE Act requirements. This dashboard contains items that identify the section of the act and corresponding tasks, the lead for that task, applicable dates associated with the task, and key points of contact. INL staff have tracked the issuance of the ADVANCE Act and are following the NRC’s actions to address the items in the act. INL Staff will work to identify areas where changes to NRC licensing and regulatory requirements will affect DOE, developers, and industry partners and will work with DOE to propose activities that support industry to implement these changes to NRC requirements.

3.4. Physical Security

The INL Regulatory Development Team has followed developments associated with changing regulations and guidance associated with the physical security of advanced and small modular reactors for the last several years. In particular, NRC rulemaking NRC-2017-0227, “Alternative Physical Security Requirements for Advanced Reactors,” and NRC-2019-0062, “10 CFR Part 53: Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors,” have presented new licensing pathways and draft guidance that provide pathways that could dramatically change the regulatory landscape for reactors within the scope of physical security. The INL team interfaced with regulators, industry groups (e.g., the NEI), and reactor vendors to understand the challenges they see and opportunities for regulatory clarity and guidance.

4. RECOMMENDATIONS FOR FUTURE ACTIVITIES

Information obtained through attendance and participation in meetings, activities, and conferences is critical to identifying recommended activities for FY-25 and beyond. Items in the following subsections were identified for potential funding in FY-25.

Under the regulatory framework modernization task, the INL Regulatory Development Team evaluated and prepared the work scope for FY-25 and beyond to include a DOE Integrated Planning List. The group participated in extensive interactive dialogue with DOE laboratories and interacted with industry stakeholders and researchers across the DOE laboratory complex to develop R&D and regulatory development work scopes and to determine resource requirements. This included the review and incorporation of items from the NEI Industry Priorities List. Additionally, the group worked to identify and prioritize industry and government needs, using them as the basis for developing a work scope for FY-25. By coordinating with industry stakeholders, DOE, and NRC, INL staff successfully identified areas of near-term R&D needs for current and near-future AR licensing-support activities that generally align with industry goals and priorities.

4.1. Multi-Lab Regulatory Coordination and Integration Group

Founded and continued through previous fiscal years, this group has been very successful at providing comments and recommendations for reports from the NEI and other NGOs, licensing activities, and regulations developed by the NRC for ARs. Funding for this group will continue into FY-25 when the main focus will be reviewing the updated 10 CFR Part 53 regulations.

4.2. Continued Interface with Industry Stakeholders

Continued interfaces with industry stakeholders, vendors, regulators, and researchers will support the development of DOE national laboratory activities that address regulatory gaps and challenges. Examples of a successful interface with industry stakeholders includes the sodium fast reactor fire protection standard identified in Section 3.3.3. FY-24’s work helped provide regulatory clarity in many areas. Work in FY-25 should seek to identify additional challenges and opportunities to address both near- and longer-term issues.

4.3. Performance-Based Physical Security Analysis

Interactions and interfaces with regulators, licensees, reactor designers, and industry groups for FY-20–24, as the NRC rulemaking “Alternative Physical Security Requirements for Advanced Reactors” has developed, have supported identifying potential guidance documents. The INL group drafted a proposal for FY-25 to develop regulatory guidance to assist applicants and licensees in meeting the proposed physical security rules and regulations under Part 73 and draft Part 53. These proposed performance-based frameworks would require license application formatting that matches the requirements and new methods proposed for regulatory compliance. This effort is anticipated to be supported by both the Regulatory Framework Modernization and Advanced Reactor Safeguards Programs. Continued attention to developments within physical security will allow the informing of feedback and public comment to regulators and understanding of industry concerns in this fluid space.

4.4. Advanced Materials and Manufacturing Technologies Support

During FY-24, it was identified that the Advanced Materials and Manufacturing Technologies (AMMT) Program will likely need regulatory support in the near future to support its obtaining endorsement of codes and standards and regulatory approval of other work performed by the program. After discussions with the AMMT NTD, it is recommended that the Regulatory Development Program provide funding for INL staff to work with AMMT staff and attend meetings such as the AMMT annual program review to help determine areas of possible future support as well.

5. CONCLUSIONS

During FY-24, the INL regulatory development department used funding provided under the regulatory framework modernization activity to support many critical activities while also achieving measurable results that aid in reactor deployments. The funding has been critical to maintaining relationships and interactions with the AR community, including with industry partners, applicants, DOE, and NRC. This report discusses these activities and provides recommendations for activities to be performed in FY25, including:

- Continued funding of the Multi-Lab Coordination and Integration Group
- Support for the molten-salt reactor campaign
- Work in performance-based physical security analysis
- Interactions with the AMMT program to determine future regulatory needs for the program
- Continued funding of the sodium reactor consensus standards development.

Activities planned to be performed in FY-25 will ensure that the Regulatory Development Program has a strong impact on the nuclear industry, NRC, and other organizations.

6. REFERENCES

Bucknor, M. 2024. “FY24 Efforts to Revive the ANS-54.8 Liquid Metal Fire Protection in LMR Plants Standard.” ANL/NSE-24/66, Argonne National Laboratory. <https://doi.org/10.2172/2446943>.

Appendix A

Meetings and Conferences Attended

A-1. Ongoing

- Every Tuesday: Regulatory Development Team Meeting
- Every other Wednesday: Advanced Reactor Technology (ART) Leads Update Meeting

A-2. Attended

- October 19, 2023: NRC Commission Meeting for Kairos Power (<https://www.nrc.gov/reading-rm/doc-collections/commission/tr/2023/index.html>)
- October 24–26, 2023: NRC Advanced Manufacturing Technologies Workshop (<https://www.nrc.gov/pmns/mtg?do=details&Code=20231129>)
- October 25, 2023: NRC Advanced Reactor Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20230810>)
- October 27, 2023: NRC Public Meeting on Draft Regulatory Guide 4034 “General Site Suitability Criteria for Nuclear Power Stations” (<https://www.nrc.gov/pmns/mtg?do=details&Code=20231171>)
- November 15, 2023: HTR TWG Meeting
- November 17, 2023: Nuclear Innovation Alliance NGO Coordination Call on Part 53
- November 30, 2023: NEI Advanced Reactor Forum
- December 6, 2023: ACRS Meeting (<https://www.nrc.gov/docs/ML2330/ML23307A110.pdf>)
- December 7, 2023: FY-23 4th Quarter Performance Evaluation
- December 7, 2023: NRC Advanced Reactor Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20230812>)
- January 17, 2024: NRRWG Meeting
- January 17, 2024: HTR TWG Meeting
- January 24, 2024: NRC AR Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20231097>)
- February 6–8, 2024: DOE-NE-52 ART Fast Reactor Program Review
- February 14, 2024: NRC/DOE/Lab Follow-up Conversation
- February 21, 2024: FY-24 First Quarterly Performance Evaluation Review Presentation
- February 28, 2024: NRC Advanced Reactor Construction Oversight Program Public Meeting (<https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML24047A274>)
- February 5–7, 2024: DOE-NE Microreactor Program Review
- March 11, 2024: NEI Advanced Reactor Forum
- March 12–14, 2024: NRC Regulatory Information Conference
- March 14, 2024: NRRWG Meeting

- March 27, 2024: ARs Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20240086>)
- April 23–25, 2024: NRIC Program Review
- May 1–2, 2024: Licensing Modernization Project Construction Workshop (attended May 1)
- May 6, 2024: Regulatory Framework Modernization Program Review
- May 7, 2024: FY-24 2Q Performance Evaluation
- May 22, 2024: NEI NRRWG Meeting
- May 23, 2024: NRC ARs Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20240427>)
- June 18, 2024: NEI AR Forum (in person)
- June 26, 2024: RHDRA Discussion with Advanced Reactor Regulatory Taskforce Members
- July 16–18, 2024: ART Gas-Cooled Reactor Program Review Meeting
- July 24, 2024: NRC AR Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20240753>)
- July 29, 2024: NRRWG Meeting (virtual)
- September 9, 2024: NEI NRRWG Meeting (Philadelphia, Pennsylvania)
- September 18, 2024: NRC AR Public Meeting (<https://www.nrc.gov/pmns/mtg?do=details&Code=20240791>)
- September 25, 2024: NRC Standards Forum (attending for NRC-INL collaborative effort)