Key Recommendations for Reforming U.S. Nuclear Energy Regulation

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I. Purpose

The timely deployment of advanced nuclear reactors at scale is a critical solution for both climate change and energy security. The deployment of these reactors requires effective and efficient nuclear reactor licensing reviews that enable safe, publicly trusted, and commercially competitive construction and operation. Effective and efficient licensing can be achieved through reforms that help NRC to implement modernized, risk-informed, performance-based, and technology-inclusive regulatory processes and frameworks.

The Nuclear Innovation Alliance (NIA) believes that urgent reform at the U.S. Nuclear Regulatory Commission (NRC) is essential to the successful development and deployment of advanced nuclear energy "to meet our climate and energy security goals." [1] NIA issued a discussion draft of its reform recommendations on February 13, 2023.[2] Since early 2023, ongoing engagement and dialogue with policymakers and various stakeholders have enriched and refined NIA's understanding of the NRC reforms needed to achieve more effective and efficient regulation.

This updated set of recommendations from NIA provides more detailed discussion on the need for reform at the NRC, the specific reforms that can help enable licensing and deployment of advanced nuclear energy at scale, and the specific roles that different players (Congress, the NRC Commission, NRC management and staff, and advanced reactor license applicants) will play in creating a modernized, effective regulator. Civil society plays an important role in informing and advocating for these reforms.

Two important developments make this update particularly timely. First, Congress recently enacted the ADVANCE Act, granting the NRC with additional authorities that the agency must effectively implement. Second, as of July 2024, the NRC has selected a new Executive Director for Operations and is in the process of filling additional key leadership positions. The incoming leadership has the opportunity to inspire, empower, and hold accountable the NRC staff for new levels of high performance.

II. The State of NRC's Readiness to Review Applications Efficiently and Effectively

Nuclear energy has long been recognized as a clean, safe, firm, and reliable energy source. The emergence of microreactors and small modular reactors (SMRs), capable

[1] The Urgency of NRC Reform
[2] NIA Discussion Draft: NRC Reform Recommendations

of supplying electricity as well as process heat, offers a promising alternative to highly reliable carbon-emitting energy generation sources (e.g., diesel and natural gas generators) for data centers, military campaigns, and industrial applications. Private companies are actively engaged in the commercialization and deployment of these innovative nuclear technologies. The deployment of new nuclear energy technologies is not just a solution for decarbonizing and stabilizing the electrical grid, but also a critical step towards enhancing global energy security.

The deployment of new nuclear reactors in the United States requires licensing by the U.S. NRC, which under the Atomic Energy Act (AEA) is responsible for the regulation of nuclear technologies and is tasked to "provide reasonable assurance of adequate protection of public health and safety and to promote the common defense and security and to protect the environment".[3] The NRC regulates and oversees the 94 operating nuclear reactors. It is also engaged in the review and approval processes of over a dozen advanced reactor technologies, including both light water and non-light water designs, at various stages of pre-application engagement and license application review.

The NRC has already made progress in reviewing and approving a new wave of advanced reactor applications. In 2023, the NRC successfully reviewed and approved the construction permit application for Kairos Power's *Hermes* test reactor. As of mid-2024, the NRC is actively reviewing construction permit applications for three new reactors (Kairos Power *Hermes 2*, Abilene Christian University *Molten Salt Research Reactor*, and TerraPower *Natrium*) and expects to start additional application reviews (including the X-energy Xe-100) by the end of 2024. However, significant uncertainties remain regarding the NRC's capacity to effectively, efficiently, and predictably license the diverse designs and substantial volume of anticipated new reactor applications.

Effective, efficient, and predictable regulation is essential to creating the social, political, and economic conditions necessary for the successful commercialization of new nuclear energy. The NRC has begun work to transform itself into a "a modern, risk-informed regulator"[4] that can effectively license advanced reactors through rulemakings and process changes. Key initiatives, such as the 10 CFR Part 53 rulemaking currently in progress,[5] the increased use of license review audits,[6] the creation of new rules to enable performance-based emergency planning zones,[7] and

[3] About NRC
[4] NRC's Transformation Journey
[5] Proposed Rule: Risk-Informed, Technology Inclusive Regulatory Framework For Advanced Reactors
[6] A licensing audit allows NRC staff access to review select internal applicant documents outside of the formal submission process for a license application. This process aims to expedite safety determinations by providing NRC staff with additional insight into complex technical issues while ensuring transparency and accountability between all stakeholders. See the NIA Licensing Efficiency Workshop Summary Report for further explanation.
[7] Final Rule: Emergency Preparedness For Small Modular Reactors And Other New Technologies

development the Advanced Nuclear Reactor Generic Environmental Impact Statement,[8] all demonstrate incremental NRC progress towards more effective licensing processes. Urgent action, however, is imperative to facilitate the efficient and effective licensing of commercial reactors as the number of expected applications ramps up dramatically in the coming decade.[9]

Creating a more effective and efficient regulator requires action by Congress, the Commissioners, NRC management, NRC staff, and advanced reactor license applicants. Congress must oversee NRC reform and enact necessary legislation. NRC Commissioners and agency leadership must implement reforms while fostering a culture that prioritizes the public interest in effective, accountable and efficient regulation. Finally, management and staff should embrace agility, innovation and collaboration, fostering open communication with license applicants who can implement best practices.

NIA defines NRC reform as a comprehensive effort involving Congress, the NRC Commissioners, NRC management and staff, and advanced reactor applicants to improve the effectiveness and efficiency of advanced reactor licensing and regulatory oversight. Reforms are needed in three distinct timeframes: near-term (mid to late 2020s, to support initial commercial deployment of advanced nuclear reactors), medium-term (early to mid 2030s, to support subsequent commercial deployment), and long-term (mid 2030s and beyond, to support widescale deployment of advanced nuclear energy).

The following sections identify NIA's specific recommendations for key stakeholders and policymakers to improve the licensing of advanced nuclear reactors by a modernized, effective NRC.

NIA's top recommendations for each group of key players (Congress, the Commission, NRC management and staff, and advanced reactor applicants) are as follows:

- Congress should conduct regular oversight hearings on the NRC's reform efforts to evaluate and ensure the implementation of modernization programs.
- The Commission should instruct staff to establish transparent, detailed, objective performance metrics and predictable milestone schedules for various licensing actions and applications.
- NRC management and staff should openly discuss organizational, cultural, and workforce challenges at the agency to identify and implement innovative solutions that enable effective change across the organization.

[8] Proposed Rule: Advanced Nuclear Reactor Generic Environmental Impact Statement
[9] Enabling High Volume Licensing of Advanced Nuclear Energy

- Advanced reactor license applicants should develop a regulatory engagement strategy and communicate early, openly, and frequently with NRC counterparts to facilitate a collaborative and transparent regulatory review process.

These reforms, along with those detailed in the remainder of the document, can help create an effective, efficient, and predictable licensing process for advanced nuclear reactors, enabling the timely deployment of nuclear energy at scale as a climate solution.

III. NIA's Recommendations to Congress

The U.S. Congress plays an important role in shaping the regulatory environment for nuclear energy. Congress controls the budget and staffing of NRC through the appropriations process, conducts oversight hearings on NRC operations, creates reporting requirements on NRC activities, and can amend the Atomic Energy Act to change the statutory mandate of the agency. Congress has direct influence on the NRC's operations and priorities, but the agency retains independence on all safety and regulatory decisions.

NIA recommends the following actions to Congress aimed at improving the NRC's performance and making regulatory processes more efficient for near-, medium-, and long-term licensing of advanced nuclear reactors.

a. *Congressional Oversight of Current NRC Reform Activities*
    i. Oversee NRC's implementation of the reforms enacted in the Nuclear Energy Innovation and Modernization Act in 2019[10] and enhanced by the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act in 2024.[11]
    ii. Conduct regular oversight hearings on the NRC's reform efforts to evaluate Commission, management, and staff implementation of existing and new modernization programs.
    iii. Request annual progress reports and regular updates on performance metrics to maintain accountability on outcomes in a timely manner.
    iv. Request NRC performance assessments of NRC activities using transparent, understandable, and verifiable performance metrics.

b. *Improving the Efficiency of Regulatory Processes*
    i. Oversee the Commission's efforts to more flexibly implement the requirements for mandatory Commission hearings for reactor applications as required by Section 189a of the AEA.

[10] S.512 – Nuclear Energy Innovation and Modernization Act
[11] S.870 - Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act included as an amendment to the Fire Grants and Safety Act

ii. Pass legislation to eliminate or reduce the AEA Section 189a requirements for mandatory hearings, especially for reactors without novel design or policy issues.
iii. Ensure timely completion of the 10 CFR Part 53 rulemaking process and ensure final rule alignment with congressional direction in the Nuclear Energy Innovation and Modernization Act of 2019 (NEIMA).
iv. Pursue opportunities for oversight or changes to the AEA to focus Advisory Committee on Reactor Safeguards (ACRS) reviews on novel safety issues to most effectively and efficiently leverage their independent technical expertise.

c. *Accountability, Transparency, and Accessibility*
   i. Use oversight hearings and letters to increase Commission accountability to congressional direction with a focus on ensuring timely and demonstrable results for NRC licensing and reform activities.
   ii. Use oversight hearings and letters to emphasize the importance of proactive, collaborative NRC engagement with stakeholders and the public.
   iii. Use congressional appropriations, oversight hearings, and letters to ensure that the NRC develops more simplified and accessible technical documents, information tools, and meetings for public stakeholders.

d. *External Feedback*
   i. Create new legislative requirements for NRC assessment and public reporting of feedback gained from stakeholder engagement, including potential incorporation of feedback into guidance or regulations.

e. *Establishment of a Regulatory Reform Panel*
   i. Task an independent government organization, or create a new independent NRC Regulatory Reform Panel, to evaluate the NRC's institutional culture and management effectiveness, including the roles and responsibilities of various NRC offices in Agency decision-making processes.
   ii. Use findings from the independent evaluation to inform congressional oversight strategy for future NRC regulatory reform efforts.

IV. NIA's Recommendations to the Commission

The NRC Commission plays a crucial role leading the agency. It votes on regulatory decisions presented by NRC staff, sets the strategic direction for the NRC, provides direction on the development of regulation and guidance, and adjudicates legal matters related to licensing and enforcement actions. Additionally, the Commission appoints the NRC's Executive Director for Operations, approves the agency's budget, and oversees major organizational initiatives and reforms. The Commission has significant power to shape the regulatory framework that governs the operation,

licensing, and oversight of nuclear power plants, research reactors, and nuclear materials users.

NIA recommends the following actions to the Commission to bolster the NRC's operational efficacy and streamline regulatory processes for near-, medium-, and long-term advanced nuclear reactor licensing.

a. *Accountability*
   i. Continue to hold NRC senior management accountable to congressional and Commission directives, ensuring timely and tangible results.
   ii. Prioritize the ongoing modernization of 10 CFR Parts 50 and 52, their associated regulations, and guidance, to make them risk-informed and performance-based as outlined in SECY-22-0052.[12]

b. *Management Reform*
   i. Advise NRC staff to establish predictable milestone schedules[13] at the onset of applications for design certifications or approvals, licenses, permits, license amendments, license renewals, certificates of compliance, power uprates, and any other activity requested by a licensee or applicant,[14] as proposed by Commissioners Caputo and Wright.
   ii. Review the role of the Advisory Committee on Reactor Safeguards (ACRS) in advising the Commission, and direct ACRS to focus reviews on novel design, technical, and policy matters.[15]

c. *Leadership and Commission Voting*
   i. Establish requirements for "Commission expectations for the effectiveness, efficiency, and timeliness of new reactor reviews," as proposed by then-Commissioner Jeff Baran and supported by Commissioner Crowell[16] for senior NRC management.
   ii. Direct NRC staff to continue to assess opportunities to further increase efficiency of licensing reviews of large numbers of new nuclear reactors.
   iii. Prioritize timely votes on Commission Papers, including new or updated rules and policy positions in SECYs, that require Commission approval for publication.

[12] SECY-22-0052: Proposed Rule: Alignment of Licensing Processes and Lessons Learned from New Reactor Licensing (RIN 3150 AI66)
[13] Measuring NRC Success, ML23241B013
[14] NEIMA, Sec.3. (10)
[15] Improving the Effectiveness and Efficiency of the Advisory Committee on Reactor Safeguards
[16] Establishing Commission Expectations for the Effectiveness, Efficiency, and Timeliness of New Reactor Reviews ML23160A213

V. NIA's Recommendations to NRC Management and Staff

Management and staff form the core of the NRC, tasked with implementing Commission directives, establishing milestones and timelines, and ensuring all operations and activities align with the agency's mission. As of July 2024, several senior leadership positions[17] at the agency are open, with selection processes underway. The incoming leaders at the NRC have an opportunity to transform the agency by setting a new strategic vision and tone for management and staff that aligns with the evolving landscape of nuclear energy in the United States.

NRC's current mission statement is to license and regulate "the Nation's civilian use of radioactive materials to provide reasonable assurance of adequate protection of public health and safety, to promote the common defense and security and to protect the environment."[18] It is imperative that NRC continue to fulfill its mission while accommodating new nuclear technologies. This requires an intensified focus on organizational performance as well as agility - "the ability of an organization to renew itself, adapt, change quickly, and succeed in a rapidly changing, ambiguous, turbulent environment".[19] NRC's incoming leadership, management and staff must implement the performance-based reforms initiated by the Commission in an agile manner.

Building on NRC's current efforts to make organizational, cultural and procedural changes to improve the near-, medium-, and long-term licensing of advanced nuclear reactors, NIA recommends prioritizing the following actions and best practices.

NRC Management

a. *Workforce Development and Management*
   i. Enhance management skills by emphasizing agile leadership principles in training and professional development programs for NRC managers.
   ii. Openly discuss organizational, cultural, and workforce challenges at the agency to identify and implement innovative solutions that enable effective change across the organization.
   iii. Improve incentive structures throughout the organization to reward risk-informed and performance-based decision-making and innovation by NRC staff.
   iv. Incorporate external project management training and certification programs to introduce and strengthen best practices into NRC project management.

[17] NRC Organization Chart
[18] About NRC
[19] McKinsey: The keys to organizational agility

v. Provide robust and continuous peer training to NRC project managers on end-to-end management and efficient project implementation.
vi. Assess staffing and resources for application and pre-application reviews and review mid-term plans (5 - 10 years) to increase overall staffing levels and prioritize critical technical staff roles to help manage the expected increased volume of license applications and other review activities.

b. Risk-Informed and Performance-Based Regulation

i. Empower NRC project managers to hold technical staff accountable on the regulatory basis for decision-making and to focus staff and applicant resources on licensing matters most important to safety and security.
ii. Ensure timely resolution of Differing Professional Views[20] while applying resources commensurate with their safety significance.
iii. Continue to prioritize the use of risk insights, engineering analysis and judgment (including the principle of defense-in-depth and the incorporation of safety margins and performance history[21]) to:
    1. Direct attention to high-priority tasks.
    2. Establish objective criteria for evaluating safety performance.
    3. Develop measurable or calculable parameters for monitoring system and licensee performance.
    4. Provide flexibility to determine how to meet the established performance criteria in a way that will encourage and reward improved outcomes.

NRC Staff

a. Clear Regulatory Basis for Staff Decision Making

i. Exercise regulatory discipline and focus on what actions are necessary and sufficient to reach a finding of reasonable assurance of adequate protection.
ii. Clearly delineate differences between a regulatory requirement and guidance.
iii. Assess safety and security based on regulatory requirements and enable applicant development of approaches that deviate from guidance.

b. Enhancements to Timeliness and Accountability

i. Document new precedents and knowledge gained through first-of-a-kind (FOAK) reviews in technology-specific review plans and guidance to enable efficient and reliable "at-scale" reviews of larger volumes of future applications.

[20] NRCAR, Part 2042: Differing Professional Views
[21] Staff Requirements - SECY-98-144 – White Paper on Risk-Informed and Performance-Based Regulation

ii. Continue to adhere to deadlines for milestones in all aspects of program and project management, rulemaking, guidance publication, and completion of public meeting summaries.
iii. Support the timely resolution of technical issues with stakeholders in a collaborative and transparent manner.

c. *Communication and Collaboration*
   i. Continue to create opportunities for problem-solving through open collaboration with applicants and other stakeholders using different public forums including workshops, public meetings, or other engagement tools. Examples of more collaborative problem solving include recent NRC staff engagement on microreactors, use of artificial intelligence, and use of risk assessment methods and metrics for advanced reactors.
   ii. Continue to prioritize improving the usability of the NRC's Agencywide Documents Access and Management System (ADAMS) for accessing technical documents through the ADAMS Public Search Modernization Project and the NRC Office of the Chief Information Officer.
   iii. Simplify accessibility to technical documents, information, tools, and meetings.
   iv. Communicate with license applicants early, openly, and often to ensure alignment on the substance and status of technical issues.
   v. Maintain transparency regarding engagement and review processes, roles, and responsibilities of NRC offices and the ACRS, as well as emergent technical issues and review challenges.

d. *Policy*
   i. Proactively elevate policy issues requiring senior management or Commission direction early in the pre-application engagement or application review process. An example of the elevation of policy issues is NRC staff development of a Commission Paper (SECY) on microreactor policy issues for the Commission.[22]

VI. NIA's Recommendations to Advanced Reactor License Applicants

Advanced reactor license applicants will be directly impacted by NRC reform, as they depend on the efficiency and efficacy of the NRC's regulatory framework. Through their detailed applications and engagement with the NRC on specific licensing issues, they can work with the NRC to improve the licensing process for both applicants and

[22] SECY-24-0008: Micro-Reactor Licensing and Deployment Considerations: Fuel Loading and Operational Testing at a Factory

the agency. More broadly, they can provide insights on the effect of the licensing process on technology development and deployment. Applicants are in the best position to support and advocate for a regulatory framework that is both robust and adaptable. By engaging proactively with the NRC, applicants can help the regulator to support innovation while maintaining high safety standards. This collaboration is essential for fostering a regulatory environment that is conducive to the deployment of advanced nuclear technologies.

NIA recommends advanced reactor license applicants prioritize the following actions and best practices to optimize regulatory engagement, enhance collaboration with the NRC, and modernize near-, medium-, and long-term licensing.

a. *Engagement Strategy*
    i. Develop a regulatory engagement strategy and create a roadmap to share with the NRC, and, to the extent practicable, public stakeholders.
    ii. Cultivate constructive relationships with the staff and solicit feedback to inform a regulatory engagement strategy.
    iii. Optimize pre-application engagement with NRC staff by identifying and prioritizing regulatory issues requiring resolution by NRC staff, management, and the Commission.
    iv. Consider requesting a pre-application readiness review and NRC staff feedback regarding areas that may not be complete or technically sufficient to support a technical review.

b. *Communications*
    i. Communicate early, openly, and frequently with NRC counterparts to facilitate collaborative and transparent regulatory review.
    ii. Update the NRC promptly regarding design or schedule changes that will affect ongoing or planned licensing reviews.
    iii. Provide prompt, clear, and complete responses to NRC requests for additional information, ensuring understanding of the requests and their regulatory bases.
    iv. Maintain open lines of communication regarding the engagement and review processes (including roles and responsibilities of NRC offices and the ACRS) and emergent technical issues and review challenges.

c. *Feedback to the Regulator*
    i. Identify regulations that are not applicable to the applicant's design and prepare a gap analysis to support aligned application development.
    ii. Engage with the regulator and other stakeholders to modernize regulatory infrastructure, focusing on development of technology-inclusive, risk-informed, and safety performance-based approaches rather than relying on applicant compliance with prescriptive regulatory requirements.

iii. Advocate for use of regulatory audits to help NRC staff understand the technical basis of applications.
iv. Ensure regulatory audits are appropriately scoped and completed using risk insights so that NRC staff resources are allocated appropriately.
v. Elevate issues to NRC senior management and the Commission if NRC staff and management fail to make timely decisions or provide adequate regulatory justification for licensing decisions or outcomes.

d. Completeness in Application

i. Submit applications that are technically sufficient and complete for the NRC to establish a review schedule and estimate the level of effort (number of NRC staff hours) to complete its review.
    1. Assess progress against schedule milestones and estimated level of effort to ensure the review is on track.
    2. Inform the NRC project manager of unexpected charges and schedule delays.
    3. Monitor NRC staff involvement to ensure fees are reasonable and charged only by NRC staff assigned to the review.
ii. Implement lessons learned and best practices from initial advanced reactor application reviews to achieve greater efficiency and effectiveness in obtaining NRC approvals.

VII. Conclusion

Urgent reform at the U.S. Nuclear Regulatory Commission (NRC) is essential for the successful development and deployment of advanced nuclear energy. This is crucial to meet our climate and energy security goals. We encourage Congress and incoming NRC leaders to inspire, empower, and hold the NRC staff accountable for achieving new levels of high performance. We urge all key players—Congress, the Commission, NRC management and staff, and advanced reactor applicants—to actively engage in this reform process. Each group has a vital role in shaping the regulatory environment for nuclear energy and can collectively enhance the NRC's performance and ensure more efficient regulatory processes.

The success of advanced nuclear energy development depends on a reformed NRC that is efficient, transparent, and accountable. These reform recommendations can help create an effective, efficient, and predictable licensing process for advanced nuclear reactors, enabling the timely deployment of nuclear energy at scale as a climate solution. By adopting these recommendations, we can achieve a regulatory environment that supports innovation and meets our critical climate and energy security objectives.