POLICY ISSUE
(Information)

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FOR: The Commissioners

FROM: Daniel H. Dorman
Executive Director for Operations

SUBJECT: VISION FOR THE NUCLEAR REGULATORY COMMISSION'S ADVANCED REACTOR CONSTRUCTION OVERSIGHT PROGRAM

PURPOSE:

The purpose of this paper is to communicate the path forward to develop the Advanced Reactor Construction Oversight Program (ARCOP). It does not address any new commitments or resource implications.

SUMMARY:

This paper focuses on the development of a framework for an effective and efficient construction oversight program for advanced reactors. As the nuclear industry's design and construction methodologies evolve to accommodate new technologies, the Nuclear Regulatory Commission (NRC) must adapt by developing a flexible oversight program to ensure the agency is applying a level of regulatory oversight commensurate with the risk posed by a variety of new facilities. Consistent with the NRC Principles of Good Regulation, the ARCOP framework reflects an approach that optimizes the NRC's established oversight framework to ensure the program is responsive to the evolving landscape of advanced reactor technologies. The ARCOP will provide reasonable assurance that advanced reactor facilities are built and will operate in accordance with their approved designs and licensing bases. The ARCOP will address each aspect of an effective oversight program (i.e., performance monitoring, enforcement, and assessment).

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This paper introduces concepts that may have policy implications. The staff plans to conduct public workshops to seek stakeholder feedback on the program's scalable approaches and their applicability to the various technologies and manufacturing methods that are being considered by the industry. The information from these workshops will be used to refine the program and may inform future policy papers for the Commission's consideration.

BACKGROUND:

The technologies being considered by the advanced reactor community are diverse and the risk profiles of potential new designs vary considerably. In addition, many advanced reactor construction projects are likely to rely more on factory assembly of safety-significant structures, systems, and components (SSCs) than previous projects, and onsite construction inspection, in some cases, may only be a small part of the integrated oversight of project quality. Given the expected diversity of advanced reactor projects and increase in offsite manufacturing and assembly of safety-significant SSCs, it is the NRC staff's view that a fresh look at manufacturing and construction oversight is warranted in the development of the ARCOP.

The NRC staff's plan for developing the construction oversight program for advanced reactors builds on experience from previous and current NRC construction oversight programs. In this paper, advanced reactors under the ARCOP framework include facilities incorporating small modular reactors and microreactors using light-water reactor (LWR) technology, as well as all non-LWR facilities. The NRC staff is proactively engaging with the industry to maintain awareness of when developers might begin construction of advanced reactors. The NRC could issue the first power reactor construction permit or combined license as early as 2025, with the possibility of limited work authorizations even earlier. Therefore, the NRC staff is working to develop an effective oversight framework to meet this timeframe.

In its Advanced Reactor Policy Statement, the Commission stated the expectation that advanced reactors will have enhanced safety margins. These include simpler designs and the use of inherent, passive, or other innovative means to accomplish safety and security functions. Advanced reactors will vary in physical size and power level, ranging from microreactors to facilities approaching the size of traditional large LWRs. Smaller and simpler reactor plant designs may require fewer safety-significant SSCs to accomplish safety and security functions. These design differences could result in reduced risk profiles for many advanced reactors. As such, the NRC staff will consider the likelihood of a range of plant risk profiles to inform and scale the scope of construction oversight needed to provide reasonable assurance of adequate protection of public health and safety.

DISCUSSION:

A successful ARCOP will need to consider the diversity of technologies and risk profiles of new designs. In addition, construction of many advanced reactors is likely to involve the manufacture and assembly of the reactor power unit, and potentially principal safety systems, at offsite domestic or foreign locations. These factors present regulatory challenges and opportunities for enhancing the current construction reactor oversight process (cROP). The NRC staff aims to optimize the NRC's approach to construction oversight, considering the diversity of technologies and construction methods that will be covered under the program.

The NRC staff's ARCOP vision looks to build on its construction oversight experience while remaining adaptable to future advancements in reactor technologies. This vision is based on the following guiding principles:

- ***risk-informed:*** uses facility risk insights to define the scope of inspection
- ***performance-based:*** adjusts oversight based on performance of licensees and suppliers
- ***technology-inclusive:*** covers the full spectrum of advanced reactor technologies being considered for NRC licensing
- ***scalable:*** uses a graded approach to inspection efforts commensurate with a facility's public health and safety risk
- ***informed:*** applies construction oversight experience and leverages lessons from past and current NRC inspection programs and other external sources
- ***comprehensive:*** provides for oversight of all activities that are significant to construction quality (procurement, manufacturing, and onsite construction), security programs, and operational readiness
- ***innovative:*** leverages new inspection tools and approaches, such as hybrid inspections, to enhance efficiency and effectiveness.

In this SECY, the terms "construction quality" and "quality of construction" refer to quality assurance during the design, fabrication, manufacture, construction, and testing of plant structures, systems, and components. As used in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants,"

> "[Q]uality assurance" comprises all those planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service. Quality assurance includes quality control, which comprises those quality assurance actions related to the physical characteristics of a material, structure, component, or system which provide a means to control the quality of the material, structure, component, or system to predetermined requirements.

In other words, adequate quality of construction of nuclear power plants means that nuclear plant SSCs are built according to their approved licensing basis (i.e., "predetermined requirements").

Building Upon Construction Oversight Experience

The ARCOP will leverage construction oversight experience from various projects, including the current fleet of operating large LWRs, the Advanced Passive (AP)1000 reactors, the SHINE Technologies, LLC (SHINE), Medical Isotope Production Facility, and fuel cycle facilities. The NRC staff is developing a cROP lessons learned report, and the ARCOP will leverage initial staff observations of the cROP for the AP1000 construction projects and will continue to incorporate cROP insights as both the NRC staff and the industry gain additional experience. The NRC staff is also revisiting NUREG-1055, "Improving Quality and the Assurance of Quality in the Design and Construction of Nuclear Power Plants—A Report to Congress," issued 1984, to capture additional insights from the last generation of large LWR construction.

Flexible and Scalable Oversight

The NRC staff's vision for the ARCOP framework is to adopt attributes that promote flexibility and scalability for oversight that is commensurate with the risk posed by the facility. The vision for the ARCOP includes three areas that are common to all the NRC's oversight programs. These areas are performance monitoring, enforcement, and assessment.

(1) Performance Monitoring

The NRC staff monitors performance during construction through inspection programs, allegations programs, and operational experience. The agency relies on these programs to establish reasonable assurance that facilities are built and will operate in accordance with their approved design and licensing bases. The scopes of the NRC's construction inspection programs are comprehensive, meaning they cover all aspects needed for nuclear safety and security. The current programs include baseline inspection plans that rely on sampling when evaluating performance of licensees and their contractors coupled with inspection of quality assurance (QA) implementation, both of which are critical for the NRC staff to ensure that a facility will meet design and licensing requirements.

We envision that, under the ARCOP, the NRC staff would base its facility-specific baseline inspection plans on areas of construction and fabrication of the facility's safety-significant SSCs, the novelty of safety features in the design, the relative risk significance of inspection areas, and the use of first-of-a-kind construction and manufacturing methods. The baseline inspection plans would be scalable and would include aspects of the implementation of the QA program to optimize the number of inspection samples in each safety-significant construction area.

The NRC staff uses a scalable inspection strategy in the construction inspection program for the SHINE Medical Isotope Production Facility. This strategy has been effective for verifying the quality of construction while optimizing the selection of SSCs for inspection samples in different construction areas. This inspection strategy also incorporates lessons learned from the Vogtle Electric Generating Plant construction project, including planning and SSC selection in a manner that aligns with the dynamic nature of a construction schedule. The approach and scoping methodology focus attention on the quality of the most safety-significant aspects of the facility while allowing flexibility in selecting specific SSCs for inspection.

The NRC staff plans to design the ARCOP to optimize the number of inspection samples in each safety-significant construction area. The program is envisioned to integrate inspections of vendors and offsite manufacturing into the ARCOP assessment process and continue construction inspections until the NRC staff both completes the prescribed inspection samples and gains confidence that the licensee and its contractors and vendors are consistently performing quality work and meeting NRC requirements.

For each advanced reactor design, the NRC staff intends to use risk insights to develop an inspection plan that appropriately focuses on areas of greatest safety significance. The NRC staff would derive these risk insights from the licensing basis and other available risk information, including insights from probabilistic risk assessments where available, and combine them with engineering judgment, based on advanced reactor technical expertise in an integrated decision-making process. For applications using the Licensing Modernization Project (LMP) methodology, as described in Regulatory Guide 1.233, "Guidance for a Technology-Inclusive, Risk-Informed, and Performance-Based Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for

Non-Light-Water Reactors" (Agencywide Documents Access and Management System Accession No. ML20091L698), the NRC staff could use the LMP results and the associated SSC categorization to underpin inspection scoping.

In addition to inspection of the construction and fabrication of the facility's safety-significant SSCs, novel safety features, and the use of first-of-a-kind construction and manufacturing methods, the ARCOP would include inspection of the licensee's development of operational and security programs. These inspections would consider the facility design and scale inspections based on each program's impact on safety or security. Inspections would also be scaled appropriately for sites that have multiple units of the same design or have similar construction activities across different designs.

The NRC staff also plans to evaluate new technologies that may enhance the efficiency of direct SSC inspections as such technologies become available. Adoption of new technologies for inspection could feed into a determination of when onsite NRC staff presence would be necessary.

The increased inspection of manufacturing activities in locations other than the facility construction site, and the potential for reduced dependence on predetermined SSC inspection samples, would be designed to promote a more dynamic and scalable inspection footprint. Further, as inspection experience is gained on particular standardized designs, the NRC staff may determine that further adjustments are reasonable for the construction of the n^{th}-of-a-kind facility.

Figure 1 shows a potential concept for the ARCOP inspection and oversight framework that would result from the scoping strategy described above. The Strategic Performance Areas are those aspects of project quality that are important to the ARCOP objective and therefore merit regulatory oversight. The staff plans to tabletop this concept with stakeholders to further develop and refine the details and to assure alignment with planned construction techniques and manufacturing capability, as well as licensees' contractual oversight of the various projects.

While the ARCOP concept would be modeled on the cROP framework, the ARCOP framework would be designed to adapt to the expected changes in future construction projects, such as increased offsite manufacturing, which could be different from past construction experience. The NRC staff will implement each ARCOP aspect (i.e., performance monitoring, enforcement, and assessment) in each of the five cornerstones of safety (see Figure 1).

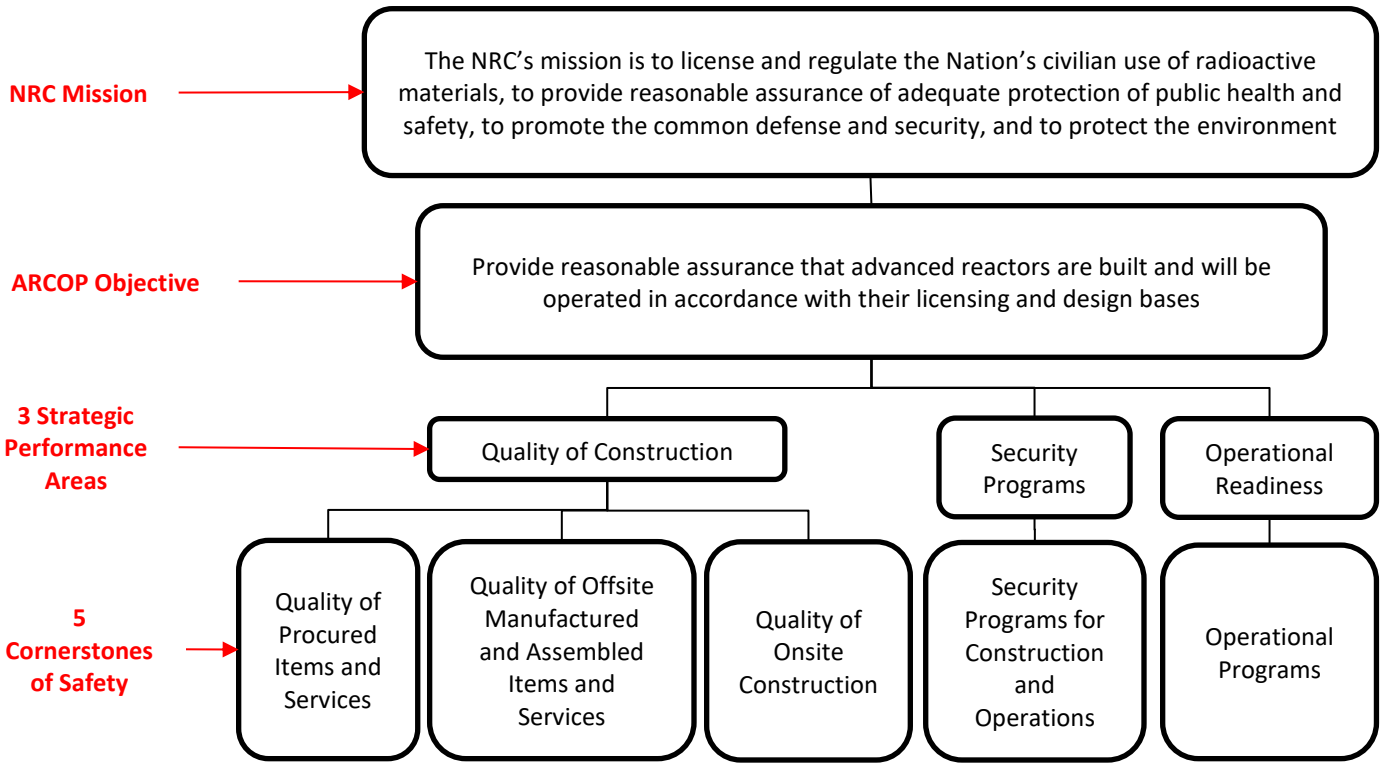

Figure 1 ARCOP strategic performance areas and cornerstones of safety

(2) Enforcement

The NRC staff is considering an ARCOP framework that would use key elements of the cROP combined with the basis of traditional enforcement to determine the significance of violations. This would allow the NRC staff to incorporate cROP lessons learned into the significance determination process. To accomplish this, the NRC staff will consider creating an interface inspection manual chapter like the enforcement manual chapters for the Reactor Oversight Process (ROP) and cROP to provide ARCOP-specific enforcement guidance that could be referenced in the Enforcement Policy. Additionally, the NRC staff will evaluate the need to either modify the screening process used to determine whether an inspection finding has minor significance (i.e., not normally documented in inspection reports), or develop new criteria specific to advanced reactors. The intended outcome is increased alignment of the significance determination process with the risk represented by advanced reactor construction violations. The NRC staff's goal is to simplify enforcement, improve its timeliness, reduce the need for design-specific construction significance determination processes, and optimize the risk assessment efforts associated with construction non-compliances, where appropriate.

(3) Assessment

The objective of the ARCOP assessment process would be to evaluate the quality of construction, security programs, and operational programs. The NRC staff could then use this assessment to adjust its inspection program.

The output of the ARCOP assessment process would focus on the overall project quality, as established by performance within each cornerstone of safety (see Figure 1). For the current fleet of large LWRs, a single licensee or construction permit holder performed the majority of construction at one site. The NRC staff expects that fabrication of significant portions of advanced reactors could take place in multiple locations. Therefore, the NRC staff plans to tailor the scope of the assessment under the ARCOP to combine all aspects affecting project quality.

To conduct a complete and accurate assessment of the construction quality of a specific advanced reactor project, the NRC staff envisions that the ARCOP would capture performance in each of the areas that contribute to construction of the facility and capture it by assessing the performance of both licensees and reactor manufacturers, who significantly contribute to overall construction quality. The NRC staff's response could be guided by a supplemental inspection chart similar to that used under cROP and ROP guidance. The NRC staff's goal is that the agency's response to the ARCOP assessment would be predictable, clear, and reliable.

The ARCOP assessment process could also allow adjustments within a preestablished nominal band of required inspection samples for each strategic performance area. The NRC staff could adjust inspection sample size within this band in response to the assessment results, or to follow up on issues within corrective action programs. This dynamic and continuous assessment approach coupled with predetermined checkpoints could allow for more timely inspection refinements. The evaluation of the overall project quality (i.e., construction, security, and operational programs) would be the principal output of the ARCOP assessment process. Similar to the current construction inspection framework in the cROP, the NRC staff would use the evaluation to support applicable licensing decisions. For example, to issue an operating license under 10 CFR Part 50, 10 CFR 50.57(a)(1), "Issuance of operating license," requires in part that the Commission must find that construction of the facility has been substantially completed, in conformity with the construction permit and the application as amended, the provisions of the Atomic Energy Act, as amended, and the rules and regulations of the Commission, and the inspection results inform the Commission's finding. For facilities licensed under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," 10 CFR 52.99(e), "Inspection during construction; ITAAC schedules and notifications; NRC notices – NRC inspection, publication of notices, and availability of licensee notifications," requires the NRC to ensure that the prescribed inspections, tests, and analyses in the inspections, tests, analyses, and acceptance criteria are performed, and 10 CFR 52.103(g), "Operation under a combined license," requires the NRC to find that the acceptance criteria are met prior to operation. The inspection results are used to inform these activities.

Other Program Considerations

The NRC staff envisions that the ARCOP could leverage available information, such as domestic and international vendor and manufacturer oversight information, to inform the inspection scope and provide the NRC staff with additional performance monitoring data. For example, the NRC staff could consider pooling inspection resources with other countries and crediting other countries' oversight activities when a manufacturer is producing SSCs for more than one country's licensees. As it develops specific program details, the NRC staff will seek Commission direction on any identified policy issues.

Stakeholder Engagement

During the Advanced Reactor Stakeholder public meeting held on March 2, 2023, the NRC staff presented an overview of ARCOP considerations to the advanced reactor community and other stakeholders. Several discussions were had, indicating wide interest in ARCOP development, including a timeline for program development and how the program could adapt to different licensing strategies and reactor designs. Further engagements are planned to share and solicit feedback on the details of these concepts as they are developed.

CONCLUSION:

The NRC staff plans to develop an oversight program that considers the diversity of advanced reactor technologies, scales to address the expected range of risk profiles of advanced reactor designs and reflects the agency's collective experience from past construction projects. As stated in the Discussion section above, the NRC staff plans to design the ARCOP to be flexible and scalable, with the ability to adapt to a variety of construction and manufacturing models. With the first advanced power reactor construction permit or combined license application possible as early as 2025, the NRC staff is working to develop the ARCOP to meet this timeframe. The NRC staff will continue to engage external stakeholders as it develops ARCOP guidance, consistent with the Principles of Good Regulation.

RESOURCES:

This paper does not address any new commitments or resource implications.

COORDINATION:

The Office of the General Counsel reviewed this Commission paper and has no legal objection.

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SUBJECT: VISION FOR THE NUCLEAR REGULATORY COMMISSION'S ADVANCED REACTOR CONSTRUCTION OVERSIGHT PROGRAM. DATED: June 6, 2023.

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