Planned Approaches and Options for ARCOP Elements

The U.S. Nuclear Regulatory Commission (NRC) staff is developing the Advanced Reactor Construction Oversight Program (ARCOP) to ensure the agency is applying a level of regulatory oversight for facility construction commensurate with the risk posed by the varied technologies proposed for commercial advanced reactors. Development of a risk-informed, performance-based, and scalable ARCOP framework is consistent with Administration priorities discussed in Executive Order (EO) 14300, "Ordering the Reform of the Nuclear Regulatory Commission" (90 FR 22587; May 29, 2025). The ARCOP optimizes the NRC's established oversight framework to provide reasonable assurance that an advanced reactor facility is built and will operate in accordance with its approved design as described in the application, as amended.

The ARCOP builds on experience gained in existing NRC oversight programs, particularly the Construction Reactor Oversight Process (cROP), and will include the essential oversight program elements of performance monitoring, dispositioning findings, including through a risk-informed significance determination process (SDP) and application of the NRC Enforcement Policy, and performance assessment. Within these elements, the staff evaluated various options related to inspection scope and methodology, enforcement in regard to issues identified at project vendor, manufacturer, or licensee facilities, and assessment of the effectiveness of onsite and offsite activities for ensuring quality such that each advanced reactor will be built and operated in accordance with its approved design as described in the application, as amended.

The staff implemented a Be riskSMART[1] framework to inform the program element options and to identify the option that represented the optimal approach for the respective program element. Specifically, the staff clearly identified the issues to address. Then, the staff identified the challenges (i.e., what can go wrong?), opportunities (i.e., what can go right?), and likely consequences associated with the options.

The staff plans to apply step 5 of the Be riskSMART framework by implementing the selected options and measuring performance to evaluate whether the ARCOP remains consistent with the guiding principles described in SECY-23-0048, "Vision for the Nuclear Regulatory Commission's Advanced Reactor Construction Oversight Program," dated June 6, 2023 (Agencywide Documents Access and Management System Accession No. ML23061A086). The staff will measure performance and revise the ARCOP, as necessary, during its annual review, which will resemble the annual review of the Reactor Oversight Process (ROP). For example, the staff will gather data, such as construction inspection hours expended, to ensure that the construction inspection effort is commensurate with the risk posed by the varied technologies proposed for commercial advanced reactors.

The staff solicited input on these options from internal and public stakeholders during a series of public workshops.[2] The staff considered stakeholder feedback when identifying the preferred

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[1] Be riskSMART guidance is in NUREG/KM-0016, "Be riskSMART: Guidance for Integrating Risk Insights into NRC Decisions," issued March 2021.

[2] Sessions 1a and 1b, February 28, and March 20, 2024: Introduction to NRC Advanced Reactor Construction Oversight Process, and the ARCOP Framework (ML24078A063)
Session 2, April 3, 2024: Inspection Scoping (ML24123A214)
Session 3, May 22, 2024: Enforcement and Significance Determination Process (ML24177A120)
Session 4, July 17, 2024: Assessment Tabletop Summary Feedback/Wrap Up (ML24227B033)
Session 5, December 10, 2024: Quality Assurance Program Inspections and Safety Culture (ML25002A037)

approaches to these ARCOP elements. This enclosure summarizes the approaches considered and the preferred approach that is presented in the body of the paper. Additional workshops will be used to gather additional stakeholder feedback on specific guidance in inspection manual chapters (IMCs) and procedures prior to implementation.

1. Inspection Scoping

For inspection scoping, the staff focused on inspections in the quality of reactor plant construction strategic performance area. The inspection scope in the security and safeguards and operational readiness strategic performance areas remains under development. The staff evaluated three options for the scope of advanced reactor manufacturing and construction inspections in the quality of reactor plant construction strategic performance area, while considering the following guiding principles:

- Inspections should verify the advanced reactor plant's ability to fulfill the fundamental safety functions (FSFs) in a risk-informed manner.
- Inspection scoping should be flexible to account for experience gained during inspections (e.g., adjustments from first reactor to Nth reactor).
- Inspections should be results driven and performance based (e.g., be quality focused and prioritize observing performance over other inspection activities).
- The construction inspection program should incorporate efficiency gains using technology-based solutions when available.
- Inspection scoping should be applicable to all advanced reactors licensed pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants" (using Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)); 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (without ITAAC); and the proposed rule for 10 CFR Part 53, "Risk Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors," 89 FR 86918, dated October 31, 2024.
- The NRC should apply the appropriate number of inspections and level of technical expertise to inspecting the quality of systems, structures, and components (SSCs) supporting FSFs.

Option 1.a: Target Specific SSCs and ITAAC

Under this option, an expert panel ranks SSCs and ITAAC in order of safety importance and risk of deficiencies occurring and going undetected and uncorrected before operations. Activities that rank above an established importance threshold are "targeted" for inspection, defining the baseline ITAAC inspections.

Note: This was the inspection scoping method used for inspecting ITAAC of the Advanced Passive 1000 (AP1000) projects.

Pros

- Provides a specific method to identify inspection samples.

- Ensures that the most safety-significant manufacturing and construction activities receive direct inspection.

Cons

- Prescriptive and does not provide for a flexible means to adjust when planned inspections cannot be conducted due to construction schedule changes (AP1000 lesson learned).[3]

- Sometimes results in repetitive inspections of similar activities after licensees have demonstrated consistent work quality in a technical area.

Option 1.b: Baseline Inspection Scoping Matrix

Under this option, an expert panel identifies SSCs, ITAAC, and construction activities that are important to the fulfillment of the FSFs. A matrix is created to define the baseline inspection program, which includes key risk information, and a list of sample opportunities organized into defined inspection areas. Samples are then selected from the list of inspection opportunities in the matrix using a risk-informed, performance-based methodology, like inspection sampling in the ROP.

Pros

- Provides for flexibility to accommodate shifting manufacturing and construction schedules while maintaining focus on the most safety-significant SSCs and ITAAC.

- Allows adjustment of the baseline inspection program based on inspection results without requiring inspection of targeted SSCs and ITAAC.

- Provides an efficient framework for establishing confidence in the quality of different technical areas.

Cons

- Introduces a small degree of subjectivity because inspectors consider different variables when choosing from multiple sample options rather than specifying exactly which SSCs and ITAAC to inspect.

- May not directly inspect an SSC or ITAAC that would have been targeted in Option 1.a.

[3] The “10 CFR Part 52 Construction Lessons-Learned Report,” dated January 16, 2024 (ML23325A202), identifies best practices, suggestions, and recommendations based on lessons learned from construction at Vogtle Electric Generating Plant, Units 3 and 4, and Virgil C. Summer Nuclear Station, Units 2 and 3, under 10 CFR Part 52.

Option 1.c: Inspect Based on Availability

Under this option, the staff would conduct periodic site inspections throughout construction and select inspection samples based on the construction activities occurring during the inspection period.

Pro

- Provides a flexible inspection scoping approach that does not rely heavily on construction schedules.

Cons

- Uses the least specific and risk-informed method of inspection scoping.
- May not result in the most safety-significant activities receiving direct inspection.
- May not provide an adequate basis for a Commission finding under 10 CFR 50.57 or 10 CFR 52.103(g).

Stakeholder Input from Public Workshops

During the initial workshop, some participants sought further clarity on using FSFs and whether inclusion of FSFs in the ARCOP would dictate how a licensee would need to describe the design in its license application. The staff clarified that the ARCOP only uses FSFs to organize the inspection scoping and to understand the safety significance of identified issues in the context of how the design controls reactivity, removes heat, and prevents the release of radionuclides. The staff considered this feedback in future development of inspection guidance to enhance clarity on the purpose of use of FSFs within ARCOP. The staff also further considered that SSCs associated with reactor safety described in license applications will align well with the FSFs based on existing regulatory requirements. Specifically, all construction permit and combined license (COL) applications, regardless of design, are required to identify principal design criteria (PDC) for the proposed facility. For a water-cooled design, the general design criteria (GDC) specified in 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants” set the minimum requirements for the PDC. These GDC are organized by sections, and the GDC associated with reactor safety align well with the FSFs. Regulatory Guide 1.232, “Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors,” discusses how GDC may be adapted for non-light water Reactor (LWR) designs to develop PDC. Like the GDC for LWRs, the non-LWR PDC included in Regulatory Guide 1.232 are well-aligned with the FSFs. The FSFs are also consistent with international standards described in International Atomic Energy Agency Specific Safety Guide 30, “Safety Classification of Structures, Systems and Components in Nuclear Power Plants,” issued May 2014.

Use of FSFs for inspection scoping and significance determination was further explored in subsequent workshops through development of an inspection scoping matrix for a hypothetical plant and screening of hypothetical inspection finding examples. The NRC received no additional comments regarding the focus on FSFs, and many stakeholders expressed support for the proposed methodology.

External stakeholders expressed general support for the proposed methodology of using baseline inspection scoping matrices to appropriately scale the inspection footprint for different designs and did not identify any additional options to be considered. The stakeholders sought further clarity on how the various inspection programs (i.e., ARCOP, Vendor Inspection Program, Fuel Cycle Inspection Program) would overlap and whether scope creep could occur. In later workshops, the staff clarified the differences among project vendors, manufacturers, and traditional supply chain vendors and the means to achieve appropriate separation between the programs to limit or eliminate overlap and ensure an efficient approach. Additionally, stakeholders initially sought clarity on how inspections would focus on implementation of quality assurance processes as opposed to verification of quality assurance outcomes. This topic was further explored with a description of inspection methodologies in latter workshops. The NRC will incorporate specific feedback into the IMCs, as appropriate.

<u>Conclusion and Action</u>

As described in this paper, the staff plans to fully develop Option 1.b, baseline inspection scoping matrix, as the approach to scoping manufacturing and construction inspections. A baseline inspection scoping matrix offers the optimal sampling strategy to ensure efficient use of staff inspection resources and the appropriate focus on safety to provide the information necessary for the Commission's finding under 10 CFR 50.57 or 10 CFR 52.103(g).

2. Options for Enforcement and Significance Determination—Onsite Licensee

The staff evaluated three options for the approach to the enforcement and SDP for findings identified during the inspection of onsite licensee construction activities in the quality of reactor construction strategic performance area, while considering the following guiding principles:

- Determining the significance of findings (including more-than-minor determination) for construction oversight should appropriately characterize finding significance based on risk to operations and should be comparable to risk thresholds in the ROP (see SRM-SECY-10-0140, "Staff Requirements—SECY-10-0140—Options for Revising the Construction Reactor Oversight Process Assessment Program, dated March 21, 2011).

- Determining the significance of findings should not be so complex as to require extensive NRC infrastructure to execute or excessive licensee time and resources to support (AP1000 lesson learned).

<u>Option 2.a: Finding Significance Determined Based on Potential Impact to FSF During Reactor Operations</u>

Under this option, finding significance is assigned based on the potential impact to an FSF during reactor operations using a qualitative SDP applicable to all designs. Finding significance will be represented by the colors green, white, and yellow.

Pros

- Is inherently risk informed and technology inclusive.

- Does not rely on probabilistic risk assessment (PRA) information, which may not be available for some projects at the onset of construction.

- Reduces the likelihood of unnecessarily escalating findings that ultimately are not risk significant (AP1000 lesson learned).

- Compares to risk thresholds in the ROP and the cROP through incorporation of the FSFs into the SDP.

Con

- Does not apply quantitative measures (such as risk achievement worth scores) to inform finding significance.

<u>Option 2.b: Design-Specific SDPs Used to Inform Finding Significance</u>

Under this option, design-specific SDPs, including quantitative measures (such as risk achievement worth scores) when appropriate, are used to inform finding significance.

Note: This method is like the AP1000 SDP.

Pros

- Is similar to risk thresholds in the ROP.

- Is risk informed and technology inclusive.

- Reduces the likelihood of unnecessarily escalating findings that ultimately are not risk significant.

- Compares to risk thresholds in the ROP and the cROP.

Cons

- Relies on PRA information, which may not be available for some projects at the onset of construction.

- Exclusive reliance on PRA information for construction findings' significance determination may result in the NRC and the licensee expending resources for significance determination that are not commensurate with the safety and risk significance of the ITAAC and SSCs because they do not consider other construction-specific factors (AP 1000 lesson learned).

- Requires significant staff resources to develop design-specific SDPs for each licensed advanced reactor design.

<u>Option 2.c: Traditional Enforcement Policy Applied to Determine Significance and Enforcement</u>

Under this option, the staff would use broad categories described in section 6.5 of the NRC Enforcement Policy to disposition construction inspection findings and use those severity levels to determine the NRC response.

Pro

- Implements the traditional NRC Enforcement Policy (ML23333A447).

Con

- This option does not mirror the ROP and in that regard is not completely aligned with Commission direction in SRM-SECY-10-0140.

Stakeholder Input from Public Workshops

Stakeholders expressed support for the development of a qualitative SDP. The workshops identified several potential enhancements to the proposed SDP, which will be considered for incorporation into inspection guidance. The staff recognizes that guidance and training are needed regarding the differences that will be expected for 10 CFR Part 50 versus 10 CFR Part 52 applicants due to the finality of the design expected. The staff also noted that increased clarity is needed to describe how to credit design features that are not subject to construction inspection (e.g., fuel design and manufacturing, which is part of the NRC's vendor inspection program) within the SDP. Stakeholders offered no additional options. The staff will incorporate the feedback into IMCs.

Conclusion and Action

As described in this paper, the staff plans to fully develop Option 2.a, finding significance determined based on the potential impact to FSFs during reactor operations, as the approach to dispositioning inspection findings under the ARCOP. This option incorporates lessons learned from implementation of the AP1000 construction SDP while continuing to focus on the risk to operations through assessing impact on the FSFs and maintains similar risk thresholds to those established in the ROP.

3. Options for Assessment

The staff evaluated the approach to the assessment of the effectiveness of a licensee, permit holder, or manufacturer in ensuring manufacturing and construction quality, while considering the following guiding principles:

- Arrive at an objective assessment of the effectiveness of a licensee, permit holder, or manufacturer in ensuring quality.

- Make timely decisions regarding appropriate agency actions in a predictable, scrutable, and repeatable manner.

- Communicate the staff's assessments of the manufacturing and construction quality of the reactor plant to stakeholders and interested members of the public.

- Support a Commission finding pursuant to 10 CFR 50.57, "Issuance of operating license," or a finding that the acceptance criteria in the ITAAC are met in accordance with 10 CFR 52.103(g).

The ROP and the cROP use an annual assessment period to review licensee performance over a 12-month period. An action matrix for each operating reactor unit and reactor unit under construction specifies the range of NRC and licensee actions and the appropriate level of communication for different levels of licensee performance. Each reactor unit is assigned to a column in its action matrix corresponding to criteria specified for the respective column.

The AP1000 lessons-learned report noted that the cROP used an annual frequency for assessment. Looking forward, small modular reactors and advanced reactors may have shorter construction and manufacturing time frames and, therefore, include faster completion times for structures and systems. The annual assessment frequency is potentially too long for a faster moving project, and as a result, the staff recommends a shorter assessment cycle. Future construction oversight programs should consider a system of more continual assessment, and the public communications associated with them.

Based on this suggestion, the staff plans to implement a continual assessment approach for advanced reactor construction and manufacturing performance. Unlike the cROP, the staff does not plan to conduct midcycle and end-of-cycle reviews for the ARCOP. Instead, the staff will assess performance after each inspection is completed and will make program adjustments as necessary based on the inspection results. The NRC will communicate assessment results to stakeholders in inspection reports.

In addition to this approach to assessment, another area of consideration is adjustment to inspection scope because of licensee or manufacturer performance. The staff considered the following three options to ensure predictable, scrutable, and repeatable agency actions are taken in response to inspection results.

Option 3.a: Traditional Action Matrix Concept for Each Project (Combines Reactor Manufacturers and Applicants or Licensees).

Under this option, inspection findings from the construction site would be combined with findings from the manufacturing facility to provide an overall integrated assessment of the project quality and associated NRC response to quality issues. A single action matrix would be generated for the entire project. The project would be assigned to a column in the action matrix corresponding to the significance of the identified issues.

Pros

- Offers a repeatable and predictable NRC response to declining performance.
- Provides an overall integrated assessment of the project quality and associated NRC response to quality issues.

C*ons*

- Results in multiple entities impacting the action matrix. Traditional implementation of an action matrix in the ROP and the cROP specifies performance and response for one licensee. This may cause confusion as to which entity findings apply.

- Could be conflated with licensee performance such that it could be interpreted that the NRC is holding licensees accountable for activities that occur at an offsite reactor manufacturing facility.

<u>Option 3.b: Traditional Action Matrix Concept for Each Reactor Plant Manufacturer and Licensee or Applicant (Separately)</u>

Under this option, reactor manufacturers and permit or license holders are assessed separately, and a separate action matrix is generated for each permit or licensee and manufacturer involved in the advanced reactor construction project. The staff would then consider the performance of each entity and conduct a combined assessment of project quality to inform decisions on ultimate findings prerequisite to operation. The licensee and applicable manufacturers would be assigned to a column in its respective action matrix corresponding to the significance of the identified issues.

Pros

- Repeatable and predictable NRC response to declining performance.

- Provides an overall integrated assessment of the project quality and associated NRC response to quality issues.

Cons

- There may be multiple reactor manufacturers conducting work in support of multiple advanced reactor construction projects, necessitating multiple action matrices.

- Difficult to understand and implement due to interrelated manufacturer and onsite licensee matrices.

<u>Option 3.c: Finding Response Table Describes Appropriate Responses to Specific Finding Types and Significance</u>

Under this option, the staff would evolve the traditional action matrix by developing a finding response table that specifies the expected NRC, licensee, and manufacturer response based on the significance of inspection findings. This is similar to a traditional action matrix concept, in that it provides a clear and predictable response to licensee and manufacturer performance that manifests itself through safety-significant findings. However, it will differ in that it will focus the response on the singular input to the table and will provide for staff consideration of similar and related findings through implementation of the associated supplemental inspection. The finding response table would be implemented for all advanced reactor construction projects such that the expected response to safety-significant findings is the same for each project.

Pros

- Is relatively simple to understand and implement.
- Does not comingle licensee and manufacturer inspection findings.
- Eliminates the need to conduct quarterly, semiannual, or annual assessment periods to determine the proper NRC response.
- Focuses on the significance of the issue with an appropriately scaled response.
- Is a timely, repeatable, and predictable NRC response to declining performance.

Con

- Differs from implementation under the ROP or the cROP in that licensees are not assigned to an action matrix column (e.g., Regulatory Response Column). Instead, supplemental NRC actions would be initiated in response to risk-significant issues by using individual NRC findings as the response table initiators. (This "con" is at least partially offset by the benefit of a quicker NRC response and a focus on the specific entity (project vendor, manufacturer, or licensee) responsible for the issue of concern.)

<u>Stakeholder Input from Public Workshops</u>

No significant concerns or other assessment options were identified.

In general, participants emphasized that a risk-informed, performance-based approach, like the ROP, should be fundamental to the ARCOP elements of inspection, issue disposition, and assessment. The staff affirmed alignment with this and described that the ARCOP framework is a risk-informed, tiered approach to ensuring advanced reactor construction quality. Within this framework, the ARCOP provides a means to collect information about licensee and manufacturer performance, assess the information for its safety significance, and provide appropriate responses.

<u>Conclusion and Action</u>

As described in this paper, the staff plans to fully develop Option 3.c, in which the finding response table describes appropriate responses to specific finding types and significance and specifies the expected response to safety-significant findings associated with an advanced reactor construction project. As the staff moves from a yearly assessment period to a continual assessment of advanced reactor construction projects, the finding response table will provide the most clear and consistent method for developing timely responses to safety-significant issues.