Technical, Licensing, and Policy Considerations for Nth-of-a-Kind Microreactors

This enclosure discusses various information topics related to the licensing and deployment of nth-of-a-kind (NOAK) microreactors, some of which may be applicable to other new reactors. Some of these are potentially generic topics raised by developers through preapplication engagement with the U.S. Nuclear Regulatory Commission (NRC) staff and in other interactions, such as the periodic Advanced Reactor Stakeholder Meetings organized by the NRC staff. The NRC staff will address design-specific issues on a case-by-case basis.

This enclosure provides the NRC staff's plans for addressing these topics, including how the staff can address them under the existing regulatory framework and potential longer-term approaches. The NRC staff will engage the Commission on any future policy topics concerning NOAK microreactors, including topics related to safety, construction inspection, security, emergency preparedness (EP), and environmental reviews.

The NRC staff recognizes that some topics discussed in this enclosure could be more broadly relevant to the deployment of all types of microreactors, not just NOAK microreactors, and other reactor technologies, such as small modular reactors and larger reactors. Although this enclosure does not explicitly address such situations, the NRC staff will consider opportunities to apply the strategies described in this paper to other reactor technologies, including through further Commission engagement, as appropriate.

1. Maximal Design Standardization in a Manufacturing License or Design Certification

Overview

Microreactor developers and potential applicants have indicated that they intend to pursue deployment of many microreactors of standard designs. Maximizing the standardization of these microreactor designs could play a significant role in shortening the schedules for and reducing the costs of reviewing applications for such reactors, as described below. In the context of the main paper and its enclosures, a maximally standardized microreactor design has the following attributes and characteristics:

- The design is a standard design as defined in Title 10 of the *Code of Federal Regulations* (10 CFR) 52.1, "Definitions," which states, "*Standard design* means a design which is sufficiently detailed and complete to support certification or approval in accordance with subpart B or E of this part, and which is usable for a multiple number of units or at a multiple number of sites without reopening or repeating the review."

- The complete plant design is certified by Commission rule under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," Subpart B, "Standard Design Certifications," or licensed by the Commission under 10 CFR Part 52, Subpart F, "Manufacturing Licenses," via a manufacturing license (ML) or a combination of the two. Under 10 CFR 52.83 and 52.171, design certification (DC) rules and MLs, respectively, finally resolve those matters resolved in connection with the issuance of the design certification rule (DCR) or in the proceeding on the ML application, including the adequacy of the design. (As discussed below, a standard design approval does not provide the same finality as a DCR or ML and therefore does not achieve all the benefits of maximal design standardization, even if the design satisfies the definition of "standard design" in 10 CFR 52.1.)

- The design uses bounding site parameters, including hazard parameters, that would make it suitable for licensing at deployment sites with a variety of site characteristics.[1]

- The design minimizes site-specific design features and interfaces between the reactor and the site (e.g., offsite power or water sources relied upon for safety functions).

- The design of an individual reactor does not include departures from the approved design.[2]

The regulations in 10 CFR Part 52 already require the attributes stated in the first two bullets above in connection with certified designs and manufactured reactors, while DC and ML applicants may choose the extent to which the site parameters encompass greater or lesser numbers of potential locations for reactors. If the number of locations encompassed by the site parameters is maximized, standardization is maximized. Similarly, 10 CFR Part 52 does not require applications to consider the attributes stated in the last two bullets, but they maximize standardization.

The current regulatory framework provides several pathways for microreactor developers to seek approval of a standard design. The regulations in 10 CFR Part 52, Subpart B, set forth the requirements and procedures applicable to Commission issuance of rules granting standard design certifications for nuclear power facilities. As stated in 10 CFR 52.47, "Contents of application; technical information," the application for a standard design certification must, among other things, "contain a level of design information sufficient to enable the Commission to judge the applicant's proposed means of assuring that construction conforms to the design and to reach a final conclusion on all safety questions associated with the design before the certification is granted."

The regulations in 10 CFR Part 52, Subpart E, "Standard Design Approvals," set out procedures for the filing, NRC staff review, and referral to the Advisory Committee on Reactor Safeguards of a standard design for a nuclear power reactor or major portions thereof. As stated in 10 CFR 52.137, "Contents of applications; technical information," the application for a standard design approval "must contain a final safety analysis report that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the structures, systems, and components and of the facility, or major portion thereof." The regulations in 10 CFR 52.137 also state, "If the applicant seeks review of a major portion of a standard design, the application need only contain the information required by this section to the extent the requirements are applicable to the major portion of the standard design for which NRC staff approval is sought."

The regulations in 10 CFR Part 52, Subpart F, set out the requirements and procedures applicable to Commission issuance of a license authorizing manufacture of nuclear power reactors to be installed at sites not identified in the ML application. As stated in 10 CFR 52.157, "Contents of applications; technical information in final safety analysis report," an ML application

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1 The regulations in 10 CFR 52.1 state, "*Site characteristics* are the actual physical, environmental and demographic features of a site. Site characteristics are specified in an early site permit or in a final safety analysis report for a combined license." They also state, "*Site parameters* are the postulated physical, environmental and demographic features of an assumed site. Site parameters are specified in a standard design approval, standard design certification, or manufacturing license."

2 While an applicant may propose departures from the approved design or postulated site parameters at a specific site, such departures would complicate the review of that application.

must, among other things, "contain a final safety analysis report…with a level of design information sufficient to enable the Commission to judge the applicant's proposed means of assuring that the manufacturing conforms to the design and to reach a final conclusion on all safety questions associated with the design."

The regulations in 10 CFR 52.63, "Finality of standard design certifications," 10 CFR 52.145, "Finality of standard design approvals; information requests," and 10 CFR 52.171, "Finality of manufacturing licenses; information requests," specify the finality provisions for these pathways for approval of a standard design. The finality provisions for a DC in 10 CFR 52.63(a)(1) state, in part, that the Commission may not modify, rescind, or impose new requirements on the certification information, whether on its own motion, or in response to a petition from any person, unless the Commission determines in a rulemaking that certain considerations warrant the change. The regulations in 10 CFR 52.63(a)(5) specify that, in general, "in making the findings required for issuance of a combined license, construction permit, operating license, or manufacturing license, or for any hearing under § 52.103, the Commission shall treat as resolved those matters resolved in connection with the issuance or renewal of a design certification rule." The regulations in 10 CFR 52.171(a)(1) and (3) include finality provisions for an ML that are similar to those for a DC.[3]

The finality provisions for standard design approvals in 10 CFR 52.145(a) state, "An approved design must be used by and relied upon by the NRC staff and the [Advisory Committee on Reactor Safeguards (ACRS)] in their review of any individual facility license application that incorporates by reference a standard design approved in accordance with this paragraph unless there exists significant new information that substantially affects the earlier determination or other good cause." This provides less finality than the finality provisions for a DC or ML, which state that in a proceeding for a referencing combined license (COL), the Commission will treat as resolved those matters resolved in a DCR or ML. The NRC staff's reliance on the standard design approval and the substance of the standard design approval are subject to hearings associated with a construction permit (CP)/operating license (OL) application or a COL application that references the standard design approval.

To achieve the maximum benefit of design standardization, applicants for licenses that reference a standardized design should minimize departures or requests for design changes.[4] To achieve that end, using bounding values for site parameters and minimizing site-specific design features and interfaces between the reactor and the site can help avoid the need for departures or changes. This can be accomplished in several ways. One approach would be to incorporate margins and flexibilities in the design characteristics and site parameters in the final safety analysis report describing the approved design and the terms and conditions of the approval (i.e., the DCR or ML) sufficient to bound a large proportion of the prospective locations

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3 In the 2007 final rule amending the regulations in 10 CFR Part 52 (72 FR 49392), the NRC stated, "In light of the NRC's review and approval of a final design as part of issuance of a manufacturing license, the final rule provides a greater degree of finality to a manufacturing license as compared with a standard design certification. Under § 52.171(a)(1), the same degree of issue finality accorded to the 'certified design' applies throughout the term of the manufacturing license."

4 The regulations in 10 CFR 52.63(b) and 10 CFR 52.171(b) include requirements related to departures from the design characteristics, site parameters, terms and conditions, or approved design in a DCR or ML. In general, departures will complicate NOAK licensing proceedings and reduce efficiency by opening matters that were resolved in a DCR or ML and thus expanding the scope of the associated NRC staff review and hearings.

for deployment of the design. Another approach would be to obtain NRC approval for several standardized "models" (or "trim levels") of a similar design, with the design characteristics of each model optimized for a range of site parameters, such as seismicity, atmospheric conditions, or potential external hazards. The terms and conditions of the DCR or ML for each model could also be appropriately tailored to the model's design characteristics and site parameters.

Other regulatory approaches may support design standardization, although they do not provide sufficient finality to ensure maximal design standardization on their own. A first-of-a-kind CP/OL or COL may be referenced in a subsequent application using a design-centered licensing review approach, or it may be used to inform changes to a DCR or ML to increase standardization.[5] A proceeding on a standalone (custom) first-of-a-kind COL or OL application, however, would resolve issues only for a contemporaneous application for an identical design as provided for in 10 CFR Part 2, Subpart D, and 10 CFR Part 50, Appendix N, as discussed below.[6] Topical reports may be used to obtain NRC review of discrete topics that could contribute to standardization, such as analysis methodologies for determining bounding site parameters. The NRC staff review of COL applications involving multiple fixed sites could be standardized by using 10 CFR Part 52, Appendix N, "Standardization of Nuclear Power Plant Designs: Combined Licenses to Construct and Operate Nuclear Power Reactors of Identical Design at Multiple Sites." Appendix N sets out the particular requirements and provisions applicable to situations in which applications for COLs under 10 CFR Part 52, Subpart C, "Combined Licenses," are filed by one or more applicants intending to construct and operate nuclear power reactors of identical design (referred to as a "common design" in 10 CFR Part 52, Appendix N) to be located at multiple sites. The regulations in 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," include an appendix with similar provisions for the CP/OL licensing process.

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Increased standardization is allowed under current regulations and would be consistent with the Commission's Policy Statement on Nuclear Power Plant Standardization, dated September 15, 1987 (52 FR 34884), which preceded the issuance of 10 CFR Part 52 and encouraged standardization to increase plant safety, improve regulatory efficiency, and reduce the complexity and uncertainty of the regulatory process. As discussed in the main paper and this enclosure, the NRC staff intends to leverage design standardization to streamline safety reviews, environmental reviews, operational program approvals, construction inspections, and other regulatory processes. This includes using maximal design standardization in a DCR or ML to reduce the scope of the NRC staff safety review at the COL or CP/OL stage to verification that site characteristics fall within the site parameters specified in the standard design and any other remaining site-specific matters. This is a critical factor in achieving the greatest efficiency gains and shortening licensing timelines. As discussed in SECY-20-0093, "Policy and Licensing Considerations Related to Micro-reactors," dated October 6, 2020 (ML20129J985), the staff is

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5 See Regulatory Issue Summary 2006-06, "New Reactor Standardization Needed to Support the Design-Centered Licensing Review Approach," dated May 31, 2006 (Agencywide Documents Access and Management System Accession (ADAMS) No. ML053540251).

6 Under 10 CFR 50.32 and 52.8(b), an application may reference information in applications, statements, or reports previously filed with the Commission, including the final safety analysis report for a COL or OL that has been issued. While such referencing may simplify the application process and facilitate NRC staff review of a subsequent application referencing a previously docketed final safety analysis report, issuance of a COL or CP and OL does not resolve design issues in a proceeding on a subsequent referencing application.

also receptive to requests for exemptions from the existing regulations that would contribute to standardization and would evaluate such exemptions on an individual basis using existing agency processes. The NRC staff remains committed to using risk insights and performance-based approaches, where justified, to improve regulatory processes. This includes the use of risk-informed techniques in the review of requested licensing actions connected with standard designs and the deployment of microreactors of common standardized designs.

The pursuit of maximal design standardization is voluntary and largely dependent on the choices, deployment models, and licensing strategies of microreactor developers and applicants. The NRC staff recognizes that stakeholders will balance aspects of design standardization, such as conservatism in the design to support bounding site parameters, with economic and operational considerations. In addition, stakeholders have expressed interest in having the flexibility to enhance designs over time, as they gain operational experience with a particular design. The NRC staff can inform developers and individual applicants of the potential regulatory impacts (e.g., available licensing pathways, schedules, and estimated review costs) of certain design decisions and changes to approved standard designs. Developers and applicants will have to weigh the potential benefits of maximal design standardization, such as increased NOAK licensing efficiency and shortened schedules, and make their own decisions.

Next Steps

Maximal design standardization is available to microreactor developers and potential applicants under the current regulatory framework. As stakeholders and the NRC staff gain experience with design standardization and its role in NOAK licensing, the staff will assess whether additional guidance development or rulemaking could further increase efficiency and will communicate with the Commission as appropriate.

The NRC staff will continue to interact with stakeholders on microreactor deployment models and licensing strategies that leverage maximal design standardization. The NRC staff encourages microreactor developers and potential DC and ML applicants to participate in preapplication engagement to foster a common understanding of the potential licensing pathways for approval of a standard design and to address design-specific regulatory matters early. Similarly, the NRC staff encourages preapplication engagement by potential COL and CP/OL applicants that intend to reference a standard design, especially when they may depart from the standard design.

2. Grading the Level of Site Characterization

Overview

Several microreactor developers have communicated that they plan to design microreactors using a set of postulated site parameters[7] that would be bounding for a large majority of potential sites throughout the U.S., so that the reactors can be deployed without the need to customize the designs for each proposed site. In accordance with 10 CFR 52.43, “Relationship

[7] Site parameters are the postulated physical, environmental, and demographic features of an assumed site and are specified in a DC or ML application. Site characteristics are the actual physical, environmental, and demographic features of a site and are specified in a CP or COL application. To avoid the need to customize or reanalyze the design for each site, applicants can choose the site parameter values specified in the DC or ML so that they bound the corresponding site characteristic values for the vast majority of potential sites.

to other subparts," and 10 CFR 52.153, "Relationship to other subparts," an application for a COL or CP may reference a standard design certification or the use of a manufactured nuclear power reactor. Under the existing power reactor regulations, the applicant would need to determine the actual characteristics of the proposed site. Existing guidance identifies methods acceptable to the staff to evaluate the site characteristics.[8] An applicant would need to verify that the site parameter values specified in the DC under 10 CFR 52.47(a)(1) or an ML under 10 CFR 52.157(f)(19) bound the corresponding site characteristic values. Site characterization information for CP or COL applications includes considerations related to human-induced external hazards, meteorology, hydrology, geology, seismology, and geotechnical engineering for a proposed site. The NRC staff anticipates that a graded approach, as described below, can be used for both first-of-a-kind and NOAK CP or COL applications. The graded approach will align the level of the site characterization that needs to be performed at the deployment sites with the safety margins and radiological consequences demonstrated for the approved standard microreactor design. Whether the use of a graded approach will reduce costs or review timeframes depends on the individual site characteristics and characteristics of the design.

The existing siting requirements in 10 CFR Part 100, "Reactor Site Criteria," call for extensive site characterizations and investigations of the actual physical, environmental, and demographic features of a proposed site. Much of the associated regulatory guidance[9] was developed with large light-water reactors (LWRs) in mind. This extensive site characterization is appropriate for large LWRs because they have high thermal power levels, large site footprints, large radionuclide inventories, and complex designs that generally rely on active safety systems, which results in designs that can account for only so much uncertainty in associated site data.

By contrast, microreactors are anticipated to have relatively simple designs, enhanced safety characteristics, and small site footprints. Based on the anticipated enhanced safety margins in these designs, the NRC staff has determined that the extent of data developed for a microreactor could be reduced and the uncertainty in the site data need not be reduced to the level needed for siting a large LWR. Accordingly, a COL or CP applicant referencing a microreactor could use a graded approach to develop the data for site characterization for microreactors of a standard design.[10]

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8 While a site may be acceptable even if one or more site characteristics do not fall within the postulated site parameters, the applicant would need to justify one or more departures from the design described in the DCR or ML under 10 CFR 52.79(d)(1) or (e)(1), respectively, in order to show that the standard design is acceptable to deploy at the proposed site.

9 LWR applicants can use the guidance in Regulatory Guide (RG) 1.206, Revision 1, "Applications for Nuclear Power Plants," issued October 2018 (ML18131A181), and SRP Chapter 2.0, "Site Characteristics and Site Parameters" (https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/ch2/index.html). Although the NRC staff developed RG 1.206 for LWRs, the staff also considers it generally applicable to non-LWRs. Non-LWR applicants implementing the Licensing Modernization Project methodology can use the guidance in RG 1.253, "Guidance for a Technology-Inclusive Content of Application Methodology to Inform the Licensing Basis and Content of Applications for Licenses, Certifications, and Approvals for Non-Light-Water Reactors," issued March 2024 (ML23269A222), DANU-ISG-2022-01, "Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications—Roadmap," issued March 2024 (ML23277A139), and DANU-ISG-2022-02, "Advanced Reactor Content of Application Project, Chapter 2, 'Site Information,'" issued March 2024 (ML23277A140). RG 1.253 also endorses NEI 21-07, Revision 1, "Technology Inclusive Guidance for Non-Light Water Reactors, Safety Analysis Report Content: For Applicants Using the NEI 18-04 Methodology," with clarifications and additions.

10 A designer could choose to lower the cost of the reactor by reducing design margins, and a referencing applicant would then need to reduce the uncertainty in the site data in order to establish that the site characteristics fall within the site parameters set for the DC or manufactured reactor. This could result in the

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In Staff Requirements Memorandum (SRM)-SECY-98-144, "Staff Requirements—SECY-98-144—White Paper on Risk-Informed and Performance-Based Regulation," dated March 1, 1999 (ML24212A161),[11] the Commission approved the issuance of a staff white paper that defined the terms and Commission expectations for risk-informed and performance-based regulation for use by the NRC staff. In its Policy Statement on the Regulation of Advanced Reactors, dated October 14, 2008 (73 FR 60612), the Commission identified numerous attributes that could help the staff establish the acceptability or licensability of a proposed advanced reactor design, including the following:

> Simplified safety systems that, where possible, reduce required operator actions, equipment subjected to severe environmental conditions, and components needed for maintaining safe shutdown conditions. Such simplified systems should facilitate operator comprehension, reliable system function, and more straightforward engineering analysis.

Using concepts from SRM-SECY-98-144 and the Advanced Reactors Policy Statement, and considering the enhanced safety characteristics anticipated in microreactor designs, the NRC staff plans to develop guidance for a graded approach to site characterization for microreactors of a standard design. This graded approach would ensure safety while increasing the efficiency of the staff safety reviews of deployment sites. For the graded approach to be effective, the applicant must be committed to maximal standardization.

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applicant referencing a microreactor design being in the same position as an LLWR applicant with respect to site characterization data.

11 Item 8, "Risk-Informed, Performance-Based Approach," in SRM-SECY-98-144 combines risk-informed and performance-based as applied to NRC activities to use considerations such as risk insights, engineering analysis and judgement, and performance history to focus on the most important activities, establish objective performance evaluation criteria and measurable monitoring systems and performance parameters, provide flexibility in determining these criteria and focus on the results as the basis for regulatory decisions.

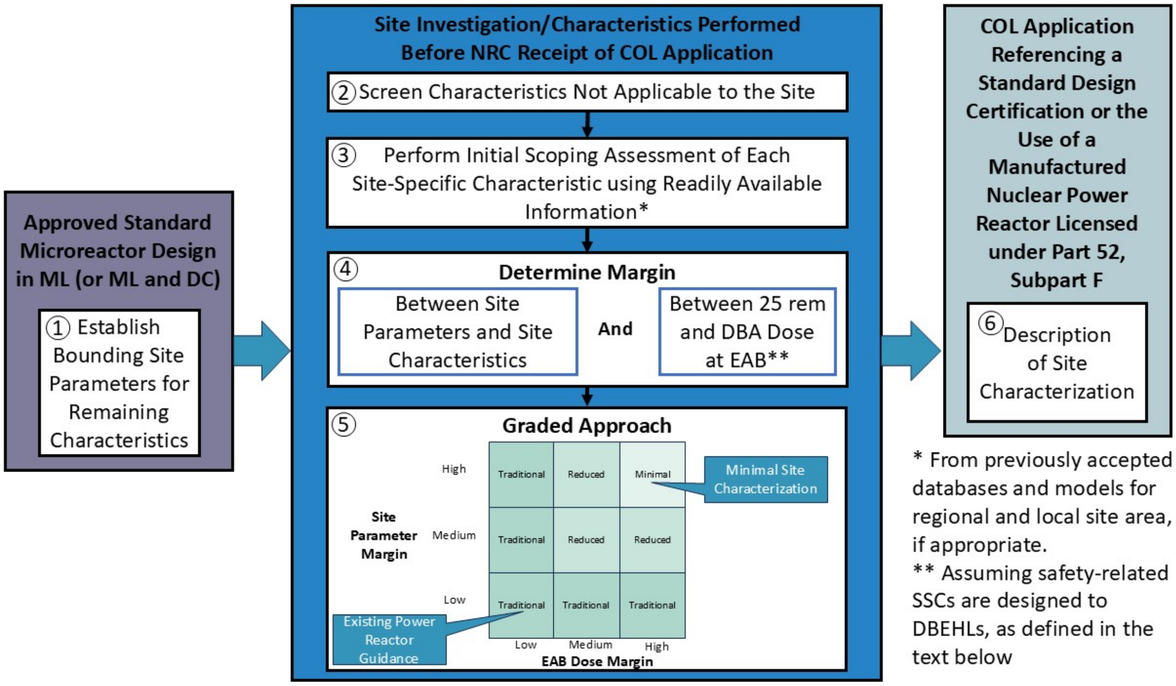

Figure 1 Conceptual approach for grading the level of site investigation and characterization

Figure 1 presents a conceptual approach for grading the level of site investigation and characterization that would need to be performed at the deployment site for microreactors of a standard design. Starting at box 1, the standard microreactor design with maximal standardization would be approved in an ML or DCR that includes a set of postulated site parameters that would be bounding for a large majority of potential sites throughout the U.S., without the need to customize the design for each proposed site. The design of the safety-related structures, systems, and components (SSCs) would account for the design-basis external hazard levels (DBEHLs) associated with the set of postulated bounding site parameters. As part of an ML or DC application, the designer or applicant would assess each site characteristic to determine the minimum postulated site parameter for each characteristic. For site characteristics that do not affect the design or operation of the microreactor (e.g. high winds may not affect a buried reactor) or for sites at which the characteristic is not present (e.g., tsunami at a midcontinental site), the site investigation could be graded to minimal. In these cases, an explanation based on readily available site characterization information could be acceptable for hazards with less prescriptive regulatory requirements and could obviate the need for exemption request reviews. For hazards with more prescriptive regulatory requirements (e.g. seismic hazards under 10 CFR 100.23, “Geologic and seismic siting criteria”), the applicant will need to provide sufficient information to meet the regulatory requirement or may request an exemption. For site characteristics that are material to the adequacy of the design at the selected site, the applicant could apply the graded approach to site characterization as shown in Figure 1 and described as follows.

A COL or CP applicant that references a certified design or the use of a reactor manufactured under an ML would assess the deployment site as shown in Figure 1, box 2 to identify any site characteristics that are not applicable to the site (e.g., sites located far from a body of water would not be subject to seiche[12]). The remaining steps in boxes 3 to 5 would then be conducted for one site characteristic at a time. As shown in box 3, the applicant would select the first site characteristic and perform an initial assessment using readily available information to determine the actual site characteristic value at the proposed deployment site. The applicant could use information from previously accepted databases or models for regional and local site area characteristics, as appropriate, including uncertainties. As shown in box 4, the applicant would then determine the amount of margin (1) between the site parameter value approved in the standard microreactor design and the actual site characteristic value at the proposed deployment site, and (2) between the doses calculated for the postulated design-basis accidents (DBAs) at the boundary of the exclusion area as compared to the associated 25-rem dose reference value in 10 CFR 50.34, "Contents of applications; technical information." As shown in box 5, the applicant would then use an NRC-approved graded approach matrix (presented conceptually in figure 1 for the purposes of this discussion) to assess the margins and identify whether to use a traditional, reduced, or minimal level of site characterization for the selected site characteristic. The applicant would then complete the steps in boxes 3 to 5 for each of the remaining site characteristics.

The graded approach to site characterization illustrated in Figure 1 and described here is a conceptual plan that will be expanded upon in a formal guidance document. In developing guidance that provides an NRC-approved graded approach matrix, the NRC staff plans to assess how to appropriately apply the graded approach for each site characteristic. The NRC staff also plans to develop appropriate values to define what is considered low, medium, and high for site parameter margins and exclusion area boundary dose margins. In addition, the NRC staff plans to define the types and extent of information that would be sufficient to establish the reduced and minimal levels of site characterization in the graded approach. The NRC staff is considering whether minimal site characterization could rely on the readily available information used during the initial site assessment step (box 3 of Figure 1). In addition, depending on the specific site selected and the amount of margin between each site parameter used in the design and the corresponding site characteristic, the NRC staff is considering whether minimal site characterization could be used for all site characteristics at a low-hazard site. Conversely, if the selected site presents a high hazard in relation to a particular site characteristic, then the applicant may need to perform a traditional level of site characterization for that characteristic, possibly while performing a reduced or minimal level of site characterization for other site characteristics.

As shown in box 6, once all the site characteristic values have been determined, among other things, the applicant will submit the COL (or CP) application (referencing a standard design certification or the use of a reactor manufactured under an ML, which may also reference a DCR) to the NRC for review. The COL (or CP) application would include a description of and basis for (1) any site characteristics that are not present at the site, (2) the actual site characteristic values, (3) the margins between the site parameters and the site characteristics, and (4) the level of site characterization performed for each site characteristic.

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12 Potentially acceptable documentation in the CP or COL application could state, "The site is located XX miles/kilometers from the nearest body of water and is not subject to seiche, therefore the site characteristic falls within the site parameter."

Regulations and Guidance

The requirements related to siting of nuclear power reactors appear in 10 CFR Part 100, 10 CFR Part 50, and 10 CFR Part 52.

The regulations in 10 CFR 100.20, "Factors to be considered when evaluating sites," identify the factors that the NRC will take into consideration in determining the acceptability of a site for a stationary power reactor. The regulations in 10 CFR 100.21, "Non-seismic site criteria," identify the criteria that applicants need to demonstrate are met to obtain site approval for commercial power reactors. The regulations in 10 CFR 100.23 identify the principal geologic and seismic siting criteria that the NRC will consider in evaluating the suitability of a proposed site and the adequacy of the design bases.

The regulations in 10 CFR 100.20(c) and 10 CFR 100.21(d) require the applicant to evaluate the physical characteristics of the site, including its seismology, meteorology, geology, and hydrology, and to establish site characteristics such that potential threats from the physical characteristics will pose no undue risk to the proposed facility. The regulations in 10 CFR 100.21(c) require the applicant to evaluate site atmospheric dispersion characteristics to verify that normal effluent release limits and postulated accident dose reference values can be met. The regulations in 10 CFR 100.23(c) require the applicant to investigate the geologic, seismic, and engineering characteristics of the site and its environs in sufficient scope and detail to permit an adequate evaluation of the proposed site; support estimates of the safe-shutdown earthquake (SSE) ground motion; and permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. All geologic and seismic factors that may affect the design and operation of the proposed plant must be investigated, whether or not they are mentioned explicitly (e.g., volcanic activity). The regulations in 10 CFR 100.23(d) state that the geologic and seismic siting factors to be considered include the SSE ground motion for the site (including any uncertainties in its derivation), the potential for surface tectonic and nontectonic deformations, the design bases for seismically induced floods and water waves, and other design conditions, such as soil and rock stability, liquefaction potential, natural and artificial slope stability, and remote safety-related structure siting.

The regulations in 10 CFR Part 50 and 10 CFR Part 52, which address the design of nuclear reactors, require the applicant to consider the site criteria of 10 CFR Part 100 in determining whether the proposed facility can be constructed and operated at the proposed site location without undue risk to public health and safety. Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50 contains the general design criteria (GDC), which establish the minimum requirements for the principal design criteria (PDC) for LWRs.[13] GDC 2, "Design bases for protection against natural phenomena," requires that SSCs important to safety be designed to withstand the effects of expected natural phenomena, with appropriate combinations of the effects of normal and accident conditions, without loss of capability to perform their safety functions. Criteria for implementing GDC 2 in regard to earthquake engineering design appear in Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50, which, among other things, defines the minimum SSE ground motion for design.

[13] The GDC are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance for establishing the PDC for such units. RG 1.232, "Developing Principal Design Criteria for Non-Light Water Reactors," issued April 2018 (ML17325A611), provides guidance for establishing PDC for non-LWRs and includes PDC for non-LWR technologies that are the same as GDC 2.

Chapter 2.0 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP),[14] instructs the staff to verify that the appropriate actual site characteristics are identified at the proposed site for early site permit and COL applications submitted under 10 CFR Part 52. In Revision 3 of the SRP, issued March 2007, Sections 2.1.1 through Section 2.1.3; Sections 2.2.1 and 2.2.2; and Section 2.2.3 provide guidance to the staff on population density and human-induced external hazards, including hazards from nearby facilities in the site vicinity. Section 2.3.1 through Section 2.3.5 provide guidance to the staff on meteorological considerations, including regional climatology, local meteorology, onsite meteorological monitoring, and atmospheric dispersion estimates. Section 2.4.1 through Section 2.4.12 provide guidance to the staff on hydrological considerations, including flood-causing mechanisms such as riverine flooding, upstream dam failure, local intense precipitation, tsunami, storm surge, seiche, ice dams and jams, channel migration, and ground water. In SRP Revision 5, issued July 2014, Section 2.5.1 through Section 2.5.5 provide guidance to the staff on geological and seismological considerations, including regional, local, and onsite geologic and seismological hazards.

Many NRC regulatory guides (RGs) are applicable to site characterization. The NRC maintains numerous hazard-specific RGs that discuss how to meet the applicable regulatory requirements; these RGs are a useful starting point for applicants considering how to use a graded approach in preparing CP or COL applications for a standard microreactor design. Other relevant RGs include the following:

- RG 1.206, Revision 1 applies to LWR technology, but is also generally applicable to other types of power reactors (i.e., non-LWRs).

- RG 4.7, Revision 4, "General Site Suitability Criteria for Nuclear Power Stations," issued February 2024 (ML23348A082), provides guidance to applicants on meeting the requirements in 10 CFR Part 100 for major site characteristics.

- RG 1.253, DANU-ISG-2022-01, and DANU-ISG-2022-02 provide site characterization guidance to non-LWR applicants implementing the Licensing Modernization Project methodology described in the Nuclear Energy Institute (NEI) report NEI 18-04, "Risk-Informed Performance-Based Guidance for Non-Light Water Reactor Licensing Basis Development," issued August 2019 (ML19241A472), as endorsed, with clarifications, in RG 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," issued June 2020 (ML20091L698).

- RG 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," issued March 2007 (ML070310619), references the American Society of Civil Engineers (ASCE) standard ASCE 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities," for determining the site-specific SSE or ground motion response spectra.[15]

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14 All sections of the SRP referenced in this information topic are available at https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0800/index.html

15 The NRC staff is updating RG 1.208 and plans to endorse the American Nuclear Society (ANS) standards ANS 2.27-2020, "Criteria for Investigations of Nuclear Facility Sites for Seismic Hazard Assessments," and ANS 2.29-2020, "Probabilistic Seismic Hazard Analysis," to provide for a graded approach to site

The NRC staff has already considered ways to appropriately scale site characterization information for advanced reactors with smaller radiological risk profiles than large LWRs. An important example is the graded siting approach for seismic hazard characterization referred to as Senior Seismic Hazard Analysis Committee (SSHAC), which staff identified as acceptable for meeting NRC requirements as explained in RG 1.208. Other examples are the incorporation of engineering judgment in the assessment of volcanic and flooding hazards (see RG 4.26, "Volcanic Hazards Assessment for Proposed Nuclear Power Reactor Sites," issued August 2023 (ML23167A078), and DG-1290 (proposed RG 1.59, Revision 3), "Design-Basis Floods for Nuclear Power Plants," issued July 2024 (ML23320A025)). The approach outlined in RG 4.26 allows an applicant to determine a maximum-magnitude hazard and then consider the effect of that hazard on its specific reactor design. The approach proposed in DG-1290, Appendix K, if it becomes effective, would be similar. The graded approach for standard microreactor designs will similarly consider alternative strategies for site characterization, such as those used for facilities with lower risk profiles (e.g., research reactors). The NRC staff will also consider how a graded approach could be applied for a microreactor of a standard design to be installed and operated at a site that has undergone a previous site characterization study, such as the site of an existing microreactor or other NRC-licensed facility.

Exemptions

Based on an initial examination of the current regulations, the NRC staff does not anticipate that exemptions will normally be needed to implement a graded approach to site characterization for microreactors of a standard design. In general, the requirements in 10 CFR 100.20 and 10 CFR 100.21 are largely performance based and may usually be implemented using the graded approach. The NRC staff will further assess how to apply a graded approach to site characterization and the potential need for exemptions for more prescriptive regulatory requirements, such as 10 CFR 100.20(c)(3) and 10 CFR 100.23, as it develops guidance on the graded approach. For example, 10 CFR 100.20(c)(3) states that factors important to hydrological radionuclide transport "must be obtained from on-site measurements." In addition, 10 CFR 100.23(c) requires investigations of "sufficient scope and detail" to determine the subsurface soil and rock properties and the geological characteristics of local and regional faults to determine the SSE ground motion for the site. The NRC staff will also assess whether the implementation of the relevant guidance for the current operating fleet sheds any light on how the agency interprets the siting regulations.

investigation and seismic hazard characterization. This activity is not yet complete. Prospective applicants that wish to use these standards before the issuance of the revision to RG 1.208 should discuss their plans with the NRC staff during the preapplication phase.

Next Steps

The NRC staff plans to develop guidance for a graded approach to site characterization for microreactors of a standard design. This guidance will align the level of the site characterization to be performed at each deployment site with the safety margins and radiological consequences demonstrated for the standard microreactor design found acceptable by the NRC. The NRC staff discussed this topic with external stakeholders at periodic Advanced Reactor Stakeholder Meetings and with the ACRS and determined that stakeholder feedback received (such as the use of publicly available, reliable data sources to inform site characterization in lieu of site data collection) can be dispositioned during development of guidance on grading the level of site characterization.

3. Deployment Site Emergency Preparedness

Overview

In accordance with 10 CFR 50.47, “Emergency plans,” the NRC will issue an early site permit that includes complete and integrated emergency plans under 10 CFR 52.17(b)(2)(ii), an OL, or a COL after the agency has made a finding of reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Whether using 10 CFR 50.47(b) together with Appendix E, “Emergency Planning and Preparedness for Production and Utilization Facilities,” to 10 CFR Part 50, or using 10 CFR 50.160, “Emergency preparedness for small modular reactors, non-light-water reactors, and non-power production or utilization facilities,” the applicant must conduct an initial exercise to demonstrate its ability to implement its emergency plan within 2 years before the issuance of an OL for the facility described in the license application for 10 CFR Part 50, or within 2 years before the scheduled date of initial fuel load for a COL issued under 10 CFR Part 52. For COL applicants under 10 CFR Part 52, 10 CFR 52.97(b) states that the site-specific COL requirements will identify the inspections, tests, and analyses, including those applicable to emergency planning, that the licensee must perform, as well as the acceptance criteria that, if met, will be necessary and sufficient to provide reasonable assurance that the facility has been constructed and will be operated in conformity with the license, the provisions of the Atomic Energy Act of 1954, as amended (AEA), and the Commission’s rules and regulations.

Guidance

The NRC employs a graded approach to EP in which requirements are set commensurate with the radiological risks and hazards posed by the facility. Microreactor applicants can use this risk-informed approach to establish emergency plans and emergency response capabilities. RG 1.242, “Performance-Based Emergency Preparedness for Small Modular Reactors, Non-Light-Water Reactors, and Non-Power Production or Utilization Facilities,” issued November 2023 (ML23226A036), provides guidance for applicants using a risk-informed, performance-based, and technology-inclusive approach to comply with 10 CFR 50.160.

The staff developed RG 1.242 to be technology inclusive and to allow for the development of specific methods for complying with EP regulations for different designs. Based on the current understanding of microreactor design characteristics and available source term information, the staff is developing specific guidance for microreactor licensing—for example, guidance on microreactor specific sizing of emergency planning zones (EPZ). The staff plans to incorporate guidance on standard approaches to EP for microreactors into a revision of RG 1.242. Consistent with the EP discussion in enclosure 1, the staff is assessing ways to increase efficiency in its reviews for microreactor technologies and standard EP approvals at the DC and ML stages. The NRC staff is also developing interim staff guidance for emergency plan reviews that will promote consistency and predictability in technical staff reviews for applicants complying with 10 CFR 50.160.

Emergency Plan Implementing Procedures

Some elements of emergency planning have associated licensing milestones that need to be considered when developing licensing strategies for NOAK microreactors. For example, section V, “Implementing Procedures,” of Appendix E to 10 CFR Part 50 requires detailed emergency plan implementing procedures (EPIPs) to be submitted no less than 180 days before the scheduled issuance of an OL or the scheduled date for initial fuel loading for a COL under 10 CFR Part 52. While the EPIPs do not require NRC approval, the timing for submittal of detailed procedures could affect licensing schedules for some microreactor applicants. To minimize delays, the NRC could review standardized detailed EPIPs that include placeholders for site-specific information for NOAK applicants.

Use of 10 CFR 50.47(b) and 10 CFR 50.33(g)(1)

Applicants may choose to comply with 10 CFR 50.47(b) and Appendix E to 10 CFR Part 50, instead of 10 CFR 50.160, and seek exemptions from certain requirements based on differences in design characteristics that significantly reduce radiological risks compared to large LWRs. If multiple applicants indicate that they intend to take this approach, the NRC staff would evaluate whether there is a need to develop guidance to allow for more efficient exemption request reviews. Such guidance could be analogous to that of NSIR/DPR-ISG-02, “Emergency Planning Exemption Requests for Decommissioning Nuclear Power Plants,” dated May 11, 2015 (ML14106A057), which was issued to collect the staff experience in reviewing exemption requests for EP for decommissioning plants and provide for the consistency of reviews.

Next Steps

The NRC staff is developing interim staff guidance and updating RG 1.242 for the review of applications under 10 CFR 50.160. As appropriate, the staff will develop and issue additional risk-informed guidance and strategies that are specific to the application of 10 CFR 50.160 or 10 CFR 50.47(b) and 10 CFR Part 50, Appendix E, and that could be employed to increase the efficiency of licensing and oversight for microreactors and multiple reactor deployment models.

To support these efforts, the staff is conducting limited research to identify bounding approaches that could enable standardized EP approvals for microreactors. The staff will engage with stakeholders and seek public comment to understand potential deployment scenarios and EP concerns and to identify ways to enhance the efficiency of EP approvals for NOAK deployment.

4. Deployment Site Security

Overview

The security programs that apply to nuclear power plant applicants and licensees are specified in 10 CFR 73.55, “Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage." Enclosure 1 gives a high-level overview of several security programs.

A nuclear power plant applicant or licensee may seek an exemption from or an alternative measure to one or more of the physical security requirements in 10 CFR 73.55. The process for doing so is described in 10 CFR 73.5, "Specific exemptions," and 10 CFR 73.55(r), respectively. In either case, the applicant or licensee must obtain NRC approval before departing from the regulations. Barring exigent or emergency circumstances, the process may take a year or longer to complete.

As the nuclear industry is exploring new reactor designs, the NRC is developing rulemakings to address the technological advancements associated with those designs. Two proposed rules are "Alternative Physical Security Requirements for Advanced Reactors; Proposed Rule," issued August 9, 2024 (89 FR 65226), which would allow small modular reactor and advanced reactor applicants to implement alternative approaches to certain physical security requirements, and "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors; Proposed Rule," issued October 31, 2024 (89 FR 86918), a rulemaking directed by the Nuclear Energy Innovation and Modernization Act that would create an optional licensing framework for all new reactor applicants under a new 10 CFR Part 53, "Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors."

One regulation proposed for consideration as part of 10 CFR Part 53, 10 CFR 53.860(a)(2), states that a licensee must comply with the proposed regulations in 10 CFR 73.100, "Technology neutral requirements for physical protection of licensed activities at advanced nuclear plants against radiological sabotage," also part of the 10 CFR Part 53 rulemaking, unless the licensee demonstrates that the radiological consequences from a design-basis threat-initiated event would result in offsite doses below the reference dose values stated in proposed 10 CFR 53.210, "Safety criteria for design basis accidents." To make this demonstration, the analysis would have to assume that licensee mitigation and recovery actions, including any operator action, are unavailable or ineffective. Additionally, under this proposed approach, should an applicant for a commercial nuclear reactor license demonstrate, pursuant to proposed 10 CFR 53.860(a)(2)(i), that an offsite release would not exceed the reference dose values defined in the safety criteria of 10 CFR 53.210, the applicant could implement the access authorization program requirements under proposed 10 CFR 73.120, "Access authorization programs for commercial nuclear power plants," instead of those under 10 CFR 73.55 or 10 CFR 73.100, 10 CFR 73.56, "Personnel access authorization requirements for nuclear power plants," and 10 CFR 73.57, "Requirements for criminal history records checks of individuals granted unescorted access to a nuclear power facility, a non-power reactor, or access to Safeguards Information." If the applicant could not meet the reference radiological dose values for an offsite release, the applicant would be required to implement a full access authorization program, including an insider mitigation program, as required in 10 CFR 73.55 or 10 CFR 73.100, 10 CFR 73.56 and 10 CFR 73.57.

Other requirements to consider are those of 10 CFR 50.34(a)(1)(ii), which states that a CP application must include a preliminary safety analysis report containing, among other information, "[a] description and safety assessment of the site on which the facility is to be located, with appropriate attention to features affecting facility design. Special attention should be directed to the site evaluation factors identified in [10 CFR Part 100]." In particular, 10 CFR 100.21(f) states, "Site characteristics must be such that adequate security plans and measures can be developed." The requirements in 10 CFR 52.17(a)(1)(x) state that an ESP applicant must also submit "[i]nformation demonstrating that site characteristics are such that adequate security plans and measures can be developed." To aid in streamlining reviews, the NOAK microreactor would have to be deployed at a site with characteristics that fall within the site parameters specified in a certified design or an ML, so no alterations of the security plan would be required.

Additionally, as stated in 10 CFR 52.97(b), the COL will identify inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient, when successfully completed or met by the licensee, to provide reasonable assurance that the facility has been constructed and will operate in conformity with the COL, the provisions of the AEA, and the Commission's rules and regulations. ITAAC as described above are not requirements for an OL under 10 CFR Part 50. The NRC staff will need to verify the completion of ITAAC with regard to the security design to make a finding under 10 CFR 52.103(g), or to verify substantial completion of construction for issuance of an OL under 10 CFR 50.56, "Conversion of construction permit to license; or amendment of license," and 10 CFR 50.57(a)(1).

NOAK Strategy

Once the NRC staff has reviewed and the Commission has approved security plans for a first-of-a-kind microreactor design, the reviews of NOAK microreactor applications may be streamlined. However, if, in reviewing the security plans for a NOAK microreactor, the NRC staff discovers any changes from the previously approved first-of-a-kind security plans, then it would need to assess the impact of those changes, increasing the scope of the NRC staff's review. Any changes made to the design of the reactor by the manufacturer (e.g., an increase in the design thermal power of the reactor) could increase the risk profile of the facility, requiring corresponding changes in the physical security plans. When reviewing a COL application for a first-of-a-kind microreactor, the NRC staff will review all significant security parameters, including site-specific considerations, that are relevant to standardization. The first-of-a-kind microreactor COL review can then be used to inform NRC reviews for follow-on NOAK microreactor applications.

The quality of the applicant's proposed description of its operational programs, including its security plans, is critical to the overall efficiency, cost, and timeline of a NOAK microreactor licensing review. Efficiency can be increased by standardizing security protocols.

The NRC staff also notes that if the first-of-a-kind reactor design process incorporates security considerations up front, addressing potential security concerns during the design phase, then less work will be needed to establish security plans for the follow-on NOAK microreactor designs. Such early consideration of security in the design process may lower the ongoing costs of security for NOAK facilities. However, use of this strategy poses certain challenges.

Special Nuclear Material

The NRC staff anticipates that most advanced reactors will use special nuclear material (SNM) of moderate strategic significance (Category II), as defined in 10 CFR 73.2, "Definitions." The physical security regulations for Category II material have not been updated since 1979 and do not address the current threat environment. Therefore, the NRC has dealt with Category II physical security on a case-by-case basis. The staff will continue its practice of evaluating the need for additional security requirements for SNM using a risk-informed analysis.

Next Steps

The NRC staff is continuing to update the regulatory framework for security. For example, the NRC staff is working on approaches to address SNM concerns to increase regulatory certainty in relation to the physical security of Category II SNM facilities.

5. Streamlined Licensing Process

Overview

Microreactor stakeholders have indicated that widespread deployment of microreactors could result in hundreds of license applications being submitted to the NRC for review and approval over the next decade and beyond. Submission and processing of applications for commercial nuclear power reactors are information-intensive activities that involve many administrative steps in addition to the NRC staff's safety and environmental reviews.[16] In the past, most CP/OL and COL applications have been for custom designs, and the NRC staff's practice has been to create the licensing documents for each application submitted under 10 CFR Part 50 or 10 CFR Part 52 as the processing and review of the application proceeds.

Submissions required of applicants in connection with the CP/OL and COL licensing processes typically include the following:

- application, including the final safety analysis report
- supplemental information (e.g., applicant responses to NRC staff requests for additional information)
- for a COL, notification of scheduled date for initial fuel loading
- for a COL, notifications related to ITAAC
- hearing-related information

The NRC staff processes each application in accordance with the administrative procedures required by the AEA and the relevant regulations and performs the verifications and reviews necessary to make the required determinations about protection of public health and safety and the common defense and security. The current regulatory framework requires the NRC staff to produce many documents throughout the CP/OL and COL licensing processes; these typically include the following:

- licensing documents:
  - NRC staff safety evaluation
  - NRC staff environmental review and record of decision
  - letter report of the ACRS
  - CP
  - OL
  - COL
  - technical specifications

16 This information topic is focused on the safety aspects of licensing. Enclosure 2 on alternative environmental reviews focuses on the environmental aspects of licensing. Although this paper discussed the safety and environmental aspects of licensing separately, NRC safety and environmental reviews would likely be performed in parallel in a coordinated manner under the proposed licensing approach.

- *Federal Register* notices:

  - notice of acceptability for docketing and availability of the application
  - notice of mandatory hearing
  - notice of opportunity to request a hearing
  - notices related to NRC National Environmental Policy Act (NEPA) documents
  - notice of issuance of a CP, OL, or COL
  - notice of the NRC staff's determination of the successful completion of inspections, tests, and analyses (for a COL)
  - notice of intended operation required by 10 CFR 52.103(a) (for a COL)
  - notice of a finding that the acceptance criteria in a COL are met
  - notices required by AEA section 182c.[17]

NOAK Strategy

The NRC staff's strategy for efficient processing of many CP/OL or COL applications referencing a certified standard microreactor design or a manufactured microreactor incorporates the use of three main tools: design-specific templates for the contents of applications, an online system for application submission and processing, and automated licensing document templates. The objective of this strategy is to leverage technology and standardization to automate the maximum number of processes that the NRC staff currently performs manually, so that the staff's review can be focused on site-specific matters and new information not approved in the proceeding on the DCR or ML for the reactor design referenced in the application. Specifically, the system would transcribe data in the application, e.g., the name of the applicant and the location proposed for the reactor, into documents such as *Federal Register* notices and the like. The templates would not be used to generate the substance of safety evaluation reports. This approach will be most beneficial for applications that reference a common maximally standardized design (i.e., a certified design or manufactured reactor without application-specific departures) and previously approved standardized operational programs. The cumulative benefits will scale with the number of applications. The NRC staff anticipates that the use of the strategy described will significantly reduce the resources needed to process a NOAK license application (not including the upfront cost of establishing the application template), compared to the resources typically needed to process one-of-a-kind applications.

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17 Section 182c. of the AEA states the following:

> The Commission shall not issue any license under section 103 for a utilization or production facility for the generation of commercial power until it has given notice in writing to such regulatory agency as may have jurisdiction over the rates and services incident to the proposed activity; until it has published notice of the application in such trade or news publications as the Commission deems appropriate to give reasonable notice to municipalities, private utilities, public bodies, and cooperatives which might have a potential interest in such utilization or production facility; and until it has published notice of such application once each week for four consecutive weeks in the Federal Register, and until four weeks after the last notice.

The first element of the strategy is as follows. A DC or ML applicant, a DC sponsor, or an ML holder would request NRC adoption of a design-specific template for the standard contents of an application for a COL or CP/OL for a reactor that references the certified design or the manufactured reactor. This could be done in parallel with the DC or ML proceeding, through a topical report, or using another appropriate vehicle. Alternately, a prospective applicant that intends to apply for many licenses referencing a common standard design could develop the template as a topical report. The NRC staff would review the template and the proposed standard technical contents to verify that they encompass all of the information that the staff would need to make the necessary findings on the adequacy of a NOAK application. The template would include placeholders for site- and applicant-specific information, including but not limited to information on the reactor location and site characteristics, external hazards, onsite construction, operational programs, decommissioning planning, design information not resolved in the DCR or ML, and other site-specific information, such as information to meet emergency preparedness requirements.

The second element of the strategy is an online system through which each applicant would submit the application and subsequent information, and which the NRC staff would use to process the application. The system would allow applicants to register and provide much of the applicant-specific information required by regulations such as 10 CFR 50.33. The design-specific template for the standard contents of an application would be used to generate an electronic application form. This form could include fields for the necessary information, which could be checked automatically by the system to verify that it met certain criteria, such as being within bounding values approved in the referenced DCR or ML. The form would also request information, such as site characterization information, necessary for the NRC staff to perform its independent reviews and verifications. The system could also prompt combined license holders to provide additional information needed by the NRC related to obtaining an authorization to operate the reactor, such as information related to the ITAAC notifications required by 10 CFR 52.99, "Inspection during construction." The system would include features to satisfy existing requirements for filing applications, such as electronic signatures, oaths or affirmations, and requests to withhold proprietary information from public disclosure.

The online system would increase efficiency by automating many administrative functions, serving as a centralized hub for the safety review, and streamlining the review and issuance of licensing documents. Upon submission of an application, the system could automatically check that the application was complete (i.e., that all fields contained valid values), assign a docket number, and create consolidated public and nonpublic versions of the application. The system would generate, but not immediately issue, the notice of acceptability for docketing and the notice of mandatory hearing using the automated templates described below (as the third element of the staff's strategy). The NRC staff would perform quality checks and route the documents for necessary management and legal reviews, after which the system would be used to distribute the application and send the notices to the *Federal Register* for publication.[18] The system would populate the template for the NRC staff safety evaluation with information specific to the applicant and the referenced common standard design, and it would notify assigned NRC staff reviewers. Similarly, the system would generate and populate other licensing documents, such as the license and required *Federal Register* notices, using information from the applicant's system registration, the application, any supplements provided by the applicant, and

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[18] Although this paper does not detail the NRC's internal processes for management and legal review, the staff would assess these processes and adjust them as appropriate to avoid unnecessary repetition in the reviews of what are anticipated to be numerous nearly identical applications for microreactors of a common design.

the NRC staff safety evaluation. All information related to the processing of the application would be centrally stored and thus available for automatic propagation throughout licensing documents as the review proceeds.

The third element of the strategy is the use of automated templates for NRC licensing documents. In this context, automation refers to the ability of the online system to automatically populate templates with information stored in the system. The NRC staff anticipates that these templates could largely be prepared generically, to apply to all microreactor applications referencing common maximally standardized designs. Some templates, such as the one for the NRC staff safety evaluation, would likely be tailored to each specific design. Also, the suite of templates would need to be tailored to the means of approval of the standard design (DC or ML) and to the licensing pathway for deployment of the reactor (CP/OL or COL). In developing the templates, the NRC staff would maximize the use of standardized language to support the inclusion of design- and applicant-specific information without the need for lengthy custom narrative descriptions. The goal would be to reduce the resources needed for the NRC staff's documentation of its safety review and for the required management and legal reviews. This approach would necessarily involve great attention to detail in the creation of the first-of-a-kind licensing documents that would form the basis for the templates. The system would need to allow the staff to promptly correct any errors identified in the templates yet prevent unauthorized access to them.

The strategy for streamlined processing of applications and licensing documents described under this information topic would provide a way to address part of the direction in section 208(b)(2)–(4) of the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy Act (ADVANCE) Act). Specifically, the use of automated standardized templates for licensing documents would reduce redundancies and increase efficiency (section 208(b)(2)) relative to the NRC staff's current practice of developing the suite of licensing documents separately for each application and manually populating them with information. The online system described here would also help to consolidate review phases, reduce the number of transitions between review teams, and establish integrated review teams (section 208(b)(3)–(4)) by serving as a centralized information repository and application processing environment. In addition, the online system could be used to facilitate coordination with other agencies involved in the NRC's licensing processes, consistent with the concept of interagency cooperation on environmental reviews specified in section 506 of the ADVANCE Act.

Next Steps

The NRC staff will continue to engage with stakeholders, including microreactor developers and potential applicants, to better understand their intended licensing strategies and deployment models and to explore how electronic processing and automation could increase regulatory efficiency. Based on the outcomes of these interactions, the staff will identify potential software solutions for establishing an online system for submission and processing of applications, considering existing NRC licensing support systems, experience with such systems in other industries, and the NRC's experience of using online applications for other regulatory activities (such as applications for relief requests and materials licenses). The staff will also consider the need to develop guidance for applicants and licensees on proposing design-specific templates for standard contents of applications, as well as guidance for NRC reviews of such templates and resulting specific applications. Although the staff expects that an online system for application submissions and NRC staff safety reviews can be implemented consistent with the current regulations and Commission policies, the staff will assess the need for further Commission engagement as development proceeds.

6. Construction Inspection

Overview

While the Construction Reactor Oversight Process was successfully implemented during construction of large LWRs at the Vogtle site, given the expected diversity of advanced reactor projects and the expected increase in offsite fabrication and assembly of safety-significant SSCs, it is the staff's view that a fresh look at construction oversight is warranted through the development of the Advanced Reactor Construction Oversight Program (ARCOP). The staff communicated to the Commission its plan for developing the ARCOP in SECY-23-0048, "Vision for the Nuclear Regulatory Commission's Advanced Reactors Construction Oversight Program," dated June 6, 2023 (ML23061A086). As stated, in part, in SECY-23-0048, the vision for ARCOP is to build on the NRC's construction oversight experience while remaining adaptable to future advancements in reactor technologies, guided by the following principles:

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

Since communicating this vision to the Commission, the staff has continued developing ARCOP. The staff is now preparing guidance documents to ensure full implementation readiness to oversee advanced reactor construction and manufacturing activities, either to support a finding of whether acceptance criteria are met under 10 CFR 52.103(g), or to verify substantial completion of construction for issuance of an OL under 10 CFR 50.56 and 10 CFR 50.57(a)(1). To support ARCOP development, the NRC staff has conducted extensive stakeholder outreach. In particular, it has hosted a series of public workshops to explore how best to scope the inspection program.

NOAK Strategy

While the ARCOP will establish the oversight role needed for manufacturing and site deployment of first-of-a-kind technologies, the decision-making processes that are being developed will also enable the NRC to adjust its oversight activities for NOAK applications.

Specifically, by applying the ARCOP inspection scoping methodologies, the NRC will be able to identify a risk-informed and performance-based inspection footprint for first-of-a-kind construction and deployment that will include the inspection necessary to verify that licensee or manufacturer performance within the ARCOP framework provides reasonable assurance that reactors of a particular design are being built and will operate in accordance with the design's licensing basis. As the NRC and the industry gain experience in the manufacturing and deployment of a given technology, the staff expects to adjust the construction inspection footprint to reflect the experience gained. This means the program will be scalable such that the amount of inspection performed will be reduced to the extent practical while ensuring the staff meets program objectives for a given construction project. The amount of scalability that can be achieved depends largely on the degree of standardization between first-of-a-kind and subsequent deployments. Significant changes to the technology itself or to construction or manufacturing techniques could limit the degree to which experience can be incorporated in scoping, which is key to reducing the inspection timeframe to enable rapid deployment.

Next Steps

The staff plans to communicate the details of the ARCOP in a separate paper to the Commission in calendar year 2025.