NRIC National Reactor Innovation Center

NEPA Roadmap for Advanced Reactor Prototype Deployment

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Summary

The National Reactor Innovation Center (NRIC) at Idaho National Laboratory (INL) in Idaho Falls, Idaho, was authorized under the Nuclear Energy Innovation Capabilities Act of 2017 (Public Law 115–248) to provide private sector technology developers with resources and infrastructure for testing, demonstration, and performance assessment to accelerate deployment of new advanced reactor technology concepts. NRIC plans to offer existing buildings and multiple undeveloped and previously developed sites at INL to advanced reactor developers to demonstrate a wide range of reactor technologies, designs, and sizes. To facilitate advanced reactor deployments, NRIC is considering innovative approaches to meeting U.S. Department of Energy (DOE), U.S. Nuclear Regulatory Commission (NRC), and other agency regulatory requirements for siting and operations early in the planning process.

Siting and building new nuclear reactors on DOE sites has not taken place for decades and numerous regulatory requirements and options should be considered. Advanced reactor prototypes sited at INL or other DOE sites will require DOE authorization prior to their construction and operation. However, regardless of where they are sited, power reactors that intend to sell commercial power to the grid require licensing by the NRC under Title 10 of the *Code of Federal Regulations* Part 50 (10 CFR Part 50) or 10 CFR Part 52. Advanced reactor deployments on DOE sites or commercial sites could involve multiple participants including the DOE Office of Nuclear Energy, the local DOE field office and operating contractor, NRC, and reactor vendors, as well as other state agencies. Various pathways may exist for acquiring the necessary authorizations to construct and operate an advanced reactor.

This report describes the various options for demonstrating reactor prototypes at DOE and non-DOE sites, benefiting from the use of a potential DOE siting or programmatic environmental impact statement (EIS), the NRC Advanced Nuclear Reactor Generic EIS, and potentially other relevant DOE or NRC National Environmental Policy Act (NEPA) documents. A subsequent report will describe the content of the environmental reports (ERs) that would be required depending on the type of authorization/license sought, including both DOE authorization under 10 CFR Part 830 and NRC licensing under both Part 50 and Part 52.

Acronyms and Abbreviations

AEA	Atomic Energy Act
AEC	Atomic Energy Commission
ANR	advanced nuclear reactor
ASLB	Atomic Safety and Licensing Board
CD	critical decision
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGS	Columbia Generating Station
COL	combined license
DOE	U.S. Department of Energy
EA	environmental assessment
EIS	environmental impact statement
ER	environmental report
ESP	early site permit
GEIS	generic environmental impact statement
GIS	geographic information system
INL	Idaho National Laboratory
MARVEL	Microreactor Applications Research Validation and EvaLuation
MWt	megawatt(s) thermal
NEPA	National Environmental Policy Act
NRIC	National Reactor Innovation Center
PNNL	Pacific Northwest National Laboratory
PPE	plant parameter envelope
SPE	site parameter envelope
UAMPS	Utah Associated Municipal Power Systems
VTR	Versatile Test Reactor

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1.0 Introduction

The National Reactor Innovation Center (NRIC) at Idaho National Laboratory (INL) in Idaho Falls, Idaho, was authorized under the Nuclear Energy Innovation Capabilities Act of 2017 (Public Law 115–248) to provide private sector technology developers with resources and infrastructure for testing, demonstration, and performance assessment to accelerate deployment of new advanced reactor technology concepts. NRIC plans to offer existing buildings and multiple undeveloped and previously developed sites at INL to advanced reactor developers to demonstrate a wide range of reactor technologies, designs, and sizes.

Siting and building new nuclear reactors on U.S. Department of Energy (DOE) sites has not taken place for decades. To facilitate advanced reactor deployments, NRIC is considering innovative approaches to meeting DOE, U.S. Nuclear Regulatory Commission (NRC), and other agency regulatory requirements for reactor siting and operations early in the planning process. Among these requirements, advanced reactor prototypes sited at INL, other DOE sites, and commercial sites will require completion of either (or both) DOE or NRC National Environmental Policy Act (NEPA) reviews prior to their construction and operation.

To streamline the DOE NEPA review process, NRIC has adapted a Plant Parameter Envelope (PPE) approach to developing an environmental impact statement (EIS) (NRIC 2021). The PPE is a set of parameters that can be used to define a surrogate reactor that bounds the impacts of future prototype deployments, thereby reducing the time and cost of subsequent project-level NEPA reviews. The PPE approach was originally developed by the Nuclear Energy Institute (NEI 2012) in support of the NRC's early site permit (ESP) process under 10 CFR Part 52. This approach has been applied by the NRC in multiple ESP reviews, most recently in the NRC's issuance of the Clinch River ESP. The NRC is also in the process of developing the Advanced Nuclear Reactor Generic EIS (ANR GEIS) using a PPE to generically resolve many environmental issues, with the goal of streamlining future NRC-licensed advanced reactor deployments.

Although deployments at DOE sites would not necessarily require NRC licensing if the projects only involve technical demonstrations, reactor vendors may request an NRC license to be able to sell power. Reactor deployment, particularly deployment of first-of-a-kind prototypes, involves significant up-front investment. These project costs can be at least partially recovered by selling power on the grid to utilities, commercial entities, municipalities, and other potential customers. Power reactors that intend to sell commercial power to the grid for these purposes require licensing by the NRC under 10 CFR Part 50 or 10 CFR Part 52 and these licensing actions would require NRC to prepare an EIS. The PPE developed by NRIC for prototype reactor deployment, if considered as the proposed action as a bounding analysis in a DOE EIS, could be used by the NRC to inform NEPA reviews at other DOE sites and at commercial sites.

This report assumes that DOE and NRC will complete early EISs using a PPE approach that makes generic determinations regarding the environmental impacts of prototype reactor deployment prior to specific reactor design and siting decisions. After completing these initial EISs, each individual project-specific reactor deployment would require either DOE or NRC to develop a subsequent NEPA review to confirm the specific reactor parameters are bounded by the PPE values. In addition, subsequent assessments of impacts that could not be assessed generically in the initial EISs may be

necessary. These subsequent reviews would require the submittal of information by reactor vendors to support project-specific NEPA reviews prior to construction.

This report describes the various options for demonstrating reactor prototypes, benefiting from the use of a potential DOE siting or programmatic EIS, the NRC ANR GEIS, and potentially other relevant DOE or NRC NEPA documents. Section 2 provides a general discussion of the NRC and DOE approval processes to establish context for NEPA review steps. Section 3 describes anticipated NEPA review steps at DOE sites and commercial sites. The general information required from vendors to support project-specific reviews is described in Section 4. Section 5 lists relevant past documents and documents currently being prepared. Section 6 provides conclusions.

2.0 NRC Licensing and DOE Authorization – Overview

Under the Atomic Energy Act of 1954, a single agency, the Atomic Energy Commission (AEC), had responsibility for the development and production of nuclear weapons and for the development and the safety regulation of the civilian uses of nuclear materials. The Energy Reorganization Act of 1974 established the NRC and split AEC's functions, assigning to one agency, now DOE, the responsibility for the development and production of nuclear weapons, promotion of nuclear power, and other energy-related work, and assigning to the NRC the regulatory work for commercial uses, which does not typically include regulation of DOE facilities.

Under the Energy Reorganization Act of 1974, DOE is charged with "encouraging and conducting research and development, including demonstration of commercial feasibility and practical applications…related to the development and use of energy from…nuclear…sources." On the other hand, under 10 CFR Parts 50 and 52 the NRC licenses and regulates commercial nuclear facilities.

NRIC and the NRC entered into a Memorandum of Understanding in 2019 describing the roles and responsibilities of each party and the cooperative activities of the parties, including the sharing of technical expertise and coordination to support the mission of research, development, demonstration, and commercial application of advanced nuclear reactor technologies (DOE and NRC 2019). As such, even if a project does not require an NRC license, the NRC may provide expertise and capabilities to support the DOE mission. Through cooperative activities, the NRC can benefit from DOE's research and development activities and from experiences in authorizing demonstration reactors.

2.1 NRC Licensing

The NRC licenses and regulates the operation of commercial nuclear power plants in the United States (NRC 2020b). Currently operating nuclear power plants have been licensed under a two-step process described in 10 CFR Part 50. This process requires both a construction permit and an operating license. Another licensing option is the combined license (COL) process under 10 CFR Part 52, which combines the construction permit with an operating license. The Vogtle Power plant, currently under construction, was licensed under the COL process (NRC 2011). Non-power research reactors such as those operating at universities have also been licensed under 10 CFR Part 50 or the Atomic Energy Act (AEA) Section 103 (42 U.S.C. § 2133) or 104(c) (42 U.S.C. § 2134(c)).

10 CFR Part 51 describes the NRC's environmental protection regulations for domestic reactor licensing, including requirements associated with the NEPA process. Under 10 CFR 51.20, issuance of permits or licenses to construct and operate a nuclear power reactor under either Part 50 or Part 52 requires the development of an EIS. These requirements would be applicable for advanced reactor deployments unless Part 51 is modified or amended to exclude certain advanced reactors.

The NRC is also proposing to amend the regulations by creating an alternative regulatory framework for licensing ANRs. The proposed rule would add a new, alternative part to its regulations that will set

out a risk-informed, technology-inclusive framework for the licensing and regulation of ANRs. Among other goals, this new approach would establish new requirements to address non-light-water reactor technologies and recognize technological advancements in reactor design. The proposed rule would add 10 CFR Part 53, “Licensing and Regulation of Advanced Nuclear Reactors.” The NRC is accepting public comment on the proposed rule until November 5, 2021. The proposed Part 53 licensing path is not addressed in this report due to the uncertainty about the timeline of its adoption and availability to vendors for licensing.

2.1.1 Part 50: Two-Step Licensing Process

All nuclear power plant applications must undergo a safety review, an environmental review, and an antitrust review by the NRC. Under Part 50, the applicant obtains a construction permit and an operating license, separately.

To construct or operate a nuclear power plant, an applicant must submit an application that includes a Safety Analysis Report and a comprehensive assessment of the environmental impact of the proposed plant. The NRC staff then reviews the application to determine whether the plant design meets all applicable regulations (10 CFR Parts 20, 50, 73, and 100). The review includes, in part:

- characteristics of the site, including surrounding population, seismology, meteorology, geology and hydrology;
- design of the nuclear plant;
- anticipated response of the plant to hypothetical accidents;
- plant operations, including the applicant's technical qualifications to operate the plant;
- discharges from the plant into the environment (i.e., radiological effluents); and
- emergency plans.

When the NRC completes its review, it issues a Safety Evaluation Report summarizing the anticipated effect of the proposed facility on public health and safety. In accordance with NEPA, NRC staff also perform an environmental review to evaluate the potential environmental impacts and benefits of the proposed plant.

The AEA requires that a public hearing be held before a construction permit is issued for a nuclear power plant. The public hearing is conducted by the NRC Commission (a group appointed by the President and confirmed by the Senate to formulate policies, develop regulations, issue orders, and adjudicate legal matters) or delegated to a three-member Atomic Safety and Licensing Board (ASLB). The NRC Commission or ASLB must determine that there is reasonable assurance that the proposed site is a suitable location, from a radiological health and safety standpoint, for a nuclear power reactor of the general size and type proposed. If satisfied such reasonable assurance exists, the NRC Commission or ASLB issues the construction permit.

After issuance of the construction permit, the applicant must submit a Final Safety Analysis Report to support its application for an operating license. This report describes the final design of the facility, as well as its operational and emergency procedures. The NRC prepares a Final Safety Evaluation Report for the operating license, and the ASLB makes an independent evaluation and presents its advice to the NRC Commission.

2.1.2 Part 52: Combined Licensing Process

10 CFR Part 52 establishes a COL process, which combines a construction permit and an operating license with conditions for plant operation. A COL under 10 CFR Part 52 authorizes construction of the facility much like a construction permit would under the two-step process in Part 50, and therefore requires the mandatory hearing discussed above for a construction permit. It contains information similar to that required in an application for an operating license issued under Part 50, and specifies the inspections, tests, and analyses that the applicant must perform. It also specifies acceptance criteria that are necessary to provide reasonable assurance that the facility has been constructed and will be operated in agreement with the license and applicable regulations.

A flowchart of the NRC COL process is included below in Figure 1.

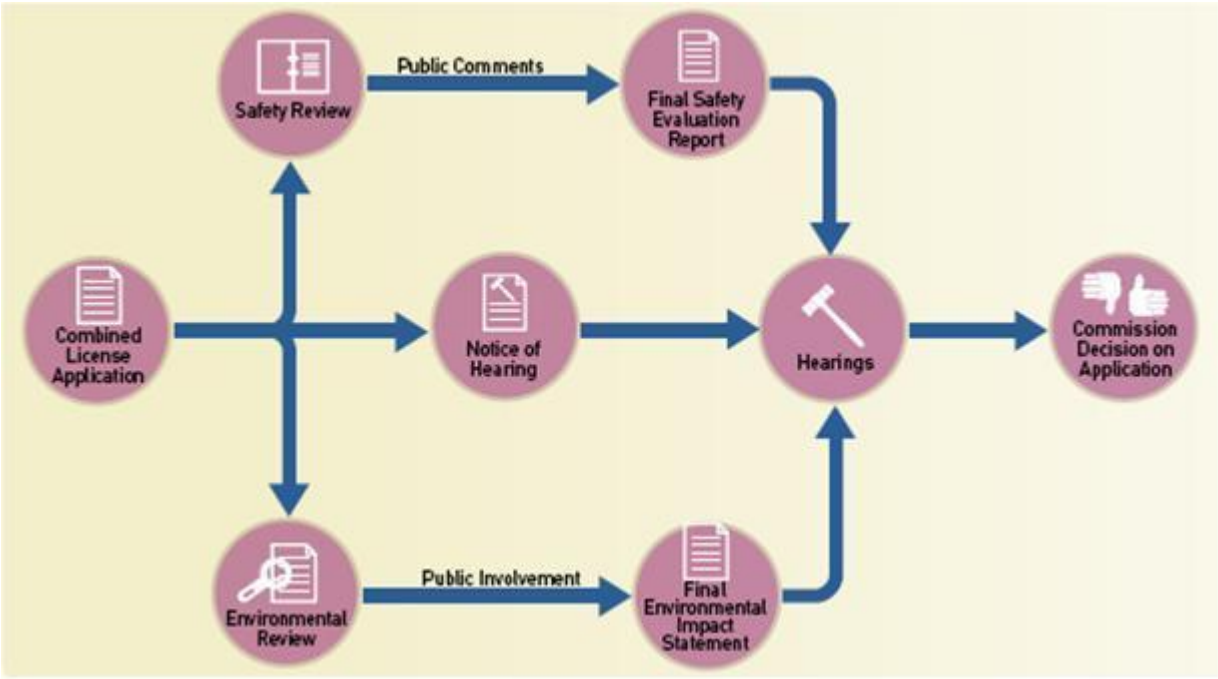

Figure 1. NRC COL Process

After issuing a COL, the Commission authorizes operation of the facility only after verifying that the licensee has completed required inspections, tests, and analyses and met the acceptance criteria.

While not required, an application for a COL under 10 CFR Part 52 can incorporate by reference an ESP (Section 2.1.2.1) and/or a design certification (Section 2.1.2.2). The advantage of this approach is that the issues resolved during the design certification rulemaking and the ESP hearing processes are precluded from reconsideration later during the COL stage, except under very limited circumstances. A COL requires preparation of an EIS for construction and operation of a specific plant design at a specific site. The Turkey Point ER in support of the COL application provides an example of the information required (NRC 2021).

2.1.2.1 Early Site Permit

Under the COL process, an applicant may apply for an ESP prior to choosing any specific design, or prior to a design certification being completed. The benefit of the ESP is that while the applicant may not have finalized or selected a reactor design, one or more sites can be approved, while site safety issues, environmental protection issues, and emergency management plans are addressed. To date, the NRC has issued six ESPs, most recently the Clinch River ESP for the Tennessee Valley Authority (NRC 2020a). An ESP may resolve site safety, environmental protection, and emergency preparedness issues independent of a specific nuclear plant design. The ESP application must address the safety and environmental characteristics of the site and evaluate potential obstacles to developing an acceptable emergency plan. The NRC review requires that the following information be included in the application:

- site boundaries;
- seismic, meteorologic, hydraulic, and geologic data;
- existing and projected future population of the surrounding area;
- evaluation of alternative sites;
- proposed general location of each plant planned to be on the site;
- number, type, and power level of the plants planned for the site;
- maximum discharges from the plant;
- type of plant cooling system to be used;
- radiation dose consequences of hypothetical accidents; and
- plans for coping with emergencies (either major features or complete and integrated plans).

The NRC documents its findings related to site safety characteristics and emergency planning in a Safety Evaluation Report and those related to environmental protection issues in Draft and Final EISs. The ESP is initially valid for no less than 10 and no more than 20 years and can be renewed for 10- to 20-year periods. An ESP requires the preparation of an EIS, while the design certification discussed below in Section 2.1.2.2 does not.

Once the ESP is issued, the licensee can later seek NRC approval to transfer the ESP to a demonstration project proponent; the transfer is processed by the NRC under 10 CFR 50.80.

2.1.2.2 Design Certification

Under the COL process, an applicant may apply for a standard design certification. The design certification is the converse of the ESP; while the ESP approves a site without finalizing the design, the design certification approves the reactor design without analyzing or selecting a site. Getting NRC approval of a reactor design can streamline the review process once a site is selected. The NRC may approve and certify a standard nuclear plant design through a rulemaking, independent of a specific site. An application for a standard design certification must contain proposed inspections, tests, analyses, and acceptance criteria for the standard design. The application must also demonstrate how the applicant complies with the Commission's relevant regulations. An application must contain a level of design information sufficient to enable the Commission to reach a final conclusion about all safety questions associated with the design. The application presents the design basis, the limits on operation, and a safety analysis of structures, systems, and components of the facility as a whole. The scope and contents of the application are equivalent to the level of detail found in a Final Safety

Analysis Report for a currently operating plant. The NRC staff prepares a Safety Evaluation Report that describes its review of the plant design and how the design meets applicable regulations.

A design certification only requires a limited NEPA review because the proposed action does not authorize construction or operation of a plant. For example, the NRC developed an environmental assessment (EA) to address severe accident mitigation design alternatives related to the design certification of the Economic Simplified Boiling-Water Reactor designed by GE-Hitachi (NRC 2014).

2.1.3 ANR GEIS

To streamline the environmental review efforts associated with the Part 50 and Part 52 processes and meeting the Part 51 environmental review requirements, the NRC is currently developing the ANR GEIS. The purpose and need for the ANR GEIS is to present impact analyses for the environmental issues common to many or most advanced reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and the NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified. The ANR GEIS is intended to improve the efficiency of licensing advanced reactors by (1) identifying the possible types of environmental impacts of constructing and operating an advanced reactor, (2) assessing impacts that are expected to be generic (the same or similar) for many or most advanced reactors, and (3) defining the environmental issues that will need to be addressed in project-specific Supplemental EISs.

The NRC decided to pursue a technology-neutral, performance-based approach using a PPE and a site parameter envelope (SPE), because ANRs may include differences in design and may be sited anywhere in the United States. The PPE/SPE will consist of bounding values or parameters, and assumptions, for specific reactor design features regardless of the site. Examples include the site footprint size, building height, water use, air emissions, employment levels, and noise generation levels. In addition, the staff developed a set of site condition values and assumptions.

To support project-specific applications, vendors would need to provide information to the NRC in the form of an ER following the guidance provided in Regulatory Guide 4.2, as amended (NRC 2018) or updated by the ANR GEIS. If the ANR GEIS is not completed or for some reason is not applicable to the proposed project, vendors would need to prepare an ER following the guidance in Regulatory Guide 4.2 (NRC 2018).

2.2 DOE Authorization

DOE regulates nuclear safety under the authority of 10 CFR Part 830. 10 CFR 830.2 excludes, in part “Activities that are regulated through a license by the [NRC].” While DOE regulations do not apply to NRC-regulated activities, DOE does authorize the testing of reactor concepts. Under the Atomic Energy Act Section 2140, no NRC license is required for “the construction or operation of facilities under contract with and for the account of the [DOE].” In accordance with the Energy Reorganization Act of 1974, DOE demonstration reactors are regulated by NRC if they are:

- operated as part of the power generation facilities of an electric utility system, or

- operated in any other manner for the purpose of demonstrating the suitability for commercial application of such a reactor.

The NEPA process must be completed before DOE makes a final decision about a proposed action and one or more alternative means of accomplishing the project goals, and before the effects can be meaningfully evaluated (CEQ 2007). For capital asset projects having a total project cost of more than $50 million (or $10 million for nuclear projects or complex first-of-a-kind projects), the “Critical Decision” (CD) process defines a series of staged project approvals necessary for the approval of the project (DOE Order 413.3B, DOE 2021). The CD process includes the following stages:

- CD-0 – Approve Mission Need
- CD-1 – Approve Alternative Selection and Cost Range
- CD-2 – Approve Performance Baseline
- CD-3 – Approve Start of Construction
- CD-4 – Approve Start of Operations or Project Completion.

Under DOE Order 413.3B, NEPA must be completed, with the publication of a Final EIS or a Finding of No Significant Impact (for an EA) prior to approving CD-2 (Approve Performance Baseline) and proceeding to CD-3 (Approve Start of Construction) (OPSS 2021). It is possible that certain reactor technical demonstrations involving outside funding would not have to follow DOE Order 413.3B, and possible that these requirements may not be applicable. However, DOE would be required to have appropriate NEPA coverage in place prior to performing final safety approvals or authorizing construction.

DOE’s NEPA “Green Book” provides guidance in promoting clarity, accuracy, and consistency in preparing DOE NEPA documents, including background information, relative to the requirements of the various sections of the document, and recommended approaches for analyzing resource impacts (DOE 2004). The Green Book provides guidance to applicants on identifying and analyzing environmental issues that would need to be included in the ER, or equivalent DOE documentation.

2.2.1 Site Use Permits

DOE may require companies interested in conducting activities at DOE sites to acquire a DOE Site Use Permit. For example, companies interested in locating commercial activities on the INL site must submit a formal site use request and be fully vetted. The intent of the Site Use Permit process is to provide a high-level strategy for conducting due diligence reviews of siting requests for commercial activities. The Siting Request requires that the company demonstrate an acceptable level of feasibility in the areas of technology development, licensing, financial capability, communication strategy (including local Tribal engagement), export control, and environmental aspects (e.g., NEPA compliance, waste disposition, etc.). Relevantly for deployment of advanced reactor demonstrations, Utah Associated Municipal Power Systems (UAMPS) applied for and was issued a Site Use Permit for use of the INL site by DOE in 2016 (DOE 2016), and Oklo obtained a Site Use Permit at the INL site in 2019 (Business Wire 2019).

2.2.2 NRIC PPE Report

Pacific Northwest National Laboratory (PNNL) developed the Plant Parameter Guidance report for NRIC in 2021 to establish plant and site parameters that could streamline DOE environmental

reviews (NRIC 2021). During the same period, the NRC was developing the ANR GEIS, and NRIC staff and NRC staff shared lessons learning in multiple staff-level discussions during the development of both documents. Through this interaction, the NRIC PPE/SPE benefited from the PPE/SPE developed for the ANR GEIS by the NRC.

The NRIC PPE was divided into size categories, including microreactors (up to 60 MWt) and small- to medium-sized advanced reactors (up to 1000 MWt). The initial intent of the PPE was that it could be used as part of the proposed action in a NEPA review at INL, and that the analysis of the surrogate plant described in the PPE as sited would provide a reasonably foreseeable estimate of impacts and thus bound the impacts of a potential advanced reactor prototype at INL. However, as of the date of publication of this report, the PPE has not been incorporated into a DOE NEPA process at INL or otherwise. This report thus includes descriptions of the environmental review process for DOE-authorized facilities, which could reference the NRIC PPE, assuming that a previous siting or programmatic NEPA document incorporating and analyzing the NRIC PPE exists, and also if no siting or programmatic NEPA document exists and an individual project-specific NEPA compliance document is necessary.

3.0 Advanced Reactor Prototype Deployment – NEPA Review Scenarios

Both the DOE and the NRC NEPA review processes are well understood and there are recent relevant examples of complex EISs being prepared by both agencies. The use of the PPE approach to assess environmental impacts prior to specific reactor designs being chosen has been demonstrated by the NRC for the review of several ESP applications (e.g., Clinch River). The NRC is currently using the PPE approach in developing the ANR GEIS, which will assess environmental impacts of deployment of a wide range of advanced reactors anywhere in the United States. The NRC also developed and updated the License Renewal GEIS for the current nuclear fleet in the United States and has tiered to this GEIS to issue 59 SEISs for reactor license renewals to date (NRC 2013). The NRC is currently in the process of reviewing and updating the License Renewal GEIS.

These NEPA reviews show that generic evaluations followed by project-specific assessments are possible and legally defensible, can save time and resources, and that this process can be applied for prototype deployments that intend to proceed without an NRC license. To discuss how this approach could be applied by NRIC or others, prototype reactor deployment scenarios are reviewed, and the associated project-specific NEPA review approaches are described. The scenarios differ based upon the nature and purpose of the review, whether the project or potential future project is NRC licensed or DOE authorized, whether the project is intended to be located on a DOE site, and whether an existing siting or programmatic EIS to streamline and support the project-specific analysis exists.

The flowchart below shows the decision paths for the regulatory scenarios described in Sections 3.1 and 3.2.

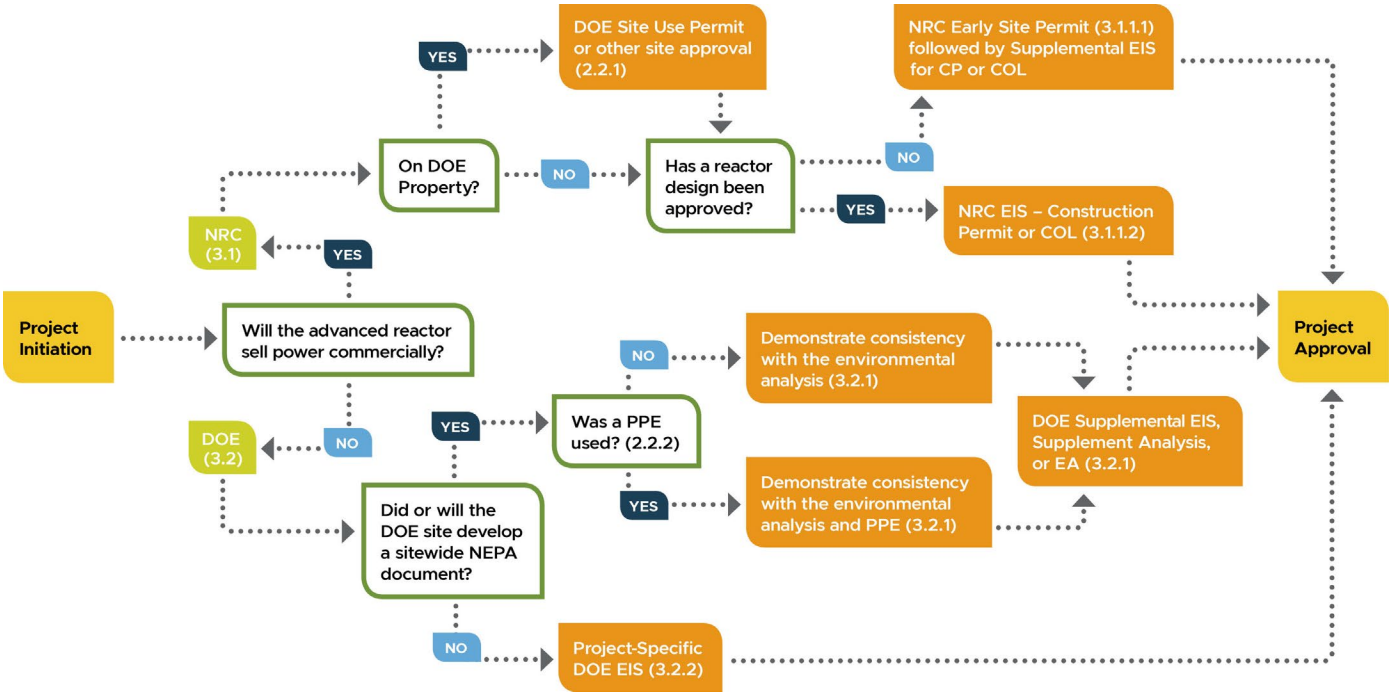

Figure 2. Reactor Deployment Licensing/Approval Flowchart

3.1 NRC Licensing

Power reactors that intend to sell commercial power to the grid require licensing by the NRC under 10 CFR Part 50 or 10 CFR Part 52 and these licensing actions would require the NRC to prepare an EIS. Commercial power reactors could be located on DOE sites or non-DOE commercial sites.

3.1.1 NRC Licensing at DOE Sites

Licensing reactors for commercial purposes under the authority of the NRC at a DOE site requires the cooperation and input of both agencies. At DOE sites such as INL, the process may differ based on the type of NRC license application. DOE or a specific DOE site could apply for an NRC ESP on DOE property, which would provide NRC approval of one or more locations for a project on DOE property prior to identifying any specific demonstration reactor design or project proponent. If both the proposed demonstration reactor and the proposed DOE site are known, either DOE, the DOE site, or a specific project proponent would not need an ESP and could proceed with an application for a NRC license for construction and operation under either Part 50 or Part 52. DOE may use the DOE Site Use Permit process to vet and determine if a demonstration project requiring a future NRC license is appropriate for the DOE site.

3.1.1.1 Early Site Permit for Multiple Potential Siting Locations

As described above, an ESP may resolve site safety, environmental protection, and emergency preparedness issues independent of a specific nuclear plant design. Early site permit applications at

DOE sites could follow one of three potential paths depending on DOE's and NRC's respective roles in the application and NEPA review processes. These scenarios assume that DOE has an affirmative obligation to complete a NEPA review for site suitability either prior to, concurrent with, or subsequent to the NRC's process for developing an EIS related to an ESP.

These scenarios also assume that DOE (or a company contracted to DOE) is the applicant for the ESP. ESPs issued by NRC to DOE for one or more sites could be transferred in the future to a project proponent for use in a construction permit or COL application. Such transfers would be processed under 10 CFR 50.80. DOE could use a process similar to the Site Use Permit process to determine the issues and conditions for transferring the ESP to a demonstration project proponent.

Scenario 1: DOE develops an EIS to identify appropriate sites and subsequently applies to the NRC for an ESP

In the first scenario, DOE would first evaluate in an EIS a comprehensive set of sites at a DOE-owned location for deploying reactor prototypes based upon the bounding values identified in the NRIC PPE, and subsequently use this information to inform environmental parameters relevant to developing an ESP application. DOE's NEPA review would resolve many of the siting-related issues at a programmatic level prior to any specific project proposal. The information developed in DOE's siting or programmatic EIS would include the information identified in Regulatory Guide 4.2 (NRC 2018) as needed in an application to the NRC for an ESP for one or more of the evaluated sites.

Scenario 2: DOE and NRC are co-lead agencies on an ESP EIS

Although this has not been previously attempted, this report assumes that it is possible that DOE and NRC could jointly develop an EIS that would meet DOE's NEPA requirements and would also serve as the EIS for an ESP application by DOE. This EIS could evaluate one or more locations on the DOE site, and its production would be led by both DOE and NRC as co-lead agencies. Similar to Scenario 1, the EIS would be based upon the bounding values identified in the NRIC PPE; however, instead of analyzing this information in a DOE EIS and then subsequently applying for an NRC ESP, the NRC and DOE would work together to include the analysis necessary to meet the requirements of both agencies, including NRC requirements described in Regulatory Guide 4.2 and its Environmental Standard Review Plan (NUREG-1555, NRC 2000). This EIS could also be informed by relevant siting parameters analyzed in the ANR GEIS, if completed.

Scenario 3: DOE applies for an NRC ESP and subsequently uses the ESP to support DOE NEPA requirements

Under this scenario, DOE would first apply for an NRC ESP, the NRC NEPA review would be completed, and the one or more DOE project-specific NEPA reviews could be conducted to complete a site suitability review. This scenario is not anticipated because DOE, as the applicant, would not kick off a process for obtaining NRC site approval without having completed some level of due diligence and vetting of the suitability of the identified site prior to or concurrent with the NRC ESP review. Because it would be preferable for the DOE site suitability NEPA compliance to be completed either prior to (Scenario 1) or concurrent with (Scenario 2) the NRC ESP EIS, this scenario is not evaluated further.

Regardless of the scenario selected above, subsequent to NRC's issuance of an ESP at a given DOE site, applications by vendors for a construction permit or COL for deploying specific reactor designs would require additional ERs at that licensing stage that focus on three evaluations:

1. The vendor would need to provide documentation demonstrating its design parameters are within the bounding values analyzed in the ESP. Depending on the value, this information may consist of design drawings, calculation packages, model runs, and/or certifications.
2. The vendor would need to provide an evaluation of environmental issues that were unresolved during the ESP review and any additional information necessary for a complete assessment. Some of the information needed to make these determinations may need to be obtained from the DOE site.
3. The vendor would also need to review the assumptions in the ESP to determine whether any new information exists, and if it does, would the new information change the significance of an impact on a resource. The vendor would need to describe its process for this review, and if there was no new and significant information, the vendor would need to provide a certification to that effect.

The Vogtle ER in support of the COL application provides an example of the information required (SNC 2009).

3.1.1.2 Construction Permit or COL for a Known Project Design and Siting Location

Where both the specific reactor design and the desired siting location on a DOE site are known, an ESP would not be necessary.[1] As with the ESP, vendors may need to first procure a Site Use Permit from the DOE site to develop information needed for an ER in an application for a construction permit or COL following guidance in Regulatory Guide 4.2 (NRC 2018). For example, DOE issued a Site Use Permit to UAMPS to characterize potential locations for licensing and constructing a NuScale plant on the INL site in 2016 (DOE 2016). The Site Use Permit acknowledged that UAMPS' interest was to construct an NRC-licensed facility, "and that, if Holder proceeds to develop the [Carbon Free Power Project] at the INL site, it must do so in compliance with NRC requirements."

If the ANR GEIS is completed by the time of the initiation of the proposed project, after acquiring a DOE Site Use Permit (if required by the DOE site in question), vendors would need to provide the following information to take advantage of the ANR GEIS analyses:

1. Documentation demonstrating that the reactor design parameters are within the bounding values in the PPE described in the ANR GEIS. Depending on the values, this information may consist of design drawings, calculation packages, model runs, and/or certifications. Information from the NRIC PPE report could be helpful in informing the values associated with design and/or siting parameters and subsequently analyzing impacts.
2. For any environmental issue for which generic determinations were not possible (defined by the NRC as Category 2 issues), or for any Category 1 issues where the PPE/SPE values or assumptions cannot be met, the vendor would need to provide information necessary for a complete assessment. Some of the information needed to make these determinations may need to be obtained from the proposed DOE site.

[1] Even with a known site and a known design, a proponent could choose to apply for an ESP pending NRC's issuance of a design certification to reach early resolution of environmental issues (NRC 2020a). However, it is assumed in this report that the ANR GEIS would be available for this purpose and that the additional benefit of an ESP would not be pursued by a vendor.

3. The vendor would also need to review the assumptions in the PPE and in the DOE Site Use Permit to determine whether any new information exists, and if it does, would the new information change the significance of an impact on a resource. The vendor would need to describe its process for this review, and if there was no new and significant information, the vendor would need to provide a certification to that effect.

Project-specific NEPA compliance for construction permit or COL applications that rely on the ANR GEIS would likely be completed through development of an NRC Supplemental EIS, although it is possible that in certain circumstances, an EA or other simpler NEPA mechanism would be appropriate.

3.1.2 NRC Licensing at non-DOE Sites

At non-DOE sites, this report assumes that the NRC licensing process, whether completed under Part 50 or Part 52, would be required for licensing. As stated in the Versatile Test Reactor (VTR) Draft EIS, “any non-government site would fall under the regulatory authority of the U.S. Nuclear Regulatory Commission (NRC)” (DOE 2020). The ANR GEIS, if completed, could be used to streamline the process. The process would thus be similar to the NRC licensing approaches described above, except that DOE would not necessarily have a role in the process (unless providing project funding, for example) for such licensing applications.

3.2 DOE Authorization

These scenarios assume that a given project is proposed on DOE property without the need or requirement for an NRC license, and therefore that DOE authorization under 10 CFR Part 830 would control.

3.2.1 DOE Sites with Existing Siting or Programmatic NEPA

This scenario assumes that the DOE site in question has developed an EIS analyzing deployment of advanced reactors either using the PPE framework developed by NRIC and PNNL or has analyzed the impacts of potential reactor deployment on the DOE site through a different NEPA mechanism. This EIS would have generically analyzed the suitability of sites and the broad conditions regarding project approval; as such, this analysis would be similar in the nature of the analysis to the NRC ESP review that identifies suitable sites prior to finalization of any specific project.

The NRC would not have an official role in DOE project authorization; however, it could provide technical expertise regarding advanced reactor technologies and deployment based upon the Memorandum of Understanding signed between DOE and NRC in 2019 (DOE and NRC 2019). Because DOE is not a cooperating agency on the ANR GEIS, the applicant could not tier to the GEIS to support the authorization; however, the ANR GEIS, once published, would likely provide analyses of environmental impacts that could be incorporated by reference into a DOE project-specific EIS. The requirements for information to support this project-specific EIS would be similar to the requirements for an ER described in Regulatory Guide 4.2 (NRC 2018), with potential specific

requirements as described in DOE's NEPA Green Book (DOE 2004). Some of this information (e.g., reactor design characteristics) may need to be developed by the applicant, while some (e.g., site characteristics and resource areas of concern) would be DOE's responsibility. Depending on the scope of the initial siting or programmatic EIS, this subsequent project-specific EIS could possibly be a Supplemental EIS, a Supplement Analysis, or an EA, instead of a stand-alone EIS.

NRIC is currently developing the regulatory infrastructure necessary to site prototype reactors at one or more locations at the INL site. To this end, NRIC's PPE could be used to define a surrogate reactor that could be assessed in a programmatic NEPA review (NRIC 2021). Under either approach, DOE would be able to make generic determinations of potential impact levels for many of the resources that could be affected. Besides the PPE, this EIS could use information developed in previous and in-progress EISs and EAs at INL, other EISs for the DOE complex, and NRC EISs for new reactors and license renewal to make generic determinations of impacts.

The information required from the vendor, DOE, and/or DOE's NEPA contractor under this scenario would be similar to that required to use prior NRC EISs. To support DOE project-specific NEPA reviews, the following information would be required:

1. Assuming DOE uses the PPE developed by NRIC as part of a siting or programmatic EIS, a vendor would need to provide documentation demonstrating its design parameters are within the bounding values in the PPE as adapted for the EIS. Depending on the values, this information may consist of design drawings, calculation packages, model runs, and/or certifications.
2. For any resource areas where PPE or SPE parameters were not developed and could therefore not be analyzed in the siting or programmatic EIS, or for circumstances where the proposed demonstration reactor exceeds the PPE/SPE values, the vendor would need to provide information necessary for a complete assessment. This requirement would be similar to the requirements of the ANR GEIS.
3. The vendor would also need to review the assumptions in the PPE and the DOE review to determine whether any new information exists, and if it does, would the new information change the significance of an impact on a resource. The vendor would need to describe its process for this review, and if there was no new and significant information, the vendor would need to provide a certification to that effect.

3.2.2 DOE Sites without Siting or Programmatic NEPA Documents

DOE sites that have not analyzed the suitability of sites or the conditions under which projects could be approved in a previous siting or programmatic NEPA analysis would be required to do so in a project-specific analysis. If no equivalent ESP-type review has been completed at the site (one of the primary benefits associated with this type of EIS), resolution of all issues regarding the project design as sited would need to be analyzed in a single comprehensive project-specific EIS.

While the ANR GEIS and the NRIC PPE could provide information and impact analysis that could be relevant and referenced in this project-specific EIS, neither document would have been incorporated into a DOE EIS and therefore the project-specific EIS would not be able to tier to such a document.

4.0 Information To Be Included in an Environmental Report (or Equivalent)

Vendor information about the specific reactor design and associated siting criteria would be required for project approval regardless of whether NRC licensing or DOE authorization is desired. In addition, project-specific information would be necessary prior to approval of construction at any specific site. The format of the information required would depend on whether the project is NRC-licensed or DOE-authorized, and whether the project-specific NEPA document tiers to a siting or programmatic EIS; however, the content of the information would be similar regardless of the licensing approach.

As described previously, Regulatory Guide 4.2 (NRC 2018) provides guidance to NRC applicants for the format and content of ERs submitted as part of an application for a construction permit, license, or other authorization to site, construct, and/or operate a new nuclear power plant. While DOE does not have an equivalent guide, information from Regulatory Guide 4.2 would likely be relevant to developing the ER (or DOE equivalent) necessary for the reviewing agency to analyze environmental impacts. If using the ANR GEIS (currently in development) or the NRIC PPE (NRIC 2021) (as analyzed in a DOE siting or programmatic EIS), the ER or equivalent would need to include information demonstrating consistency with defined PPE and SPE parameters, or would need to develop and provide analysis for PPE and SPE parameters that have been exceeded. In addition, project-specific information would be necessary, including but not limited to Endangered Species Act and National Historic Preservation Act consultations and environmental justice. The applicant would also be required to provide information necessary to show compliance with applicable Federal and State environmental statutes and permitting requirements, including those under the Clean Water Act, the Clean Air Act, and the Coastal Zone Management Act.

The information specified in Regulatory Guide 4.2 (NRC 2018) is generally relevant and necessary for whichever agency is the lead or party responsible party for analyzing environmental impacts. Some information listed in Regulatory Guide 4.2 is specific to NRC requirements and would not be necessary for a DOE review. For example, DOE would not necessarily need a vendor to demonstrate a need for power in the proposed service area of the site. Regulatory Guide 4.2 specifies information related to the following topical areas, which generally match the organization of the subsequent NRC EIS incorporating these data or information. Concurrent with the development of the ANR GEIS, Regulatory Guide 4.2 is in the process of being updated to include additional information about the ER requirements associated with advanced reactors.

Regulatory Guide 4.2 requires input on the following broad categories:

- Chapter 1 – Introduction
  - Plant Owners and Reactor Type
  - Description of the Proposed Action
  - Purpose and Need
  - Project Schedule
  - List of Required Permits and Licenses

- Chapter 2 – Affected Environment
- Chapter 3 – Site Layout and Project Description
  - Proposed Plant Structures, Systems, and Components
    - Rated and design core thermal power
    - Rated and design core electrical output
    - Reactor-power-conversion system
    - Descriptions of the reactor(s)
    - Cooling system
    - Auxiliary and service power load
    - Description of all proposed plant structures, systems, and components
  - Building Activities, Methods, and Durations
  - Operational Activities (land, water, air)
  - Radioactive Waste Management
    - Waste management and effluent control systems
    - System process flow diagrams
    - Sources of radioactive liquid and gaseous waste
    - Principal release points
  - Nonradioactive Waste Management
    - Description of effluent rates and frequencies of release
    - Pollutant concentrations
    - Procedures for disposal
- Chapter 4 – Environmental Impacts from Construction
- Chapter 5 – Environmental Impacts from Operation
- Chapter 6 – Fuel Cycle, Transportation, and Decommissioning Impacts
- Chapter 7 – Cumulative Impacts
  - Description of past, present, and reasonably foreseeable future actions in the geographic area of interest
- Chapter 8 – Need for Power
- Chapter 9 – Environmental Impacts of Alternatives
  - No Action Alternative
  - Energy Alternatives
  - System Alternatives
- Chapter 10 – Conclusions

DOE data call requirements for an advanced reactor would be similar to those in Regulatory Guide 4.2, and would likely include requests for information related to the following:

- GIS data
  - Site and area boundaries
  - Roads
  - Facilities
  - Surface water

- Infrastructure
  - System capacities
  - Electricity
  - Water
  - Sewage
  - Fuel
- Noise
  - Recent noise measurements or surveys
  - Noise sources, locations, and noise levels
- Traffic
- Surface Water and Groundwater
  - Site plans
  - National Pollutant Discharge Elimination Standards permits
  - Site/facility water sources
- Socioeconomics and Environmental Justice
  - Average employee salary
  - Total number of workers
- Biological/Natural Resources
  - Biological surveys
  - Relevant natural resources management documents/reports/plans
  - Species studies and inventories
  - Necessary consultations
  - GIS layers
- Cultural Resources
  - Cultural resource surveys
  - Archaeological reports
  - National Historic Preservation Act Section 106 agreements

Unlike the requirements associated with NRC Regulatory Guide 4.2, where the data call format matches the EIS format, DOE's data call requirements do not directly match their EIS format. For example, the VTR Draft EIS was organized as follows:

- Chapter 1 – Introduction and Purpose and Need
- Chapter 2 – Description of Alternatives
  - Proposed VTR
  - No Action Alternative
  - Site Alternatives
  - Reactor Fuel Production Alternatives
  - Alternatives Considered and Dismissed from Detailed Analysis
- Chapter 3 – Affected Environment
  - Land Use and Aesthetics
  - Geology and Soils

  - Water Resources
  - Air Quality
  - Ecological Resources
  - Cultural and Paleontological Resources
  - Infrastructure
  - Noise and Vibration
  - Human Health
  - Traffic
  - Socioeconomics
  - Environmental Justice
- Chapter 4 – Environmental Consequences
  - Construction/Facility Modification
  - Operations
  - Reactor Fuel Production Options
  - Combined VTR and Reactor Fuel Production Impacts
- Chapter 5 – Cumulative Impacts
- Chapter 6 – Resource Commitments
- Chapter 7 – Laws, Regulations, and Other Requirements.

The specific resource information in each topical area that should be included in an applicant's ER (or DOE equivalent) depends on the type of license or authorization required and which previous NEPA assessments have been completed by DOE and NRC.

A subsequent iteration of this report will provide additional detail about the similarities and differences between NRC and DOE data and information needs and how these are carried forward into the environmental analysis. The subsequent report will develop a proposed format for vendors to use when developing data and information to be carried forward into a DOE-authorized reactor review.

5.0 Relevant Past and Current Documents

The following are completed, planned, or ongoing assessments and guidance documents related to NRC and DOE NEPA reviews for siting and operating advanced non-light-water reactors.

NRC Documents

Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437)(NRC 2013). This GEIS for license renewal examines the possible environmental impacts that could occur as a result of renewing licenses of individual nuclear power plants under 10 CFR Part 54.

Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Columbia Generating Station — Final Report (NUREG-1437, Supplement 47) (NRC 2012). This Supplemental SEIS was prepared in response to an application submitted by Energy Northwest to renew the operating license for the Columbia Generating Station.

Final Supplemental Environmental Impact Statement for COLs for Vogtle Electrical Generating Plant Units 3 and 4. This EIS was issued for a COL following the initial EIS that was completed at the ESP stage (see Section 2.1.2) (NRC 2011).

Final Supplemental Environmental Impact Statement for COLs for Turkey Point, Units 6 and 7. This EIS was issued for a COL application (see Section 2.1.2) (NRC 2016)

Final Environmental Impact Statement for Clinch River ESP. This EIS applied the NEI 10-01 PPE framework in support of an ESP for new nuclear power units demonstrating small modular reactor technology (see Section 2.1.2.1) (NRC 2019).

Generic Environmental Impact Statement for Advanced Nuclear Reactors. This GEIS is in development and uses a technology-neutral plant and SPE approach to present impact analyses common to many or most advanced reactors that can be addressed generically, thereby eliminating the need to repeatedly reproduce the same analyses each time a licensing application is submitted and allowing applicants and NRC staff to focus future environmental review efforts on issues that can only be resolved once a site is identified (see Section 2.1.3).

DOE Documents

Draft Environmental Impact Statement for the Virtual Test Reactor. This EIS evaluates the potential environmental impacts of proposed alternatives for the construction and operation of a new test reactor at INL (DOE 2020).

Environmental Assessment for the Microreactor Applications Research Validation and Evaluation (MARVEL) Microreactor. This EA evaluates the environmental impacts of a proposal to construct a microreactor inside INL's Transient Reactor Test Facility. The MARVEL design is a sodium-potassium-cooled, thermal microreactor with a power level of less than 100 kW of electricity using high-assay low-enriched uranium nuclear fuel (DOE 2021)

NRIC Advanced Nuclear Reactor Plant Parameter Envelope and Guidance. This PPE/SPE establishes parameters for microreactors and small- to medium-sized advanced reactors, which could be incorporated into an EIS to evaluate bounding environmental impacts of the deployment of any particular advanced reactor with design parameters falling within the envelopes (NRIC 2021).

DOD Documents

Environmental Impact Statement for Construction and Demonstration of a Prototype Advanced Mobile Nuclear Microreactor (PELE) (85 FR 12274). This EIS is in development and analyzes the design, construction, and demonstration of a prototype mobile nuclear reactor, which may be carried forward for analysis as potential Mobile Nuclear Power Plant reactor design.

6.0 Conclusions

Whether a reactor would require an NRC license and/or DOE authorization, regardless of the siting location, depends on the purposes and goals of the project. While the processes for NRC licensing and DOE authorization differ and there are multiple approval scenarios under each, the information necessary to inform the environmental review would be similar. Application of PPE and SPE values, as analyzed and applied in the ANR GEIS and potentially applied in a DOE or other siting or programmatic EIS, can streamline the process, by allowing applicants to demonstrate that their reactor prototypes have been bounded by previous environmental reviews. During the project-specific NEPA review for deployment of a specific reactor design conducted after either a NRC or DOE programmatic NEPA review, the impacts of the proposed reactor would be compared with the impacts of the surrogate reactor previously analyzed. Assuming that the impacts are bounded by the analyses of the surrogate reactor, the applicant would need to demonstrate that the impacts are bounded, but no additional impact analysis would be needed. For specific parameters exceeding the values identified in the PPE, additional design-specific or project-specific NEPA analysis would be necessary. This would likely be completed through the development of a Supplemental EA or EIS, depending on the overall project level of impact and the significance of the values exceeding the PPE.

The benefit of the ANR GEIS (for NRC licensing) or a DOE siting or programmatic EIS incorporating the NRIC PPE and SPE values (for an NRC ESP or a DOE authorization) is that it would resolve certain project- and site-related issues prior to finalization of specific project designs or siting locations. If these documents are not applicable or have not been completed, instead of being able to demonstrate consistency with a generic analysis, the project-specific EIS would need to analyze all aspects of the reactor design, siting, and transportation that have an environmental nexus. To streamline potential future project-level reviews, DOE could apply directly to NRC for an ESP for one or more sites on DOE property. The associated EIS could be informed both by the NRIC PPE parameters and the ANR GEIS PPE parameters, and could serve to meet the NEPA and site suitability requirements of both agencies.

The breadth of information to be included in an applicant's NRC ER (or equivalent for a DOE NEPA review) depends on whether the responsible agency can rely upon previous analysis in the ANR GEIS or a DOE siting or programmatic EIS (for example, using the NRIC PPE [NRIC 2021]). A subsequent report will identify specific resource information that should be included in an applicant's ER depending on the type of license or authorization required and which previous NEPA assessments have been completed by DOE and NRC.

7.0 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, Energy, Part 20, "Standards for Protection Against Radiation."

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

10 CFR Part 51. *Code of Federal Regulations*, Title 10, *Energy*, Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

10 CFR Part 52. *Code of Federal Regulations*, Title 10, *Energy*, Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

10 CFR Part 53. *Code of Federal Regulations*, Title 10, *Energy*, Part 53,

10 CFR Part 54. *Code of Federal Regulations*, Title 10, *Energy*, Part 53, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants.”

10 CFR Part 73. *Code of Federal Regulations*, Title 10, *Energy*, Part 73, "Physical Protection of Plants and Materials."

10 CFR Part 100. *Code of Federal Regulations*, Title 10, *Energy*, Part 100, "Reactor Site Criteria."

10 CFR Part 830. *Code of Federal Regulations*, Title 10, *Energy*, Part 830, “Nuclear Safety Management.”

42 U.S.C. § 2133. Atomic Energy Act Section 103, “Commercial Licenses.”

42 U.S.C. § 2134(c). Atomic Energy Act, Section 104, “Medical, Industrial, and Commercial Licenses,” Subpart C, *Research and Development Activities*.

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