



2024 TECHNICAL REPORT

Nuclear Facility Separation

Topical Report ANT LR 2024-03

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Topical Report ANT LR 2024-03

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E. Thornsby

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3420 Hillview Avenue, Palo Alto, California 94304-1338 USA
800.313.3774 ▪ 650.855.2121 ▪ askepri@epri.com ▪ www.epri.com



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LMNT Consulting, LLC
4811 Fairvista Drive
Charlotte, NC 28269

Principal Investigator
S. Nesbit

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ABSTRACT

Currently, the worldwide nuclear industry is looking at a number of opportunities for the expanded use of nuclear energy to support future energy markets and achieve goals for clean and reliable energy. A concept called nuclear facility (NF) separation, introduced in a recent EPRI report (3002026499) [1], has the potential to lower design, construction, and operating costs, especially in new applications which may utilize nuclear energy in non-electric applications. In this context, NF separation is used to focus nuclear plant license applicant/operator and regulator resources on the portions of the plant that could affect public health and safety in a significant way. This is done by clearly establishing how “separation” (encompassing physical, functional, and programmatic separation) can be achieved such that the licensing requirements are clearly delineated between the most significant aspects of a nuclear plant and those that are not required to meet higher nuclear quality expectations. The motivation for introducing this concept and applying it more clearly to nuclear plant licensing is that organizations considering industrial applications of nuclear energy have expressed concerns that the proximity of a nuclear plant may adversely affect their non-nuclear operations by imposing nuclear quality requirements on adjacent facilities (AFs). Providing a clear regulatory delineation between the NF and AFs should help ameliorate those concerns.

This topical report addresses current regulatory implications of NF separation using the United States framework as a basis. However, given significant similarities among individual countries/regions in the wider global regulatory framework, it is expected that the overall concept could be extended (with some adaptation) to other regulatory environments. In this report, the detailed discussion and the example are based on the U.S. regulations to illustrate the practical implementation of the concept. The report supports the general conclusion that most of the U.S. regulatory requirements associated with a construction authorization or operating license are not applicable to AFs outside the NF, provided the nuclear plant satisfies the separation criteria in EPRI report 3002026499, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities* [1].

In addition, the report describes processes for documenting NF separation and ensuring that separation is maintained throughout the lifetime of the plant. It also includes examples of how NF separation could be implemented for advanced nuclear power reactors.

Keywords

Advanced reactors
Design envelope
Nuclear facility separation

EXECUTIVE SUMMARY

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Product Title: Nuclear Facility Separation: Topical Report ANT LR 2024-03

Primary Audience: Developers of new reactors interested in reducing reactor capital and operations and maintenance costs

Secondary Audience: Future owner-operators and other stakeholders interested in reducing reactor capital and operations and maintenance costs

KEY RESEARCH QUESTION

Can a clearer definition of the separation of the nuclear facility portion of a nuclear plant from adjacent facilities provide efficiencies in construction, licensing, and operations?

RESEARCH OVERVIEW

The purpose of this research is to describe how the EPRI separation approach described in EPRI 3002026499 impacts licensing and certification requirements for nuclear power reactors in the United States Code of Federal Regulations. Through an analysis of the U.S. licensing requirements for nuclear plants, this topical report provides a formal approach to developing an appropriate regulatory scope by applying the principle of nuclear facility separation.

KEY FINDINGS

- If the separation criteria of EPRI report 3002026499, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities*, are met, most of the technical requirements associated with the regulations governing licensing of nuclear reactors in the United States will be applicable only to the identified nuclear facility, not to adjacent facilities.
- The report includes an example of how nuclear facility separation could be implemented for all types of nuclear reactors licensed under the Nuclear Regulatory Commission regulations in 10 CFR Part 50 or 10 CFR Part 52.

WHY THIS MATTERS

The report provides a methodology for achieving efficiencies from nuclear facility separation in a form suitable for regulatory review and approval.

HOW TO APPLY RESULTS

Following its review and approval by the NRC, this report will provide a reference for reactor developers and reactor owner-operators seeking to streamline the regulatory process for new nuclear plants incorporating nuclear facility separation.

LEARNING AND ENGAGEMENT OPPORTUNITIES

- Users of this report may contact EPRI for further information or engagement opportunities regarding this report.

EPRI CONTACTS: Eric Thornsby, Principal Technical Leader, ethornsby@epri.com

PROGRAM: Advanced Nuclear Technology, P 41.08.01

IMPLEMENTATION CATEGORY: Reference

ACRONYMS

AC	alternating current
AF	adjacent facility
ARCAP	Advanced Reactor Content of Application Project
ASME	American Society of Mechanical Engineers
BPV	boiler and pressure vessel
CFR	Code of Federal Regulations
DID	defense-in-depth
ECCS	emergency core cooling system
FSAR	final safety analysis report
GDC	General Design Criteria
HALEU	high assay low enriched uranium
HTGR	high temperature gas-cooled reactor
ITAAC	Inspections, Tests, Analyses, and Acceptance Criteria
LWR	light water reactor
MW _{th}	megawatt-thermal
NF	nuclear facility
NRC	Nuclear Regulatory Commission
OM	operation and maintenance (in the context of the ASME Code)
PDC	principal design criteria
PRA	probabilistic risk assessment
PSAR	preliminary safety analysis report
RG	regulatory guide
SAR	safety analysis report
SRP	Standard Review Plan
SSC	structure, system, or component (or structure, system, and component, depending on context)
TMI	Three Mile Island
TRISO	tristructural isotropic

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1 INTRODUCTION

1.1 Background

The Nuclear Regulatory Commission (NRC) and its predecessor organization, the Atomic Energy Commission, have been licensing nuclear reactors for use in the United States since the 1950s. The first commercial nuclear power plant, Shippingport, received its operating licensing in 1957. Most of the larger reactors were light water reactors (LWRs) operated for the production of electricity. Such plants consist of a large number of structures, systems, and components (SSCs), some of which are used to enable and control a nuclear chain reaction in the core, and others of which use the energy (hot water or steam) to power a turbine generator and produce electricity for the grid. In normal operation, very few of the radionuclides produced by the operation of the reactor escape the plant boundary to reach the surrounding environment. Off-normal events and accidents could result in more significant radionuclide releases and measurable radiation dose to members of the public, with the potential for prompt or latent adverse health effects. Accordingly, nuclear power plants also include SSCs intended to prevent or mitigate potential off-normal events and accidents and thereby protect the public from the inadvertent and uncontrolled release of radionuclides.

For practical reasons, plant SSCs are often (but not always) grouped together physically based on function and purpose. For example, SSCs like the reactor vessel and primary coolant system piping are located inside the containment structure. Safety systems like control rods or coolant injection are located in the containment or the attached auxiliary building. Power conversion equipment like feedwater pumps, the turbine generator, and the condenser are located in the turbine building. Nuclear facility (NF) separation, as discussed in this report, is a more intentional and structured approach than that taken with the current generation of operating nuclear reactors. NF separation establishes a formal functional boundary between the NF (with at least one nuclear reactor) and adjacent facilities (AFs) that interface with the NF and carry out the commercial or research mission of the plant (e.g., generating electricity, producing process heat, and irradiating material). This topical report addresses the implications of NF separation on licensing and operating a nuclear plant, with a goal of simplifying the overall process and enabling savings in the cost of construction and operation.

1.1.1 Need

Nuclear energy is reliable, dispatchable, and carbon free, and it has a high energy density. Its primary output is heat, which can be utilized for a number of energy applications, including electricity, process heat, district heating, district cooling, and desalination. As a result, it offers many advantages in a future sustainable energy system.

Currently, there are a number of challenges to the expanded use of nuclear energy to support future energy markets. These include high capital costs, high operations and maintenance costs, and other barriers unique to utilizing nuclear energy in non-electric applications.

NF separation has the potential to lower design, construction, and operating costs. This would be done by focusing nuclear plant license applicant/operator and regulator resources on the portions of the facility that could affect public health and safety in a significant way.

1.1.2 EPRI Technical Report on Separation

In November 2023, EPRI issued report 3002026499, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities* [1]. The report defines a technology- and regulator-neutral methodology to demonstrate separation of an NF from AFs. In this sense, “separation” is defined to be a structured approach to the design and licensing of a nuclear plant that appropriately addresses quality requirements in AFs, including the appropriate design, technical, and regulatory footprint between the NF and AFs.

The report is certainly applicable to nuclear power reactors operating in the traditional electricity generation mode. It is also applicable to reactors involved in different clean energy missions, such as providing process steam for industrial uses or heating a process fluid for energy storage, and to research missions such as support of advanced reactor development. Moreover, EPRI 3002026499 is applicable to nuclear reactors worldwide; it is not predicated on any particular regulatory system. The report provides the methodology to demonstrate separation, guidance on how to develop reactor technology for utilization in separated facilities, and guidance on verifying and maintaining separation.

Some of the key definitions and concepts associated with EPRI 3002026499 are repeated here for convenience.

Definitions (taken from EPRI 3002026499):

Nuclear facility (NF): Any facility that contains at least one nuclear reactor.

Adjacent facility (AF): Any facility outside the boundary of the NF (but functionally related to the NF) that can impact the NF due to NF transients initiated by systems interfacing to the AF and external hazards originated from the AF.

NF boundary: The physical, functional, and programmatic boundary that delineates the scope between the NF and AFs.

NF design envelope: The set of technical parameters at the NF boundary that is used as input for the safety assessment of the NF. This includes parameters for interfacing systems and external hazards.

Nuclear quality requirements: These are the requirements imposed on the design, procurement, testing, installation, operations, and maintenance of SSCs due to the function that the SSC provides with regard to demonstrating compliance to nuclear regulatory requirements for the NF. These may include technical requirements, such as seismic requirements, or process requirements, such as design, procurement, testing, or quality assurance requirements.

Regulatory limits: Regulatory limits include all applicable radiological and nuclear safety limits defined by the regulator. These may include dose limits, effluent release limits, fuel damage limits, and offsite release limits. The scope of this methodology is focused on nuclear regulatory limits, but the same process could consider other limits (e.g., chemical hazards).

Safety assessment: The set of qualitative and quantitative analyses required to demonstrate that regulatory limits are met.

The separation concept is presented in Chapter 1 of EPRI 3002026499 as the following:

- Divide a facility into a nuclear portion (that is, NF) and a non-nuclear portion (that is, AFs) with a clear physical, functional, and programmatic boundary between the two.
- Identify the interfacing systems and external hazards that can affect the NF.
- Define the parameters for the interfacing systems and external hazards at the NF boundary in the NF design envelope.
- Demonstrate the safety case using the NF and the NF design envelope, including verification of key separation criteria.

Verification of the NF design envelope is then managed separately from the demonstration of the safety case—first during construction of the facility, and then during operations and maintenance.

Figure 1-1 illustrates this concept.

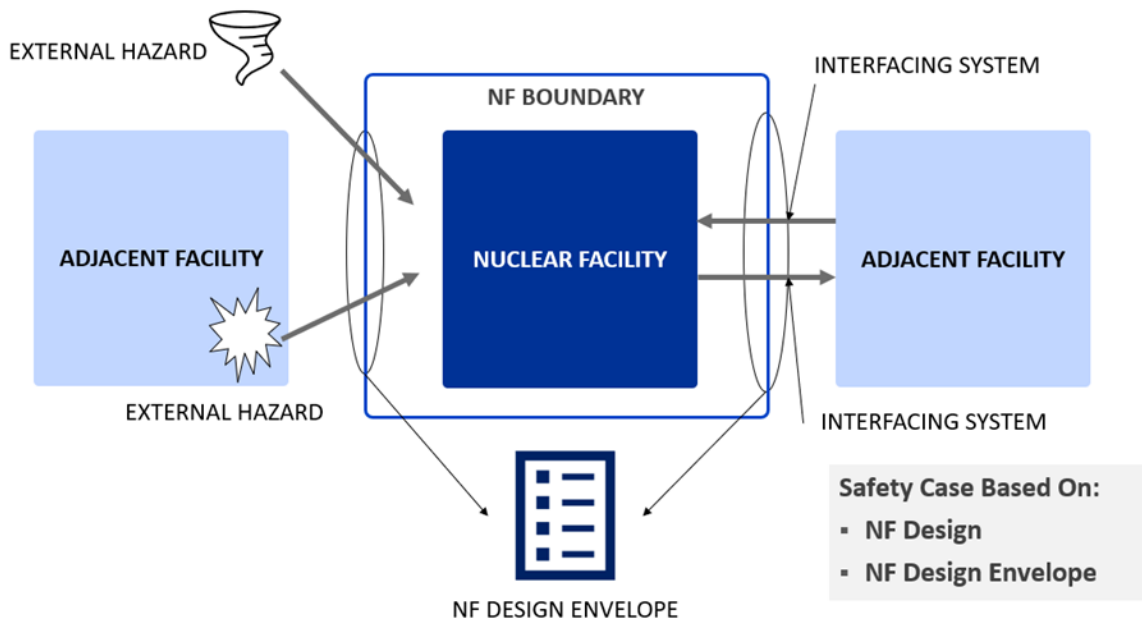


Figure 1-1. Concept for separating an NF from AFs (Figure 4 from EPRI 3002026499)

Chapter 2 of EPRI 3002026499 describes a process for performing the design and safety assessment of a nuclear plant and demonstrating separation between the NF and the AF or AFs. The goal of the process is to verify that two separation criteria are met. Those criteria are defined and discussed under Step 5 of Chapter 2 of the EPRI report:

Criterion 1

For normal conditions, the amount of radiation and radiological material crossing the NF boundary shall be maintained within regulatory limits.

To meet this criterion, the NF design must ensure that any potential exposure to radiation or radiological material during normal conditions is controlled within acceptable limits at the NF boundary. This eliminates the need for AF SSCs to meet nuclear quality requirements for control of radiation and radionuclides, and eliminates the need for the regulator to review those SSCs.

Criterion 2

For abnormal and accident conditions, the safety assessment shall demonstrate that all applicable regulatory limits are met with the following constraints:

- The safety assessment is based on the parameters defined in the NF design envelope.
- Only NF SSCs and NF operator actions can be credited in the safety assessment.

Meeting this criterion eliminates the need for nuclear quality requirements to be applied for SSCs outside the NF, and minimizes the need for regulatory oversight of the AFs. Specifically, oversight can be limited to inspection that the verification of the NF design envelope has been performed.

Chapter 2 of EPRI 3002026499 addresses various scenarios for application of NF separation. The baseline process description applies to the concurrent development of NF and AF designs. The following other scenarios are also discussed:

- Existing NFs (adding a new AF, such as a hydrogen production facility, to a pre-existing NF)
- Existing AFs (adding a new NF, such as a nuclear reactor to produce steam for an existing chemical plant, to an existing AF)
- Pre-approved reactor design (using a pre-approved design, such as a standard design certification under 10 CFR Part 52,¹ for deployment at a specific site)

¹ U.S. Code of Federal Regulations (CFR) Title 10 refers to regulations associated with energy applications and includes licensing of currently operating light water reactors (LWRs).

The separation methodology of EPRI 3002026499 is independent of technology and, as stated previously, applicable to nuclear reactors worldwide. The regulatory implementation details discussed in this report use the U.S. framework as a basis. However, given significant similarities in the regulatory framework of some individual countries/regions, it is expected that the overall concept could be extended (with some adaptation) to those other regulatory environments.

1.1.3 TerraPower Topical Report on Natrium Nuclear Island

TerraPower submitted topical report NATD-LIC-RPRT-0001, “Regulatory Management of Natrium Nuclear Island and Energy Island Design Interfaces,” to the NRC for review in October 2022 [2]. The NRC issued a final safety evaluation (SE) on the report in September 2023 [3]. The activity was part of pre-submittal interactions between TerraPower and the NRC on the Natrium reactor. Subsequent to issuance of the SE, in March 2024 TerraPower submitted a construction authorization request for a Natrium reactor at a site near Kemmerer, Wyoming.

The “nuclear island” in the TerraPower report is analogous to the NF as used in this report. While NATD-LIC-RPRT-0001 did not apply the specific separation methodology of EPRI 3002026499, the TerraPower report was consistent with the general approach of EPRI 3002026499; that is, it used functional separation between the NF and AFs to focus the regulatory review on the NF. Unlike this topical report, the TerraPower report was design-specific for the Natrium reactor. Also, NATD-LIC-RPRT-0001 did not address the range of NRC requirements considered in this report in a generic manner, but instead focused on four specific regulations as they relate to Natrium:

- License Required; Limited Work Authorization (10 CFR 50.10)
- Operators’ Licenses (10 CFR Part 55)
- Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants (10 CFR 50.65)
- Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants (10 CFR 50, Appendix B)

This topical report addresses all of these regulations except 10 CFR Part 55. See Section 1.2 below for further discussion of the scope of this topical report.

Because of these differences between NATD-LIC-RPRT-0001 and EPRI 3002026499, the conclusions in the NRC SE for NATD-LIC-RPRT-0001 are not directly applicable to this report. However, the detailed regulatory analyses in this topical report (Appendices A and B) note those instances in which NATD-LIC-RPRT-0001 addressed the same regulatory requirement.

1.2 Scope and Purpose

This topical report addresses current regulatory implications of NF separation in the United States. It describes how the separation approach described in EPRI 3002026499 impacts licensing and certification requirements for nuclear power reactors in 10 CFR Part 50 [4] and

10 CFR Part 52 [5]. It describes processes for documenting NF separation and ensuring that separation is maintained throughout the lifetime of the plant. The report includes an example of how NF separation could be implemented for advanced nuclear power reactors.

This topical report supports the general regulatory conclusions identified in Chapter 6 of EPRI 3002026499, and the information in the report may be used to support designs and/or site-specific regulatory actions as described and justified in application-specific submittals. Specifically, those conclusions are that, for plants meeting the separation criteria of EPRI 3002026499:

- Except for those regulations identified in Table 3-1 of this topical report, 10 CFR Part 50 requirements associated with a construction authorization or operating license are not applicable to AFs outside the NF.
- Except for those regulations identified in Table 3-1 of this topical report, 10 CFR Part 52 requirements for a combined license or design certification are not applicable to AFs outside the NF.
- Information on AFs is not required in the safety analysis report (SAR) unless it is specifically required by 10 CFR 50.34 or 10 CFR 52.79.

This topical report is intended for application to the range of potential scenarios discussed in EPRI 3002026499 and Section 1.1 of this report. NF separation may be addressed in an original license application or in an amendment to an existing license. The license could be issued under 10 CFR Part 50 or 10 CFR Part 52, as discussed in Chapter 2 of this report. The regulatory analysis in Chapter 3 should be applicable to any of the scenarios, while the process for verifying that separation criteria are met may vary depending on the specific situation.

1.3 Content and Structure

Chapter 2 of the report addresses current and potential new licensing pathways for nuclear reactors in the United States. Chapter 3 summarizes a regulatory analysis of the implications of NF separation for the two current reactor licensing regulations: 10 CFR Part 50 for traditional two-step licensing (an initial construction permit followed by an operating license) and 10 CFR Part 52 for standard design certifications and combined construction and operating licenses. Chapter 4 covers the documentation of NF separation during initial licensing and afterward, during plant operation. Chapter 5 provides an example application of NF separation. Chapter 6 presents a summary of the report and the conclusions for which NRC regulatory approval is sought. Chapter 7 presents the report references. Appendices A and B contain the details of the regulatory analysis that is summarized in Chapter 3.

2 LICENSING PATHWAYS

In the United States, the NRC is responsible for licensing various types of nuclear reactors. For nuclear power reactors, there are different approaches to obtaining an operating license. The main approach used for reactor licensing for many decades is contained in 10 CFR Part 50, Domestic Licensing of Production and Utilization Facilities. In its current form, 10 CFR Part 50 provides for two classes of license:

- Class 103 licenses, which cover commercial and industrial facilities as established in 10 CFR 50.22
- Class 104 licenses, which address medical therapy and research and development facilities in accordance with 10 CFR 50.21

In practice, all of the commercial nuclear power reactors currently operating in the United States, with the exception of Vogtle Units 3 and 4, obtained Class 103 licenses under 10 CFR Part 50.² Licensing under 10 CFR Part 50 is addressed further in Sections 2.1 and 2.2.

As used in 10 CFR Part 50, the word “facilities” is intentionally broader than “reactors.” 10 CFR Part 50 can conceivably be applied to other facilities, such as reprocessing plants. In practice, the regulation has evolved over the decades such that the provisions are focused on nuclear power reactors. This report pertains only to nuclear reactors, not to other facilities.

The NRC issued 10 CFR Part 52 to establish an alternative licensing process for nuclear power plants. It sets forth regulatory requirements associated with a number of processes: early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses. The regulation applies only to nuclear power reactors. This report specifically addresses standard design certifications (10 CFR Part 52, Subpart B) and combined licenses (10 CFR Part 52, Subpart C) as discussed in Sections 2.3 and 2.4, respectively.

As of the publication of this topical report, the NRC is developing a new regulation for the licensing of advanced reactors—10 CFR Part 53. That potential future regulation is discussed further in Section 2.5.

Chapters 2 and 3 of EPRI 3002026499 describe a process that integrates the establishment of the NF boundary and associated design envelope as part of the overall facility design and safety assessment. For the purpose of this licensing discussion, it is assumed that the EPRI 3002026499 process (depicted in Figure 5 of EPRI 3002026499 and denoted the “Separation

² At the time all currently operating reactors other than Vogtle 3 and 4 were ordered, 10 CFR Part 50 was the only available option (10 CFR Part 52 had not yet been promulgated). Numerous plants began the licensing process under 10 CFR Part 52 in the 2000s, and some of those plants received combined licenses, but only the Vogtle units completed construction.

Process” in this topical report) is followed. With that being said, it is not essential that the process be followed in all aspects, only that the NF boundary and associated design envelope be established and the separation criteria met.

In August 2019 the Nuclear Energy Institute (NEI) developed guidance document NEI 18-04, Revision 1, “Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development” [6], as an optional licensing approach for advanced non-LWRs. NEI 18-04 describes a methodology for selection of licensing basis events; safety classification of SSCs and associated risk-informed special treatments; and determination of defense-in-depth (DID) adequacy for non-LWRs. The approach is also referred to as the Licensing Modernization Program (LMP) methodology. The NRC endorsed the document in Regulatory Guide (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” [7], issued in June 2020. It is not necessary for an advanced non-LWR to follow the NEI 18-04 methodology to take advantage of NF separation as described in this report. However, the application of the LMP is entirely consistent with NF separation. The expectation is that the SSCs identified as necessary to address licensing basis events and provide for DID and the meeting of cumulative risk targets (i.e., safety-related and non-safety-related with special treatment SSCs per NEI 18-04) would be physically located within the NF boundary.

2.1 10 CFR Part 50 Construction Permit

The 10 CFR Part 50 reactor licensing process is often referred to as “two-step licensing.” The first step is the issuance of the construction permit, as described in 10 CFR 50.35. When issued, the construction permit allows the applicant to proceed with construction of the facility. In the second step, the applicant amends the application to provide further technical or design information as may be required to complete the safety analysis. Once the NRC has reviewed the additional information and made a finding that the application meets the necessary requirements, including that the facility can be “operated ... without undue risk to the health and safety of the public,” the NRC will issue an operating license, as described in 10 CFR 50.50.

The standards for issuing a construction permit are less stringent than those associated with an operating license. The primary advantage of two-step licensing is that it allows the applicant to start construction prior to resolving all issues associated with the application.

For the purpose of this section of the report, it is assumed that the applicant is using two-step licensing for a design that is not complete at the point of submitting the construction permit application. Accordingly, the safety assessment of the design would also not be fully mature at that point. It is anticipated that, at the point of submitting a construction permit application, the applicant has developed an initial concept of the NF boundary and design envelope such that the Separation Process has been exercised through at least one iteration, but the separation evaluation is not fully mature. With that being said, nothing would preclude an applicant from obtaining a construction permit with no mention of NF separation in the application and subsequently applying for an operating license that incorporates NF separation.

The regulatory evaluation of the 10 CFR Part 50 requirements is provided in Chapter 3 and Appendix A of this report.

2.2 10 CFR Part 50 Operating License

The operating license application is the second step of the two-step licensing process under 10 CFR Part 50. Historically, at the time of operating license application, construction is under way, and the design and safety assessment have matured to the point that the applicant can put forward a case that the requirements for issuing an operating license have been met. At the time of the operating license application, this report anticipates that the Separation Process will have been fully exercised and the separation evaluation finalized. The operating license application should take advantage of NF separation in the demonstration that regulatory requirements have been met.

2.3 10 CFR Part 52 Design Certification

10 CFR Part 52, Subpart B, addresses standard design certifications. The focus of Subpart B is an applicant seeking “a standard design certification for a nuclear power plant design which differs significantly from light water reactor designs [licensed as of 1989 and that] uses simplified, inherent, passive, or other innovative means to accomplish its safety functions.” The intent is that an applicant for a construction permit or combined license may reference an already-completed standard design certification and thus streamline the licensing process.

The purpose of a design certification is to document regulatory approval for a nuclear power plant design. The applicant exercises the design certification without a specific site. However, the applicant provides a reference conceptual design for those portions of the plant for which the applicant does not seek certification [see 10 CFR 52.47(a)(24)]. The applicant also specifies interface requirements to allow completion of the final safety analysis report (FSAR) [see 10 CFR 52.47(a)(25)].

The applicant may develop the nuclear plant design required for a design certification in a manner that enables the application of NF separation, and this would be reflected in the reference design and interface requirements. Such an approach to the non-site-specific design provides an advantage in meeting the final plant NF separation criteria. However, NF separation consistent with the NF separation criteria in Report 3002026499 cannot be demonstrated fully until there is an application with both a design and a site.

Determining the extent to which the technical requirements are applicable to areas and facilities outside the NF should be informed by the regulatory evaluation of the 10 CFR Part 50 requirements corresponding to specific 10 CFR Part 52, Subpart B, requirements.

2.4 10 CFR Part 52 Combined License

10 CFR Part 52, Subpart C, addresses combined licenses. As the name suggests, combined licenses provide for a construction permit and an operating license in one licensing action. The primary advantage of the combined license is that it can reduce licensing risk by requiring only one major licensing action, versus the two separate ones (construction permit and operating license) needed under 10 CFR Part 50. A combined license applicant is expected to provide information generally consistent with the scope and level of detail of an operating license application under 10 CFR Part 50. The regulatory evaluation of the 10 CFR Part 52, Subpart C, requirements is addressed in Chapter 3 and Appendix B of this report.

2.5 10 CFR Part 53

Pursuant to the Nuclear Energy Innovation and Modernization Act [8], in 2019 the NRC initiated the development of a technology-inclusive, risk-informed, performance-based regulation addressing the construction, operation, and decommissioning of advanced nuclear reactors. As of the submittal of this topical report, the NRC is developing such a proposed rule—10 CFR Part 53, Licensing and Regulation of Advanced Nuclear Reactors [9]. However, the formal rulemaking process had not begun. This topical report does not address 10 CFR Part 53. Depending on how the rulemaking progresses, it may be appropriate at a later date to revise this topical report to address specifically the requirements of 10 CFR Part 53.

3 REGULATORY ANALYSIS

This topical report documents regulatory analyses performed on the two primary regulations governing the licensing and operation of nuclear power plants, 10 CFR Part 50 and 10 CFR Part 52. The objective of the analyses is to identify specific regulations that could credibly be applicable to areas and/or facilities located outside the NF. The remainder of the regulations would not be applicable to such areas and/or facilities. The two-step process is as follows:

1. Break the regulation into appropriate constituent sections or subsections. This is done in a manner that would provide as much specific and useful information about each component of the regulation as possible.
2. Categorize the regulation into one of the following groups:
 - Administrative requirements: These are regulatory requirements that do not address technical or quality matters, but instead address administrative matters, such as information to be provided or processes to be followed. Administrative requirements do not relate to the ability of an SSC to accomplish its intended function.
 - Not applicable to areas and facilities outside the NF (including AFs): These requirements are satisfied by the SSCs within the NF and do not require information associated with areas or facilities outside the NF to demonstrate compliance.
 - Potentially applicable to areas and facilities outside the NF: These requirements could require information associated with areas or facilities outside the NF to demonstrate compliance.

The regulatory evaluation is predicated on the facility satisfying the separation criteria from EPRI 3002026499 (and repeated in Section 1.1.2 of this topical report). In addition to the separation criteria, EPRI 3002026499 describes a process for establishing NF separation, but that process is not mandatory for the purpose of this topical report. The regulatory evaluations summarized in this section are not based on the process used to achieve NF separation.

The results of the analyses of 10 CFR Parts 50 and 52 are reported in Appendices A and B, respectively. The evaluations indicate that most of the pertinent licensing requirements do not impact areas and facilities outside the NF provided the separation criteria are met. The results are further summarized in Table 3-1 below, which collects the potentially applicable requirements from Part 50 and Part 52 and associates them with general categories, such as emergency planning. Thus, Table 3-1 identifies the general categories that may require consideration of information related to areas or facilities outside the NF.

An applicant taking advantage of NF separation to constrain the scope of regulatory review will need to consider the requirements identified in Appendices A and B (and summarized in Table 3-1) for its specific reactor technology and site. 10 CFR Part 50 and Part 52 requirements not identified in Table 3-1 need no further consideration relative to areas or facilities outside the NF.

There are, of course, other NRC regulations that apply to nuclear reactors licensed under 10 CFR Part 50 or Part 52. For example, 10 CFR Part 20 establishes standards for protection against radiation that must be met for plant workers and the public. 10 CFR Part 55 addresses operators' licenses. 10 CFR Part 73 establishes requirements related to physical security and protection against radiological sabotage. 10 CFR Part 100 establishes siting criteria for nuclear power reactors. It would be possible to extend the regulatory analysis to other NRC regulations, but 10 CFR Parts 50 and 52 lay out the licensing requirements for reactors and, in the process, reference other pertinent regulations. Therefore, the 10 CFR Part 50 and Part 52 regulatory analyses are considered adequate to support the findings of this topical report. An applicant for a license or certification may elect to extend the approach by performing a regulatory analysis of one or more other regulations for its specific design and application.

The case of 10 CFR Part 55, Operator Licenses, merits further discussion here. It is the only regulation in Title 10 of the CFR, apart from Part 50, that is cited specifically in the Natrium topical report on nuclear island and energy island separation (see Section 1.1.3 of this report). 10 CFR Part 55 does not levy specific requirements directly on SSCs, but it does address the licensing of operators. 10 CFR 50.54(i) states that personnel who manipulate the controls of the facility must be reactor operators or senior reactor operators licensed pursuant to 10 CFR Part 55. 10 CFR Part 55 also provides clarification about what constitutes "controls." The NRC, in its SE of the Natrium topical report, concluded that the operation of the main turbine generator in the Natrium energy island does not fall under the scope of 10 CFR 50.54(i) because the Natrium energy island steam loads do not directly affect the reactivity or power level of the reactor.

This topical report does not explicitly consider 10 CFR Part 55 because it is outside of 10 CFR Parts 50 and 52. 10 CFR 50.54 is titled Conditions of Licenses, and the contents apply to a range of conditions associated with operating a nuclear reactor (for example, quality assurance, testing, safeguards, emergency plans, security, insurance, and decommissioning). 10 CFR 50.54 is considered explicitly in the regulatory analysis of 10 CFR Part 50, as documented in Appendix A. The analysis found the requirements in 10 CFR 50.54 to be administrative in nature; that is, they do not levy technical or quality requirements on the facility. That is not intended to imply that all portions of 10 CFR 50.54 (or any other administrative requirement) are completely unrelated to all areas outside the NF.

Table 3-1. Areas of regulation potentially applicable to facilities and areas outside the NF (10 CFR Parts 50 and 52)

Regulatory Considerations Potentially Related to Areas and Facilities Outside the NF	10 CFR Part 50	10 CFR Part 52
Limited work authorization	50.10	52.80(c)
Intended use of the reactor and nature and inventory of radioactive material	50.34(a)(1)(ii)(A); 50.34(b)(11)	
Evaluation of safety features and engineered barriers	50.34(a)(1)(ii)(D); 50.34(b)(11)	
Summary description of the facility and site information	50.34(a)(2)	
Emergency planning	50.34(a)(10); 50.34(b)(6)(v); 50.47; 50.160; Appendix E	52.79(a)(21); 52.79(a)(29)(ii)
Construction impacts	50.34(a)(11); 50.34(b)(6)(vii)	52.79(a)(31)
Earthquakes	50.34(a)(12); 50.34(b)(10); Appendix S	52.79(a)(19)
Siting and site information (including natural phenomena hazards)	50.34(b)(1); General Design Criteria (GDC) 2; Appendix Q	52.79(a)(1)
Preoperational testing and initial operations	50.34(b)(6)(iii)	52.79(a)(28)
Operator training	50.34(b)(8)	52.79(a)(14); 52.79(a)(34)
Security	50.34(c)	52.79(a)(35)
Safeguards	50.34(d)	52.79(a)(36)
Protecting the environment during construction, operation, and decommissioning	50.36b	
Fire protection	50.48; GDC 3	52.79(a)(6); 52.79(a)(40)
American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code and Operation and Maintenance (OM) Code	50.55a(f), 50.55a(g)	52.79(a)(11)
Changes, tests, and experiments relating to the facility, as described in the FSAR	50.59	
Loss of all AC power	50.63; GDC 17; GDC 18	52.79(a)(9)
Maintenance rule	50.65	52.79(a)(15)
Mitigation of beyond-design-basis events	50.155(c)	52.80(d)
Control room and auxiliary shutdown	GDC 19	

Table 3-1 (continued). Areas of regulation potentially applicable to facilities and areas outside the NF (10 CFR Parts 50 and 52)

Regulatory Considerations Potentially Related to Areas and Facilities Outside the NF	10 CFR Part 50	10 CFR Part 52
Residual heat removal	GDC 34	
Cooling water (for important to safety SSCs)	GDC 44; GDC 45; GDC 46	
Compliance with Three Mile Island (TMI) requirements		52.79(a)(17)
Unresolved safety issues and medium- and high-priority generic safety issues		52.79(a)(20)
Radiation protection program		52.79(a)(39); 52.79(a)(45)
Evaluation against Standard Review Plan (SRP)		52.79(a)(41)
Probabilistic risk assessment (PRA)		52.79(a)(46)
Considerations for combined licenses referencing an early site permit, standard design approval, standard design certification, and manufacturing license		52.79(b) through 52.79(e)
Inspections, tests, analyses, and acceptance criteria (ITAAC)		52.80(a)
Environmental report		52.80(b)

The identified categories in Table 3-1 are discussed in summary fashion below. For applicants using NF separation, safety and radiation protection will focus on the NF. However, the NRC regulations are wide ranging, and even applicants with NF separation will need to address, or at least assess, areas outside the NF relative to a subset of the regulations.

- Limited work authorizations are addressed in both 10 CFR Part 50 and 10 CFR Part 52. Activities constituting construction as defined in the regulations (and therefore requiring a construction permit or a limited work authorization) could involve areas outside the NF (e.g., security-related SSCs). Note that 10 CFR 50.10 was also addressed in TerraPower topical report NATD-LIC-RPRT-0001 [2].
- Inventory of radioactive materials relates to information required in the SAR per 10 CFR Part 50. The requirements are solely informational in nature.
- Evaluation of safety features and engineering barriers per 10 CFR Part 50 may involve dose calculations at points outside the NF.
- The summary description of the facility and site information relates to information required in the SAR per 10 CFR Part 50. The requirements are solely informational in nature.
- Emergency planning shows up in both 10 CFR Part 50 and 10 CFR Part 52 as an area that could be applicable to areas and facilities outside the NF. Emergency planning involves using information from meteorological and radiological monitoring to evaluate the progression of an accident and the need for protective measures. For current LWRs, it typically involves facilities and equipment located well away from the nuclear plant (for example, instruments, sirens, and emergency operations facilities). The new emergency preparedness requirements that became effective December 18, 2023, are expected to reduce the impact outside the NF for small modular reactors and other new technologies, but large LWRs must comply with the existing regulations.
- Construction impacts are included in both 10 CFR Part 50 and 10 CFR Part 52. They relate to multi-unit sites and address issues such as the impact of construction on operating reactors.
- The earthquake category also appears in both 10 CFR Part 50 and 10 CFR Part 52. It is expected that SSCs relied upon to prevent or mitigate accidents would all be located in the NF. However, determining or validating the vibratory ground motion for which such equipment must be designed would rely on seismic hazard information from outside the NF. In addition, while equipment outside the NF would not be required to withstand earthquakes, 10 CFR 50.34(a)(12) requires the verification of no unacceptable interactions between non-seismically qualified SSCs outside the NF and required SSCs within the NF.
- Information on the reactor site and information related to siting are required by various parts of both 10 CFR Part 50 and 10 CFR Part 52. This also ties into site evaluation factors in 10 CFR Part 100.
- 10 CFR Part 50 and 10 CFR Part 52 requirements for information in the SAR related to pre-operational testing and initial operations are broad and could conceivably apply to AFs. One of the proposed findings in Chapter 6 would constrain such information to NF information for applicants that have demonstrated NF separation.

- Operator training and operator requalification information are addressed in 10 CFR Part 50 and 10 CFR Part 52. Operator responsibilities may extend beyond the NF to interfacing systems.
- Physical security requirements could require consideration of areas and facilities outside the NF. 10 CFR 50.34(c) and 10 CFR 52.79(a)(35) require a security plan addressing compliance with the requirements of 10 CFR Part 73, Physical Protection of Plants and Materials. Absent knowledge of the security strategy and equipment associated with a specific reactor and site, it is not possible to make a blanket statement that all pertinent aspects of physical security will be confined to the NF.
- Similarly, safeguards are covered in both 10 CFR Part 50 and 10 CFR Part 52. Information in various plans addressed by the regulations may extend beyond the NF.
- Provisions for protection of the environment during construction, operation, and decommissioning per 10 CFR 50.36(b) may relate to areas outside the NF.
- Fire protection is addressed in both 10 CFR Part 50 and 10 CFR Part 52. The fire protection strategy and equipment will be design- and site-specific and may extend beyond the NF.
- Both 10 CFR Part 50 and 10 CFR Part 52 contain extensive requirements related to codes and standards. The vast majority of the requirements relate to safety-related SSCs that would be in the NF, but applicability outside the NF cannot categorically be ruled out, as discussed in Appendices A and B.
- Regulations governing changes, experiments, and tests are documented in 10 CFR 50.59. These would be expected to be applicable primarily to the NF. However, the possibility that changes to the AF could have impacts on equipment in the NF cannot be ruled out. Such changes would be addressed programmatically as described in Chapter 4.
- Loss of all alternating current (AC) power is addressed in 10 CFR 50.63 and 10 CFR 52.79(a)(9). The associated requirements include a station blackout duration during which a plant must withstand a loss of all AC power, and that duration is impacted by the expected frequency and duration of a loss of all offsite power. That frequency and duration depends on the grid, which is outside the NF.
- It is expected that the vast majority of SSCs subject to the maintenance rule would be in the NF. However, the criteria of the maintenance rule (10 CFR 50.65, invoked in 10 CFR Part 52 as well) are such that some SSCs in AFs could be included. Note that 10 CFR 50.65 was also addressed in TerraPower topical report NATD-LIC-RPRT-0001 [2].
- The manner in which applicants address mitigation of beyond-design-basis events as required in 10 CFR Parts 50 and 52 will be design- and site-specific. The potential involvement of areas outside the NF, such as through storage of mitigating equipment, cannot categorically be ruled out.
- The General Design Criteria (GDC) are LWR-specific, deterministic requirements established in 10 CFR Part 50, Appendix A, and invoked by 10 CFR Part 52. GDC relate to facets of plant design such as control room and auxiliary shutdown capability, residual heat removal, and

cooling water. These will have to be addressed on an application-specific basis. A non-LWR applicant would be exempt from compliance with GDC but would be expected to establish its own principal design criteria (PDC), which may be informed by the GDC.

- 10 CFR Part 52 includes requirements related to the TMI-2 accident, Unresolved Safety Issues, and generic safety issues. These requirements cover a wide range of topics, and the latter two are moving targets in that issues may be added to or removed from the lists at any time. Accordingly, these requirements will require application-specific evaluation.
- The radiation protection program required by 10 CFR 52.79(a)(40) would be expected to focus on the NF, but program elements such as monitoring may extend into auxiliary facilities.
- Because the SRP (NUREG-0800) is wide-ranging, elements of it may extend beyond the NF. Therefore, compliance with 10 CFR 52.79(a)(41) may involve auxiliary facilities.
- 10 CFR Part 52 requires the applicant to have a probabilistic risk assessment (PRA) and describe the PRA in the SAR. The PRA model will be design- and site-specific and could be impacted by areas outside the NF.
- 10 CFR Part 52 addresses considerations for applications referencing an early site permit, standard design approval, standard design certification, and manufacturing license. The extent to which these considerations would involve areas outside the NF is dependent on the design, the site, and these other permits, approvals, certifications, or licenses.
- The inspections, tests, analyses, and acceptance criteria (ITAAC) addressed in 10 CFR Part 52 are potentially applicable to areas and facilities outside the NF because they include emergency planning.
- The environmental report required by 10 CFR 50.82 will likely address environmental impacts outside the NF.

4 DOCUMENTATION OF SEPARATION RESULTS

An applicant using NF separation to demonstrate inapplicability of regulatory requirements to AFs must 1) provide documentation that the separation criteria are met and 2) describe the program(s) ensuring that separation is maintained through the life cycle of the plant, as needed. This chapter addresses how applicants should address these requirements.

4.1 Documentation of Separation

Documentation of separation must be provided in the SAR that is included in the license application for the plant. This may be done in one of two ways: 1) as part of the application itself, or 2) through a topical report that is reviewed and approved by the NRC and incorporated by reference in the application. Potential advantages of the topical report approach include 1) reducing the scope of the application review and 2) resolving separation-related issues as early as possible in order to better inform downstream design and regulatory decisions. Both the application-only and topical report options are feasible, and the applicant should choose the best approach for its situation. Whatever approach is ultimately followed, it is recommended that NF separation be a topic of pre-application discussions between the applicant and the NRC, and those discussions should be factored into the applicant's decision on how to address documentation of separation.

For applicants that elect to include separation information in the application itself, specific chapters and sections of the SAR in which to include this information are recommended in Section 4.1.1 below. If the applicant elects to provide the NF separation information in a topical report, the SAR chapters and sections discussed below would reference the appropriate portions of the topical report to ensure that the required information is incorporated by reference in the SAR.

4.1.1 *Location of Separation Information in the Safety Analysis Report*

The organization of the information in the SAR is also a decision for the applicant that should be taken in consultation with the NRC, but there are precedents and guidance that will inform the approach taken. The following guidance addresses three specific cases: traditional large LWRs, non-power reactors, and advanced non-LWRs.

4.1.1.1 Traditional Light Water Reactors

There is an established organization for LWR SARs that traces back to several regulatory guidance documents. For applications submitted under 10 CFR Part 50, the applicable documents are RG 1.70, Revision 3, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition" [10], and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants—LWR Edition" [11]. RG 1.70 outlines a 17-chapter SAR, and the most recent version of NUREG-0800 outlines a 19-chapter

SAR, with the first 17 chapters consistent with RG 1.70.³ The NRC also issued RG 1.206, Revision 1, “Applications for Nuclear Power Plants” [12], with format and content guidance for applications submitted under 10 CFR Part 52. RG 1.206 provides for a 19-chapter SAR, consistent with NUREG-0800.

Because they predate the EPRI methodology for NF separation, the aforementioned regulatory guidance documents do not address the location of information that would support the use of NF separation. Based on the organization of information provided by RG 1.70, RG 1.206, and NUREG-0800, it is recommended that an applicant using the standard LWR format and content include a new Section 3.14 in SAR Chapter 3 (Design of Structures, Components, Equipment, and Systems) that summarizes NF separation at a high level and provides information on the incorporation of NF separation in the design (for example, technical information and evaluation summaries associated with NF separation).

In addition, SAR Chapter 13 (Conduct of Operations) should include a summary of the program(s) ensuring that NF separation is maintained throughout plant operations. The program information should be included within Section 13.4 (Operational Programs). The approach is illustrated in Figure 4-1.

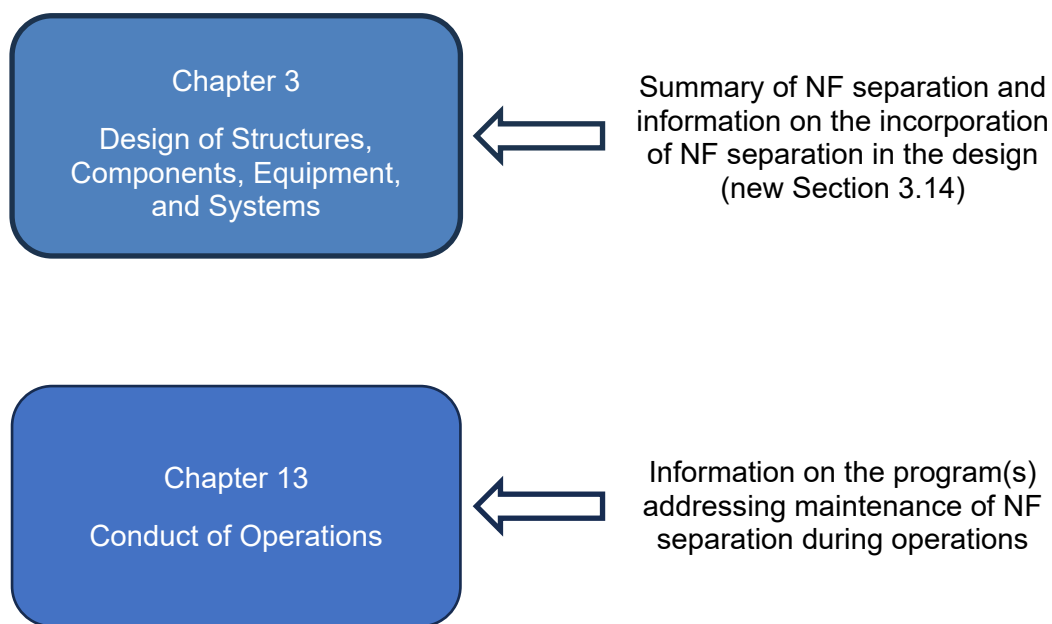


Figure 4-1. NF separation information in an LWR SAR

³ Chapters 18 and 19 address human factors engineering and probabilistic risk assessment, respectively. Increased focus in both areas was one of the many changes instituted after the TMI Unit 2 accident in 1979.

4.1.1.2 Non-Power Reactors

The NRC issued NUREG-1537, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” in February 1996. Therefore, the document does not address the location of information that would support the use of NF separation. Based on the organization of information provided in Part 1 of NUREG-1537 (Format and Content), it is recommended that an application following this guidance address NF separation as described below and shown in Figure 4-2.

- Summarize NF separation at a high level in Section 1.2, Summary and Conclusions on Principal Safety Considerations.
- Add a new Section 3.6 in SAR Chapter 3 (Design of Structures, Systems, and Components) that provides information on the incorporation of NF separation in the design (for example, technical information and evaluation summaries associated with NF separation).
- Add a new Section 12.12 in SAR Chapter 12 (Conduct of Operations) to summarize the program(s) ensuring that NF separation is maintained throughout plant operations.

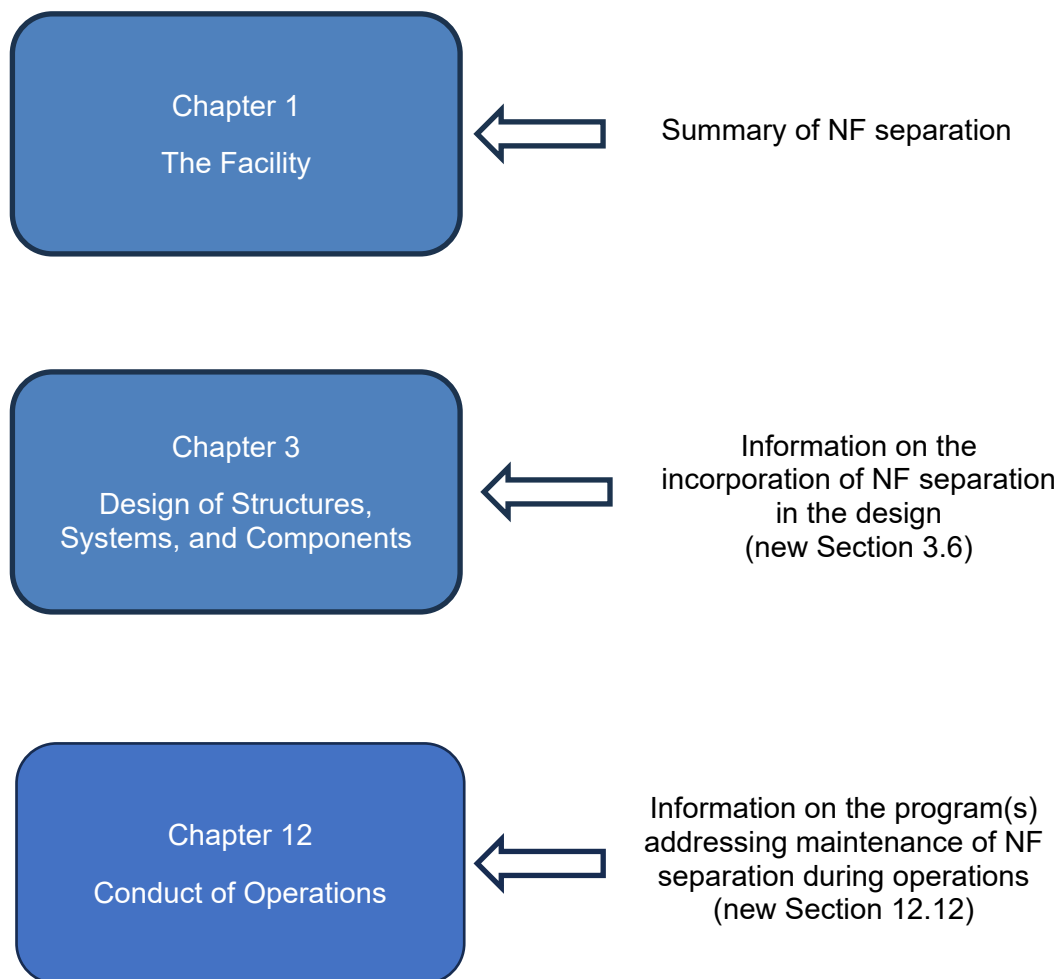


Figure 4-2. NF separation information in a non-power reactor SAR

4.1.1.3 Advanced Reactors

As part of the NRC’s Advanced Reactor Content of Application Project (ARCAP), in 2023 the agency issued draft guidance documents for the review of non-LWR applications for construction permits or operating licenses under 10 CFR Part 50 and for combined licenses, manufacturing licenses, standard design approvals, and design certifications under 10 CFR Part 52. The NRC finalized those guidance documents in March 2024. One of the ARCAP guidance documents, DANU-ISG-2022-01, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications—Roadmap” [13], incorporates a 12-chapter SAR organization that differs significantly from the traditional LWR approach. The first eight chapters are based on the advanced reactor SAR guidance document 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” [14], and the associated NRC 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” [15].

Therefore, the aforementioned documents provide no guidance on where to include information that supports the use of NF separation. Based on the organization of information as provided in DANU-ISG-2022-01, NEI 21-07, Revision 1, and RG 1.253, it is recommended that the applicant using ARCAP guidance include information pertaining to NF separation in several places, as described below and shown in Figure 4-3:

- NF separation should be introduced in SAR Chapter 1 (General Plant Information, Site Description, and Overview of Safety Analysis) in a new Section 1.3.4.
- Information on the incorporation of NF separation in the design (for example, technical information and evaluation summaries associated with NF separation) should be described in a dedicated section of SAR Chapter 2 (Methodologies, Analyses, and Site Evaluations).
- The program(s) ensuring that NF separation is maintained through the life cycle of the plant should be summarized in SAR Chapter 8 (Plant Programs).

While this section of the topical report provides guidance for advanced reactor applicants that follow the SAR organization documented in DANU-ISG-2022-01, it is important to note that applicants are not obligated to do so. If an advanced reactor applicant uses a different organization for its SAR, the applicant should identify appropriate locations in the SAR for the NF separation information. In such an instance, it is recommended that the applicant and the NRC engage in pre-application discussions on this point with a goal of identifying mutually agreeable locations for NF separation information in the SAR.

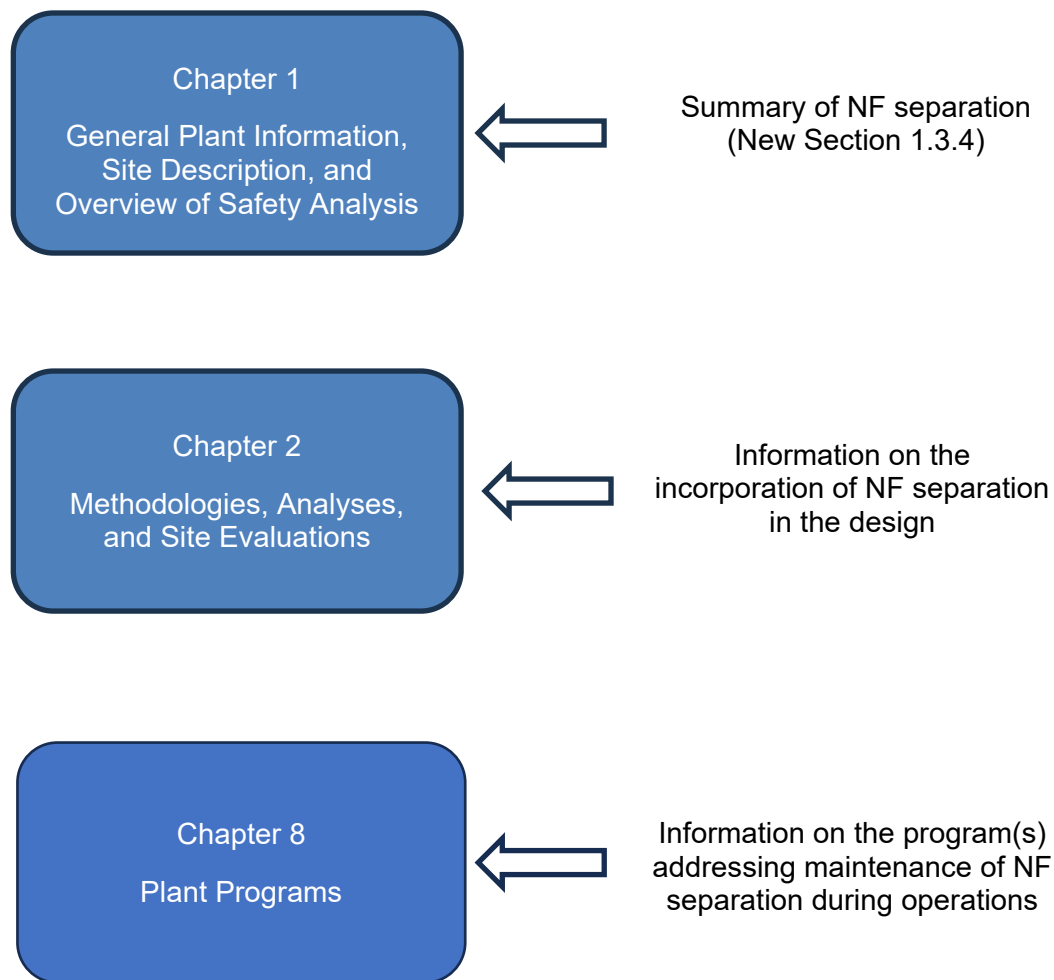


Figure 4-3. NF separation information in an advanced reactor SAR

4.2 Content of Separation Information

The elements of separation information required in the SAR (or incorporated by reference) are described below:

- **Description of the NF boundary:** The definition of the boundary shall be provided through a combination of diagrams and text. The result should be a clear understanding of the physical and functional location of the boundary. In addition to the summary information in the SAR, the boundary shall be reflected in licensee-controlled design products such as isometric piping diagrams and wiring diagrams. EPRI 3002026499, Chapter 2, Step 2, provides a discussion of considerations associated with the NF boundary.
- **Description of the NF design envelope:** The envelope includes identification of interfacing systems (mechanical, electrical, and instrumentation and control). To the extent interfacing systems have the potential to impact the licensing basis safety analyses, ranges of associated parameters (e.g., pressure, flow, temperature for a fluid system) and failure

modes should be identified. The envelope also includes external hazards that could impact the NF. In addition to the summary information in the SAR, documentation of the NF design envelope shall be maintained in a licensee-controlled design record. EPRI 3002026499, Chapter 2, Step 3, provides a discussion of considerations associated with the NF design envelope.

- Verification that the separation criteria are met: The criteria are discussed in EPRI 3002026499, Chapter 2, Step 5, and are repeated in Section 1.1.2 of this topical report. The SAR (or topical report that is included by reference) shall contain a summary of the evaluation that demonstrates each criterion is met. The evaluation of each criterion shall be maintained as a licensee-controlled design record.
- Evaluation of instances in which full NF separation is not met (if any): The applicant shall identify the specific instances in which the separation criteria are not met and address the implications of not meeting the criteria on the general conclusions (see Chapter 6) and specific requested regulatory findings associated with the license or design certification application. This evaluation of instances in which full NF separation is not achieved should be summarized in the SAR and documented in more detail in plant records, as appropriate.
- Program(s) for ensuring that NF separation is maintained: A plant that has committed to maintaining NF separation shall include provisions in its design control procedures to assess design changes to ensure that the NF design envelope remains applicable and consistent with the licensing basis. The program or programs shall be summarized in the SAR at a level of detail that is consistent with the guidance provided in NEI 21-07, Revision 1, Section C.8, on plant program SAR documentation. While NEI 21-07 applies specifically to advanced reactors following the LMP approach to developing the plant licensing basis, the NEI 21-07 guidance for SAR documentation on programs should be appropriate for other reactors and/or approaches to the licensing basis.

5 EXAMPLE

This chapter of the topical report provides an example of application content to be developed by an applicant taking advantage of NF separation. This example is based on the proposed project to construct and operate an Ultra Safe Nuclear Corporation (USNC) Micro Modular Reactor™ (MMR™) on the University of Illinois Urbana-Champaign (UIUC) campus for the purpose of conducting research and providing process steam for the campus. For brevity, this report refers to the project as the “UIUC Project.” UIUC is currently in the pre-application engagement phase of licensing. As of the submittal of this topical report, plans call for submittal of a construction permit application for a Class 104 license under 10 CFR Part 50.

The information presented in this section of the topical report is purely an illustrative example of the application of NF separation to a planned facility. The information is generally reflective of the current state of the UIUC Project, but in some cases the information has been modified to better serve the purpose of demonstrating how this topical report may be applied. No assurances are provided as to the accuracy of the information in this example, and the inclusion of this material in the topical report does not constitute a request for an NRC SE of NF separation for the UIUC Project.

For the purpose of this example, it is assumed that the UIUC Project follows the first approach described in Section 4.1.1, i.e., the documentation of NF separation is provided as part of the submittal of a preliminary safety analysis report (PSAR) for a construction permit application. Further, for illustrative purposes, it is assumed the UIUC Project PSAR follows the outline for advanced reactors (see Section 4.1.1.3).⁴ Specific information included in the PSAR in order to document NF separation is discussed in Sections 5.1 through 5.5. Other PSAR information would support the demonstration of NF separation, such as the list of safety-related SSCs in PSAR Chapter 5. For the purposes of this example, such information is assumed to be present as specified in other documentation, and is not provided or discussed in detail herein.

Much of the information in the PSAR is, by definition, preliminary, subject to modification in the FSAR that is submitted with the operating license application. Accordingly, it is expected that the demonstration of NF separation in the PSAR is subject to confirmation in the FSAR.

This section of the topical report describes the information to be provided, and in some cases it provides specific information based on the current state of the UIUC Project. *Italicized text denotes descriptions of what would be included, as opposed to actual examples of that material.*

⁴ The UIUC Project PSAR is actually being developed consistent with the guidance in NUREG-1537, not the recently developed guidance for advanced reactor applications. The advanced reactor guidance is used in this example because it is anticipated to be the most prevalent approach among future applications.

5.1 Background

The material in this section is intended to provide an overview of the UIUC Project sufficient for understanding the example NF separation information. In an actual advanced reactor PSAR, this type of information would be included in Chapter 1.

5.1.1 Project Overview

The University of Illinois Urbana-Champaign is proposing to construct a research reactor (also known as a non-power utilization facility) using high-temperature gas-cooled reactor (HTGR) technology. UIUC plans to build and operate USNC's Micro Modular Reactor™ (MMR™) HTGR-based design. The high-temperature helium will be circulated through a heat exchanger to provide high-temperature molten salt in an intermediate loop. The energy in the salt will produce steam for use in research and demonstration. The plant does not generate electric power; facility electric power needs are supplied from the electrical grid. Figure 5-1 is a simplified process diagram that illustrates the approach.

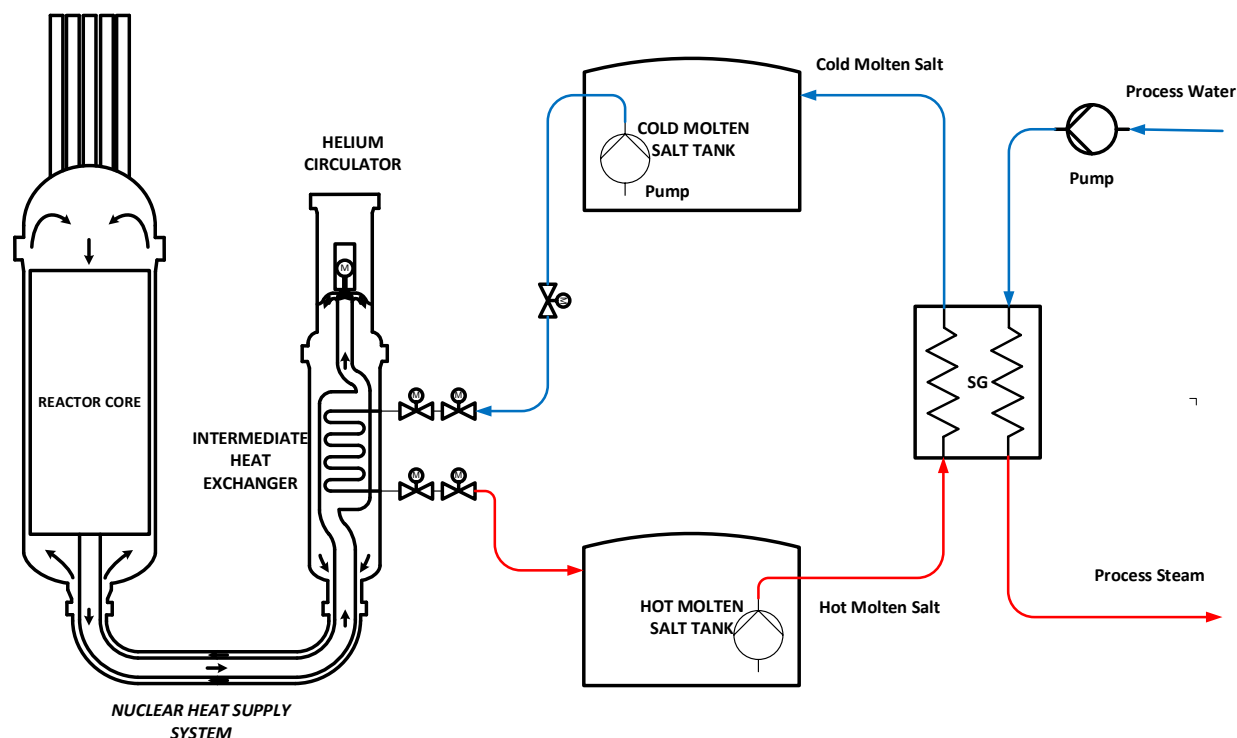


Figure 5-1. UIUC Project simplified process diagram

5.1.2 MMR

The MMR is a flexible HTGR designed to operate up to 45 MW_{th}, depending on application needs. For the UIUC Project, the MMR research reactor will be licensed to a maximum operating power limit of 10 MW_{th}. The reactor will be fueled with high assay low-enriched uranium (HALEU) at an enrichment from 5% to 19.75% ²³⁵U in the form of tristructural isotropic (TRISO) particles embedded in silicon carbide Fully Ceramic Micro-Encapsulated (FCM™) pellets

that are stacked in columns in solid hexagonal graphite blocks. The MMR is designed for passive safety response to event sequences in the design basis and relies on functional containment as the primary means to limit release of radioactivity to the environment.

The MMR uses considerably different technology and safety capabilities than the LWR technology that is the focus of many regulations. For example, the MMR does not require an active or passive emergency core cooling system (ECCS) to rapidly replenish primary coolant to recover the fuel in the event of a rupture of the primary pressure boundary. Large safety margins are provided by both the fuel and the reactor design.

- The fuel is composed of TRISO particles, which provide a highly effective fission product retention capability. In response to an EPRI topical report on the performance of TRISO fuel, the U.S. NRC issued a Safety Evaluation Report with some limitations and conditions that are considered in the MMR design. The fission product retention capability of TRISO fuel particles contributes to a “functional containment” whereby the TRISO particles serve as the first containment barrier when operated within the range of qualification parameters.
- The TRISO particles in MMR fuel are encased in an FCM pellet of silicon carbide that provides an additional layer of retention for fission products, thereby achieving functional containment.
- The low power density of the active fuel region leads to slow fuel heat-up during loss of heat removal events.
- Low thermal power results in a small inventory available for release of the most limiting short-lived fission products for public safety, such as ^{131}I and ^{85}Kr . The increased inventory of long-lived fission products associated with a long core life is addressed by the DID approach to functional containment.
- The low power rating also reduces the decay heat that must be removed in postulated accidents, simplifying passive decay heat removal.
- Heat transfer fluid used for core cooling during normal operation is an inert, chemically stable, single-phase gas (helium).
- Safety-related core cooling is passive and capable of maintaining fuel and component temperatures below limits with no helium, electrical power, or operator action.
- Intermediate heat transfer is performed by a molten salt loop that effectively isolates the reactor from transients in the adjacent plant power conversion system.
- The reactor is below ground. Although it does not have or need a leak-tested containment building, it is surrounded by a concrete structure (the citadel) that provides DID for retention of fission products to the environment and provides protection against external hazards.

Table 5-1 provides a high-level summary of key design features of the MMR and a comparison of those features to those of current LWRs.

Table 5-1. MMR key design features and comparison to LWR features

Feature	MMR	LWR	Remarks
Operating power level	Maximum research reactor allowed power (10 MW _{th}) for UIUC deployment	3000 to 4400 MW _{th} (AP1000 3415 MW _{th})	Full MMR power is less than decay heat of large LWR more than 24 hours after shutdown; short-lived fission product inventory is small.
Heat transfer fluid	Helium—inert gas; single phase under all conditions; low stored energy	Water—also serves as moderator; scrubs fission products; high stored energy; undergoes phase change that causes high pressure and temperature in surrounding structure	Water coolant causes corrosion, and blowdown can damage safety systems by impingement, pressure, moisture, and temperature.
Containment	Functional: TRISO integrity at high temperatures, with supplemental passive barriers for DID, continuously confirmed by radiological monitoring while operating	Large containment building subject to high pressure and temperature; many penetrations requiring active isolation, periodic leak testing, and maintenance	Functional containment is a set of barriers that effectively limit physical transport of radioactive material to the environment and serve as basis for the revised PDC in RG 1.232.
Safety-related AC power systems	None	Class 1E AC distribution and emergency diesel	MMR safety is provided by passive systems.
Fuel form	Uranium oxycarbide TRISO particles encased in FCM pellets in hexagonal graphite fuel blocks	Uranium dioxide pellets encased in zirconium alloy tubes	Insubstantial fission product release from MMR during operation or accidents.
Form (²³⁵ U) enrichment	HALEU ≤19.75% ²³⁵ U	LEU <5% ²³⁵ U	Both are low-enriched uranium; MMR higher enrichment provides for longer core life.
Fuel damage temperature	>3272°F (1800°C)	2200°F (1204°C)	Zirconium-water reactions start at about 1800°F (982°C) in LWRs.
Emergency replenishment of coolant	None; fuel limits met for unmitigated primary system blowdown	ECCS needed	Must quickly recover LWR fuel with water if loss of coolant occurs.
Hydrogen management	External/internal flooding might release hydrogen (graphite-water reaction)	Zirconium-water reaction produces hydrogen if clad exceeds 2200°F (1204°C)	Acceptance criteria limit mass of LWR fuel clad reacted.
Primary system corrosion mechanisms	While helium itself is noncorrosive, contaminants must be controlled to low levels to avoid degradation of graphite and other materials	Various types of stress corrosion cracking; boric acid corrosion (pressurized water reactors)	Helium is inert, whereas hot water is corrosive unless water chemistry is carefully controlled.

5.2 PSAR Chapter 1 (New Section 1.3.4, Nuclear Facility Separation)

PSAR Chapter 1 is entitled “General Plant and Site Description and Overview of the Safety Analysis.” The following section of Chapter 1 provides an overview of NF separation for the UIUC Project.

The UIUC Project incorporates NF separation between the nuclear reactor and associated systems, referred to as the NF, and the remainder of the plant, referred to as the AFs. The approach is described further in EPRI report 3002026499, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities*, November 2023.

The NF is defined as the following:

- Reactor systems, including:
 - Reactor core
 - Reactor internals
 - Reactor control and shutdown
- Reactor protection system
- Heat transport systems, including:
 - Hot gas duct system
 - Helium circulator
 - Intermediate heat exchanger
- Reactor cavity cooling system
- Fuel handling and storage systems
- Radioactive waste processing and decontamination systems
- Safety-related DC power system

Major portions of the NF are shown pictorially in Figure 5-2. It depicts the “citadel building,” which is located below grade and contains all safety-related systems.

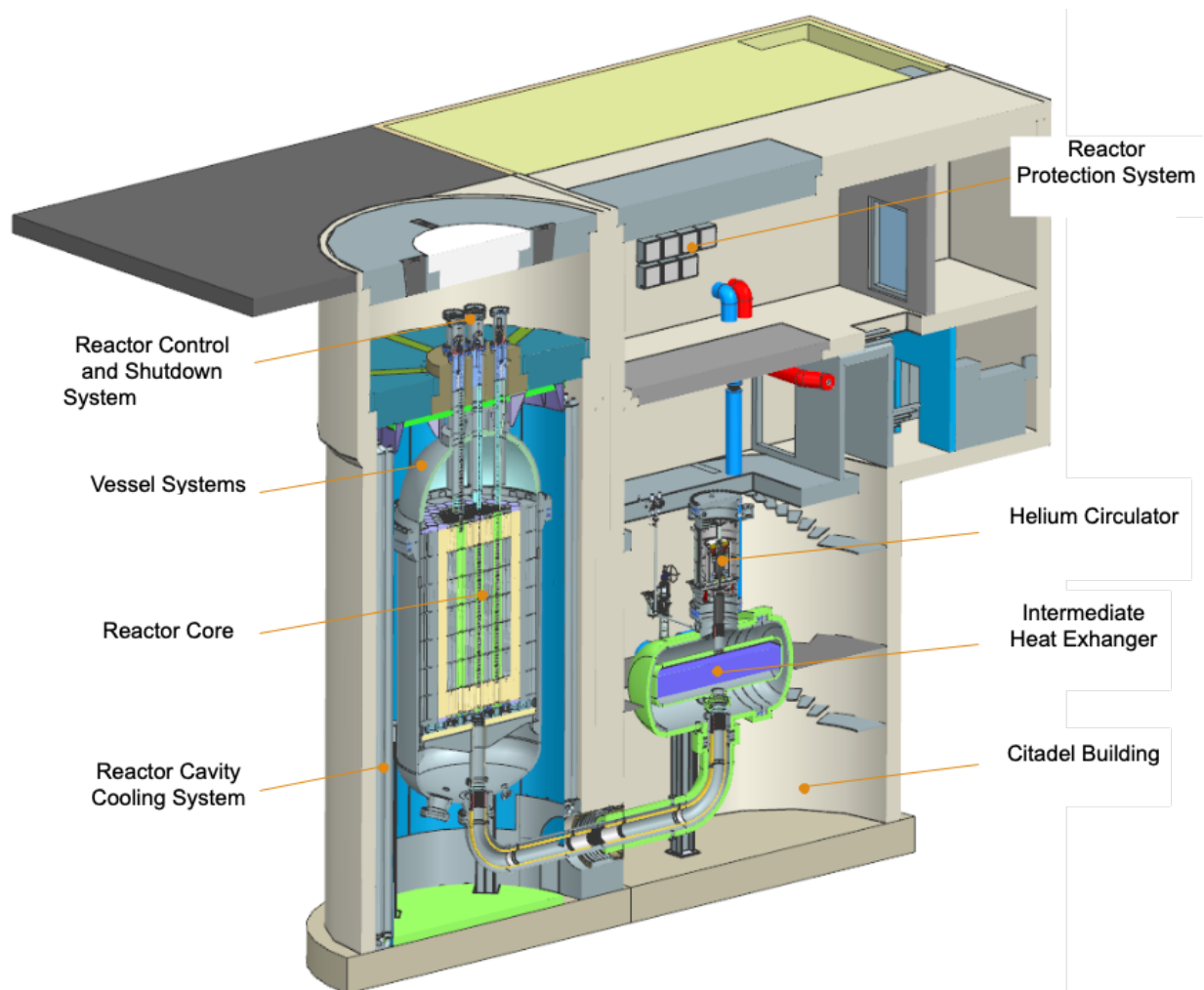


Figure 5-2. Citadel building

The primary boundary between the NF and the AFs is in the molten salt system. Physically, the boundary is at the first valve between the intermediate heat exchanger outlet and the hot salt tank and at the last valve between the cold salt tank and the intermediate heat exchanger inlet. The boundary is shown schematically in Figure 5-3.

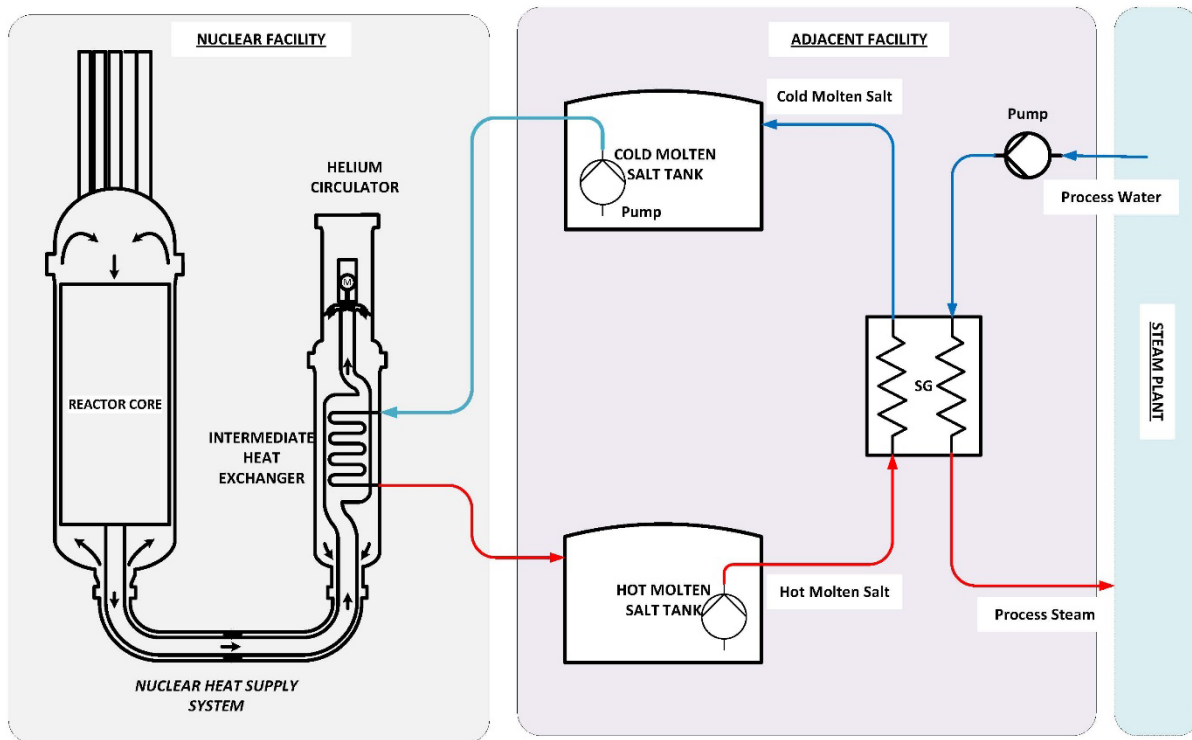


Figure 5-3. NF boundary on schematic diagram

All plant systems that are part of the NF are located in the citadel building except the following:

- Fuel handling and storage systems (reactor services building)
- Radioactive waste processing and decontamination systems (operations building)

The physical locations of the NF relative to the overall site are shown on Figure 5-4. The buildings containing elements of the NF are colored blue.

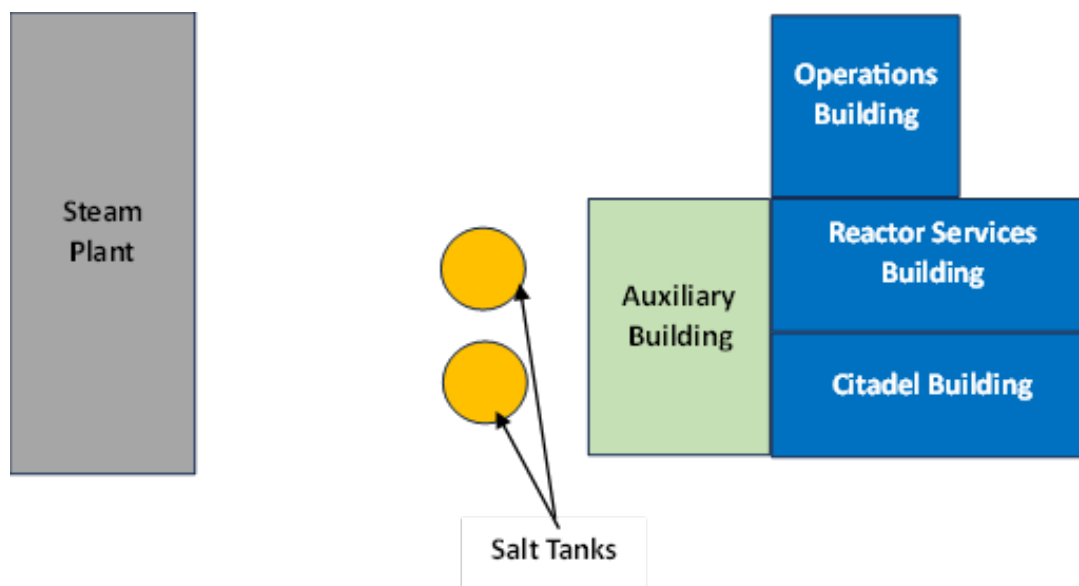


Figure 5-4. General layout

The NF design envelope is described conceptually below. Detailed information is provided in the appropriate sections of the SAR.

The molten salt system crosses the NF boundary. The plant does not rely upon the molten salt system for protection of public health and safety during licensing basis events. There are no failure modes associated with the molten salt system that result in the reactor operating outside of its safety limits. Hence, while physical separation at the NF/AF boundary may not be part of the design of the molten salt system, functional separation is ensured by this system's non-impact on the NF. Additional detail on licensing basis events is provided in PSAR Chapter 3.

Electrical power is provided from the grid through the plant electrical power system to NF components (e.g., the helium circulator) to support normal plant operation. With one exception, the plant does not rely upon electrical power for protection of public health and safety during design basis events. The reactor protection system requires DC electrical power to perform its safety function of reactivity control (e.g., initiation of a reactor trip signal). The safety-related DC power system within the NF provides the necessary power. The DC power system is fed by batteries within the NF, which are charged by normal AC electrical power via an inverter. The reactor will automatically trip if the battery voltages drop below a preset limit, protecting against a loss of power event. Additional detail on the reactor protection system and its design basis is provided in PSAR Chapter 6.

Instrumentation and control systems are not required for protection of public health and safety. No automatic actions are needed to actuate the reactor cavity cooling system, which ensures that fuel temperatures remain low enough to prevent excessive radionuclide releases. Instrumentation and control considerations associated with licensing basis events are described in PSAR Chapter 3.

External hazards are assessed for potential impact on the safety-related equipment in the NF, including the potential for AF structures damaged by an earthquake to prevent NF SSCs from accomplishing their safety functions. The external hazards are documented in PSAR Chapter 2.

PSAR Section 2.Y⁵ dispositions the construction application requirements that are potentially applicable to areas and facilities outside the NF.

5.3 PSAR Chapter 2 (Section 2.X, Verification of Nuclear Facility Separation)

PSAR Chapter 2 is entitled “Methodologies, Analyses, and Site Evaluations.” The following section of Chapter 2 summarizes the evaluation of the NF separation criteria.

NF separation criteria are established in EPRI report 3002026499, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities*, November 2023 (Chapter 2, Step 5). Both separation criteria are fully met. The criteria and the means for satisfying them are discussed below.

Criterion 1

For normal conditions, the amount of radiation and radiological material crossing the NF boundary shall be maintained within regulatory limits.

To meet this criterion, the NF design must ensure that any potential exposure to radiation or radiological material during normal conditions is controlled within acceptable limits at the NF boundary with no reliance on AF SSCs. This eliminates the need for AF SSCs to meet nuclear quality requirements for control of radiation and radionuclides, and eliminates the need for the regulator to review those SSCs.

Criterion 1 is met through a variety of NF SSCs, depending on the nature of the radioactive material.

The vast majority of the radioactivity at the plant is contained in the reactor core, which is part of the NF. The reactor core is in the below-grade reactor citadel, which includes shielding to ensure that doses outside the NF boundary are low enough for continuous occupancy by members of the public. There is no spent fuel storage on site. When the reactor is refueled, the spent fuel will be loaded into spent fuel casks inside the reactor citadel and transported off site.

Solid radioactive materials generated by operation of the reactor are generally fixed in place. Activation products are very low relative to those of current LWRs. Solid materials are surveyed and controlled when they leave a radiation area. Solid radioactive waste is managed in the solid

⁵ This topical report example uses a capital letter (in this case, Y) to represent the section number when the specific number is not known.

radioactive waste processing systems in the operations building. In that area, low level radioactive waste is collected, processed, compacted, and stored until it is shipped off site for disposal.

The amount of liquid radioactive waste is also very low relative to that produced by current LWRs. The coolant is a gas rather than a liquid, and liquids are carefully controlled to prevent entry into the reactor coolant system. Liquid radioactive waste is primarily generated as a byproduct of radioactive waste processing operations in the operations building. The waste is stored in the operations building until it is shipped off site or discharged to the environment in accordance with environmental permits and NRC limits in 10 CFR Parts 20 and 50.

Small amounts of gaseous radioactive material are generated during reactor operations. Radioactive contaminants are removed by the helium purification system in the reactor citadel. Gaseous radioactive material is collected and stored in waste gas tanks (which are monitored) and periodically released to the atmosphere in a controlled manner via the unit stack. All releases are in accordance with environmental permits and NRC limits in 10 CFR Parts 20 and 50.

Further descriptions of measures for the control of routine plant radioactive effluents, plant contamination, and solid waste are provided in PSAR Chapter 9.

Criterion 2

For abnormal and accident conditions, the safety assessment shall demonstrate that all applicable regulatory limits are met with the following constraints:

- The safety assessment is based on the parameters defined in the NF design envelope.
- Only NF SSCs and NF operator actions can be credited in the safety assessment.

Meeting this criterion eliminates the need to apply nuclear quality requirements for SSCs outside the NF and minimizes the need for regulatory oversight of the AFs. Specifically, oversight can be limited to inspection that the verification of the NF design envelope has been performed.

As described in PSAR Chapter 1, the MMR employs a functional containment safety approach based on FCM fuel to provide reasonable assurance of adequate protection of public health and safety. The design incorporates passive heat removal features and requires no operator action to prevent or mitigate licensing basis events. The UIUC Project established its licensing basis events and safety-related SSCs following the methodology described in IMRDD-MMR-23-03, “University of Illinois Urbana-Champaign High Temperature Gas-cooled Research Reactor: Event Sequence Identification and SSC Safety Classification Methodology,” August 31, 2023. The licensing basis events are documented in PSAR Chapter 3, and the safety-related SSCs are documented in PSAR Chapter 6. The licensing basis events consider a complete loss of normal heat removal through the molten salt system; thus, operation of the molten salt system is not

relied upon for protection of public health and safety. The identification of licensing basis events included consideration of external hazards associated with the site, including areas outside the NF. All safety-related SSCs are located in the NF.

5.4 PSAR Chapter 2 (Section 2.Y, Evaluation of Potential Impacts Outside the Nuclear Facility)

This section addresses potential impacts of areas outside the NF on compliance with the regulations associated with a construction permit application.

EPRI report 3002030485, *Nuclear Facility Separation: Topical Report ANT LR 2024-03*, Appendix A, identifies those 10 CFR Part 50 requirements that potentially involve areas outside the NF. Table 5-2 addresses and provides the disposition for all such requirements that are pertinent to a construction permit application.

Table 5-2. Disposition of 10 CFR Part 50 requirements potentially applicable to areas outside the NF

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.10	Limited work authorization—requirements for construction	Potentially applicable to areas and facilities outside the NF. 50.10(a)(1) sets forth criteria for activities that constitute construction. Criteria (i), (ii), and (iii) should be met provided NF separation criteria are met. To proceed with AF construction prior to obtaining a construction permit or limited work authorization, the applicant should ensure the other criteria are met as well: (iv) SSCs whose failure could cause a reactor scram or actuation of a safety-related system (v) SSCs necessary to comply with security requirements (vi) SSCs necessary to comply with fire protection requirements (vii) Emergency facilities—technical support center and operations support center Disposition: N/A. No limited work authorization is sought.
50.34	Content of application, technical information	Addresses the types of information to be provided in an application. Specific sections are addressed individually below.
50.34(a)(1)(ii)	Description and safety assessment of the site and a safety assessment of the facility	Specific characteristics are addressed individually below.
50.34(a)(1)(ii)(A)	Intended use of the reactor and nature and inventory of radioactive materials	Potentially applicable to areas and facilities outside the NF. Should be applicable only if there is a storage area for radioactive material located outside the NF. An example might be a warehouse storing a radioactive component awaiting shipment off site for disposal. Disposition: N/A. No radioactive materials are to be stored outside the NF.
50.34(a)(1)(ii)(D)	Evaluation of safety features and engineered barriers	Potentially applicable to areas and facilities outside the NF. Safety analysis includes evaluation of doses at the exclusion area boundary and in the low population zone. Depending on the location of the boundary and zone, meteorology outside the NF could impact the results. Disposition: N/A. Exclusion area boundary and low population zone doses are evaluated at the NF boundary.
50.34(a)(2)	Summary description of the facility	Potentially applicable to areas and facilities outside the NF. AFs may be mentioned, but no significant detail must be provided for the AFs. Disposition: AFs are described in PSAR Chapter 1.

Table 5-2 (continued). Disposition of 10 CFR Part 50 requirements potentially applicable to areas outside the NF

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.34(a)(10)	Discussion of the preliminary emergency plan	Potentially applicable to areas and facilities outside the NF. The discussion may include facilities and equipment outside the NF, such as meteorological and radiological monitoring equipment. Disposition: The preliminary plan contains limited mention of areas and facilities outside the NF. See Preliminary Emergency Plan submitted with the construction permit application.
50.34(a)(11)	Impact of construction on operating nuclear power plants on the same site	Potentially applicable to areas and facilities outside the NF. Disposition: N/A. No operating nuclear plants on the site.
50.34(a)(12)	Compliance with earthquake engineering criteria (Appendix S)	Potentially applicable to areas and facilities outside the NF. This is only for verification of no unacceptable interactions with the NF. Disposition: Engineering review confirmed no unacceptable interactions of facilities outside the NF with the NF.
50.34(a)(13)	Aircraft impact assessment [refers to 10 CFR 50.150(b)]	Not applicable to areas and facilities outside the NF. Requirements in 50.150(b) are on design features and functional capabilities required for core cooling, spent fuel cooling, and spent fuel integrity, which should be associated with the NF. Disposition: N/A. Would be applicable only to power reactor applications.
50.34(b)	FSAR	Addresses the types of information to be provided in the FSAR. Specific sections are addressed individually below. Disposition: All FSAR requirements are N/A for a construction permit application.
50.34(c)	Physical security plan	Potentially applicable to areas and facilities outside the NF. The physical security plan addresses compliance with 10 CFR Part 73. The security plan could address SSCs located outside the NF and activities conducted outside the NF. Disposition: N/A (applicable to operating license application only).
50.34(d)	Safeguards contingency plan	Potentially applicable to areas and facilities outside the NF. Procedures in the plan could involve areas outside the NF. Disposition: N/A (applicable to operating license application only).
50.36	Technical specifications (tech specs)	Addresses the tech spec requirements. Specific sections are addressed below. Disposition: N/A (applicable to operating license application only).

Table 5-2 (continued). Disposition of 10 CFR Part 50 requirements potentially applicable to areas outside the NF

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.36b	Conditions to protect the environment during construction, operation, and decommissioning	Potentially applicable to areas and facilities outside the NF. Any such conditions would be based on the environmental report submitted pursuant to 10 CFR 51.50 and 51.53. Conditions of this type would be specific to the site and technology in question. Disposition: N/A. No necessary conditions for protecting the environment were identified in the environmental report.
50.47	Emergency plans <i>(For applicants not able to or choosing not to follow the approach provided by the 2023 emergency preparedness rule as covered in 10 CFR 50.160)</i>	Potentially applicable to areas and facilities outside the NF. Some aspects of emergency planning will be outside the NF (e.g., an emergency operations facility or backup emergency operations facility). See also 50.34(a)(10) and 50.34(b)(6)(v). Disposition: N/A (applicable to operating license application only). Also, the UIUC Project is a non-power production facility and plans to follow RG 2.6.
50.48	Fire protection	Potentially applicable to areas and facilities outside the NF. Depends on characteristics of the site and design. Disposition: N/A (applicable to operating license application only).
50.55a(f)	Preservice and in-service testing requirements	Potentially applicable to areas and facilities outside the NF. Applies the ASME BPV Code and the ASME OM Code to systems and components of boiling and pressurized water-cooled nuclear power reactors. These systems and components will most likely be in the NF; however, the use of the ASME BPV Code and the ASME OM Code outside the NF cannot categorically be ruled out. Disposition: N/A (applicable to operating license application only).
50.55a(g)	Preservice and in-service inspection requirements	Potentially applicable to areas and facilities outside the NF. Applies the ASME BPV Code and the ASME OM Code to systems and components of boiling and pressurized water-cooled nuclear power reactors. These systems and components will most likely be in the NF; however, the use of the ASME BPV Code and the ASME OM Code outside the NF cannot categorically be ruled out. Disposition: N/A (applicable to operating license application only).

Table 5-2 (continued). Disposition of 10 CFR Part 50 requirements potentially applicable to areas outside the NF

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.59	Changes, tests, and experiments relating to the facility as described in the FSAR	Potentially applicable to areas and facilities outside the NF. The term “facility as described in the FSAR” is broad and could be construed to cover AFs mentioned in the SAR. However, when separation criterion (SC) 1 is satisfied, changes outside the NF should not require a reevaluation of public health and safety. The exception is a substantive change to an AF that impacts the NF design envelope. Such a change would require evaluation in accordance with 10 CFR 50.59, as described in Chapter 4 of this report. Disposition: N/A (not applicable until operating license is issued).
50.63	Loss of AC power (station blackout)	Not applicable to areas and facilities outside the NF. Not applicable to non-LWRs per NRC guidance in DANU-ISG-2022-01 [13]. Disposition: N/A (applicable to LWRs only).
50.65	Maintenance rule	Potentially applicable to areas and facilities outside the NF. The scope of the maintenance rule includes safety-related SSCs [10 CFR 50.65(b)(1)] and certain nonsafety-related SSCs [10 CFR 50.65(b)(2)]. Per SC2, the safety-related SSCs will be in the NF. 10 CFR 50.65(b)(2) sets forth three criteria for nonsafety-related SSCs to be covered by the maintenance rule. The first two, relied upon to mitigate accidents or transients or used in plant emergency procedures, should not be met per SC2. However, compliance with SC1 and SC2 is not sufficient to demonstrate that the third criterion—failure of the SSC could cause a reactor trip or actuation of a safety system—would not be satisfied. Therefore, it is possible some nonsafety-related SSCs in the AF would meet the criteria for inclusion in the maintenance rule. Thus, a specific evaluation with respect to 10 CFR 50.65 will be required. Disposition: N/A (not applicable until operating license is issued).
50.155	Mitigation of beyond-design-basis events	Potentially applicable to areas and facilities outside the NF. 10 CFR 50.155(c) imposes requirements on equipment that may be relied upon for mitigation of beyond-design-basis events. Such equipment may be portable and stored outside the NF. The regulation requires that any such equipment be “reasonably protected from the effects of natural phenomena.” Disposition: N/A (not applicable until operating license is issued).

Table 5-2 (continued). Disposition of 10 CFR Part 50 requirements potentially applicable to areas outside the NF

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.160	Emergency preparedness for small modular reactors, non-LWRs, and non-power production or utilization facilities <i>(Optional should licensees opt to follow the approach provided by the 2023 emergency preparedness rule)</i>	Potentially applicable to areas and facilities outside the NF. One example of where this regulation applies would be a plume exposure pathway that extends beyond the NF. Another would be the offsite emergency operations facility and backup facilities. In any event, 10 CFR 160(b)(2) requires conducting a “hazard analysis of any contiguous or nearby facility, such as industrial, military, and transportation facilities, and include any credible hazard into the licensee’s emergency preparedness program that would adversely impact the implementation of emergency plans.” Disposition: N/A. The UIUC Project is a non-power production facility and plans to follow RG 2.6.
Appendix A—General Design Criteria (GDC)		
PDC are required for all facilities licensed under 10 CFR Part 50 or Part 52. The GDC in Appendix A establish minimum requirements for PDC for water-cooled nuclear power reactors. The PDC also “provide guidance in establishing the principal design criteria” for non-water-cooled nuclear power reactors (see Introduction to 10 CFR Part 50, Appendix A). The GDC are addressed below, with the assumption that the facility applying NF separation is a water-cooled reactor similar to nuclear power reactors currently operating in the United States. Disposition: N/A. The GDC do not apply to the UIUC Project because it is not an LWR or a nuclear power reactor.		
Appendix E—Emergency Planning and Preparedness for Production and Utilization Facilities		
Potentially applicable to areas and facilities outside the NF. The rationale is the same as for 10 CFR 50.34(a)(10). Disposition: See 50.34(a)(10).		
Appendices O–P—Reserved		
Appendix Q—Pre-application Early Review of Site Suitability Issues		
Potentially applicable to areas and facilities outside the NF because it addresses siting issues. Disposition: Not applicable to a construction permit application.		
Appendix S—Earthquake Engineering Criteria for Nuclear Power Plants		
Potentially applicable to areas and facilities outside the NF. SSCs outside the NF could be involved in the evaluation of the operating basis earthquake ground motion. SSCs required to withstand the safe shutdown earthquake should be inside the NF per SC2, but an evaluation of potential interactions with SSCs outside the NF must be made. See 10 CFR 50.34(a)(12). Disposition: See 50.34(a)(12).		

5.5 PSAR Chapter 8 (Section 8.Z, Nuclear Facility Separation Program)

PSAR Chapter 8 is entitled “Plant Programs.” The following section provides summary detail for the plant program that addresses NF separation on an ongoing basis.

The Nuclear Facility Separation Program works through plant configuration management and change control procedures to ensure that separation between the NF and AFs is maintained throughout plant operation. The program applies to the NF and to AFs and addresses safety-related SSCs. NF separation is described in EPRI report 3002026499, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities*, November 2023. Regulatory implications are addressed in EPRI report 3002030485, *Nuclear Facility Separation: Topical Report ANT LR 2024-03*, September 2024. The controlling plant program document is (document number), “Nuclear Facility Separation Program,” which will be developed and incorporated by reference in the SAR at the time of application for an operating license.

6 SUMMARY

6.1 Regulatory Conclusions

EPRI report 3002026499 defines a technology- and regulator-neutral methodology to demonstrate separation of an NF from AFs associated with the NF. This topical report provides evaluations of certain regulations applied to U.S. nuclear plants that assess the extent to which those regulations would apply to the AFs. This report also describes how documentation describing NF separation and addressing its regulatory implications may be provided in a license or design certification application to the NRC.

This topical report substantiates the following general regulatory conclusions for nuclear plants that meet the separation criteria of EPRI 3002026499:

- Except for those regulations identified in Table 3-1 of this topical report, 10 CFR Part 50 requirements associated with a construction authorization or operating license are not applicable to AFs outside the NF.
- Except for those regulations identified in Table 3-1 of this topical report, 10 CFR Part 52 requirements for a combined license or design certification are not applicable to AFs outside the NF.
- Information on AFs is not required in the SAR unless it is specifically required by 10 CFR 50.34 or 10 CFR 52.79.

6.2 Considerations for Applicants

Applicants may choose to use the regulatory evaluations in this report to support additional regulatory findings associated with applications for a specific design and/or site. Such findings could support specific regulatory actions such as limited work authorizations and exemption requests. The applicant would be responsible for identifying and providing justification for such regulatory actions in an appropriate submittal or submittals to the NRC.

7 REFERENCES

- [1] EPRI, *Technical Methodology to Demonstrate the Separation of Nuclear Facilities from Adjacent Facilities*. EPRI, Palo Alto, CA: 2023. 3002026499.
- [2] TerraPower, “Regulatory Management of Natrium Nuclear Island and Energy Island Design Interfaces (NATD-LIC-RPRT-0001).” Bellevue, Washington: 2022.
- [3] U.S. NRC, Final Safety Evaluation for Topical Report NATD-LIC-RPRT-0001, “Regulatory Management of Natrium Nuclear Island and Energy Island Design Interfaces.” U.S. NRC, Rockville, MD: 2023.
- [4] U.S. NRC, *10 CFR Part 50: Domestic Licensing of Production and Utilization Facilities*. U.S. Government Publishing Office, Washington, DC.
- [5] U.S. NRC, *10 CFR Part 52: Licenses, Certifications, and Approvals for Nuclear Power Plants*. U.S. Government Publishing Office, Washington, DC.
- [6] Nuclear Energy Institute, “Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development” (NEI 18-04, Revision 1). Nuclear Energy Institute, Washington, DC: 2019.
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- [9] U.S. NRC, *Proposed Rule: Risk-Informed, Technology-Inclusive Regulatory Framework for Advanced Reactors (SECY-23-0021)*. U.S. NRC, Rockville, MD: 2023.
- [10] U.S. NRC, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition” (Regulatory Guide 1.70, Revision 3). Rockville, MD: U.S. NRC, 1978.
- [11] U.S. NRC, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants—LWR Edition” (NUREG-0800). U.S. NRC, Rockville, MD. Dates vary by chapter.
- [12] U.S. NRC, “Applications for Nuclear Power Plants” (Regulatory Guide 1.206, Revision 1). U.S. NRC, Rockville, MD: 2018.

- [13] U.S. NRC, “Review of Risk-Informed, Technology-Inclusive Advanced Reactor Applications—Roadmap (DANU-ISG-2022-01).” U.S. NRC, Rockville, MD: March 2024.
- [14] Nuclear Energy Institute, “Technology Inclusive Guidance for Non-Light Water Reactors: Safety Analysis Report Content for Applicants Using the NEI 1804 Methodology” (NEI 21-07, Revision 1). Nuclear Energy Institute, Washington, DC: 2022.
- [15] U.S. NRC, “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” (Draft Regulatory Guide DG-1404). U.S. NRC, Rockville, MD: March 2024.

A EVALUATION OF 10 CFR PART 50 REQUIREMENTS FOR APPLICATION OUTSIDE NUCLEAR FACILITIES

The following table documents the evaluation of 10 CFR Part 50 requirements for the need to address SSCs and areas outside the NF in order to demonstrate compliance with the regulation.

Those parts of the regulation noted as “administrative requirements” are those that do not levy technical or quality requirements on the facility, but instead address administrative matters, such as information to be provided or processes to be followed. In general, administrative requirements apply only to SSCs within the NF, but a blanket statement that no administrative requirements apply to AFs cannot be made on a generic basis.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.1	General Provisions—Basis, purpose, and procedures applicable	Administrative requirement.
50.2	General Provisions—Definitions	Administrative requirement.
50.3	General Provisions—Interpretations	Administrative requirement.
50.4	General Provisions—Written communications	Administrative requirement.
50.5	General Provisions—Deliberate misconduct	Administrative requirement.
50.7	General Provisions—Employee protection	Administrative requirement.
50.8	General Provisions—Information collection requirements	Administrative requirement.
50.9	General Provisions—Completeness and accuracy of information	Administrative requirement.
50.10	Limited work authorization—Requirements for construction	Potentially applicable to areas and facilities outside the NF. 50.10(a)(1) sets forth criteria for activities that constitute construction. Criteria (i), (ii), and (iii) should be met provided NF separation criteria are met. To proceed with AF construction prior to obtaining a construction permit or limited work authorization, the applicant should ensure the other criteria are met as well: (iv) SSCs whose failure could cause a reactor scram or actuation of a safety-related system (v) SSCs necessary to comply with security requirements (vi) SSCs necessary to comply with fire protection requirements (vii) Emergency facilities—technical support center and operations support center <i>Note that this regulation was also addressed in TerraPower topical report NATD-LIC-RPRT-0001 [2].</i>
50.11	Exceptions to licensing requirements	Administrative requirement.
50.12	Exemptions	Administrative requirement.
50.13	Attacks by enemies of the U.S.	Administrative requirement.
50.20	Class of licenses	Administrative requirement.
50.21	Class 104 licenses	Administrative requirement.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.22	Class 103 licenses	Administrative requirement.
50.23	Requirement for construction permit	Administrative requirement.
50.30	Filing applications	Administrative requirement.
50.31	Combine licenses	Administrative requirement.
50.32	Elimination of repetition in applications by incorporation by reference	Administrative requirement.
50.33	Content of application, general information—Financial information, emergency response plans of local and state governments, etc.	Administrative requirement.
50.34	Content of application, technical information	Addresses the types of information to be provided in an application. Specific sections are addressed individually below.
50.34(a)(1)(ii)	Description and safety assessment of the site and a safety assessment of the facility	Specific characteristics are addressed individually below.
50.34(a)(1)(ii)(A)	Intended use of the reactor and nature and inventory of radioactive materials	Potentially applicable to areas and facilities outside the NF. Should be applicable only if there is a storage area for radioactive material located outside the NF. An example might be a warehouse storing a radioactive component awaiting shipment off site for disposal.
50.34(a)(1)(ii)(B)	Generally accepted engineering standards applied to the reactor	Not applicable to areas and facilities outside the NF.
50.34(a)(1)(ii)(C)	Unique, unusual, or enhanced safety features	Not applicable to areas and facilities outside the NF.
50.34(a)(1)(ii)(D)	Evaluation of safety features and engineered barriers	Potentially applicable to areas and facilities outside the NF. Safety analysis includes evaluation of doses at the exclusion area boundary and in the low population zone. Depending on the location of the boundary and zone, meteorology outside the NF could impact the results.
50.34(a)(1)(ii)(E)	Construction permit requirements	Administrative requirement.
50.34(a)(2)	Summary description of the facility	Potentially applicable to areas and facilities outside the NF. AFs may be mentioned but no significant detail must be provided for the AFs.
50.34(a)(3)(i)	PDC	Not applicable to areas and facilities outside the NF. PDC should be applicable to NF SSCs per SC2.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.34(a)(3)(ii)	Design bases and relation to PDC	Not applicable to areas and facilities outside the NF. The design bases should be associated with the NF.
50.34(a)(3)(iii)	Materials of construction, general arrangement, and dimensions	Not applicable to areas and facilities outside the NF. The design basis should be associated with the NF, so the information on materials of construction, general arrangement, and dimensions outside the NF should not be pertinent.
50.34(a)(4)	Preliminary evaluation and analysis of the design and performance of the SSCs of the facility relative to public health and safety	Not applicable to areas and facilities outside the NF. Such SSCs should be within the NF per SC1 and SC2.
50.34(a)(5)	Variables for preliminary tech specs	Not applicable to areas and facilities outside the NF. Tech specs should be focused on NF SSCs per SC2.
50.34(a)(6)	Preliminary plan for organization, training, and conduct of operations	Not applicable to areas and facilities outside the NF. Facets of organization, training, and conduct of operations related to public health and safety should be focused on the NF per SC2.
50.34(a)(7)	Description of quality assurance program	Not applicable to areas and facilities outside the NF. The quality assurance program should be focused on the NF per SC2.
50.34(a)(8)	Identification of SSCs requiring research and development	Not applicable to areas and facilities outside the NF. While it is possible research and development could be ongoing on AF SSCs, it is clear from the context of the requirement that the requirement is meant to apply to SSCs credited in the safety assessment and therefore in the NF.
50.34(a)(9)	Technical qualifications of the applicant	Administrative requirement.
50.34(a)(10)	Discussion of the preliminary emergency plan	Potentially applicable to areas and facilities outside the NF. The discussion may include facilities and equipment outside the NF, such as meteorological and radiological monitoring equipment.
50.34(a)(11)	Impact of construction on operating nuclear power plants on the same site	Potentially applicable to areas and facilities outside the NF.
50.34(a)(12)	Compliance with earthquake engineering criteria (Appendix S)	Potentially applicable to areas and facilities outside the NF. This is only for verification of no unacceptable interactions with the NF.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.34(a)(13)	Aircraft impact assessment [refers to 10 CFR 50.150(b)]	Not applicable to areas and facilities outside the NF. Requirements in 50.150(b) are on design features and functional capabilities required for core cooling, spent fuel cooling, and spent fuel integrity, which should be associated with the NF.
50.34(b)	FSAR	Addresses the types of information to be provided in the FSAR. Specific sections are addressed individually below.
50.34(b)(1)	Information related to siting per 10 CFR Part 100	Potentially applicable to areas and facilities outside the NF per the siting criteria in 10 CFR Part 100.
50.34(b)(2)(i)	Information on SSCs "... sufficient to permit understanding of the system designs and their relationship to safety evaluations"	Not applicable to areas and facilities outside the NF. The list of items that "shall be discussed insofar as they are pertinent" includes "... the reactor core, reactor coolant system, instrumentation and control systems, electrical systems, containment system, other engineered safety features, auxiliary and emergency systems, power conversion systems, radioactive waste handling systems, and fuel handling systems." While some of those may be AFs, they should not be pertinent to the safety evaluation for the reactor provided the separation criteria are met.
50.34(b)(3)	The kinds of radioactive materials to be produced in operation and the means for controlling and limiting radioactive effluents and radiation exposures within Part 20 limits	Not applicable to areas and facilities outside the NF. SC1 addresses radiological considerations associated with normal operations.
50.34(b)(4)	Analysis and evaluation of the design and performance of SSCs relative to considerations in 50.34(a)(4)	Not applicable to areas and facilities outside the NF. Per 50.34(a)(4), such SSCs should be within the NF per SC1 and SC2.
50.34(b)(5)	Resolution of safety questions identified at the construction permit stage	Not applicable to areas and facilities outside the NF. Safety questions at the construction permit stage should be focused on NF SSCs.
50.34(b)(6)(i)	Organizational structure and personnel qualifications	Administrative requirement.
50.34(b)(6)(ii)	Managerial and administrative controls	Administrative requirement.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.34(b)(6)(iii)	Plans for pre-operational testing and initial operations	Potentially applicable to areas and facilities outside the NF. Some pre-operational testing may involve AFs that interface with the NF. Only portions of such testing that has the potential to impact the satisfaction of the separation criteria need be addressed in the SAR. Other AF testing and initial operation information should not be included in the SAR.
50.34(b)(6)(iv)	Plans for normal operations	Not applicable to areas and facilities outside the NF. Per the SC, AF normal operation should not impact public health and safety through impacts on the NF.
50.34(b)(6)(v)	Plans for coping with emergencies (see Part 50, Appendix E)	Potentially applicable to areas and facilities outside the NF. Some aspects of emergency planning will be outside the NF (e.g., an emergency operations facility or backup emergency operations facility). See also 50.34(a)(10).
50.34(b)(6)(vi)	Proposed tech specs	Not applicable to areas and facilities outside the NF. Tech specs should be focused on NF SSCs per SC2.
50.34(b)(6)(vii)	Impact of onsite construction activities for multi-unit sites	Potentially applicable to areas and facilities outside the NF. Requires consideration.
50.34(b)(7)	Technical qualifications of the applicant	Administrative requirement.
50.34(b)(8)	Description and plans for operator requalification program	Potentially applicable to areas and facilities outside the NF. Could impact AFs, depending on the nature of the operator training program.
50.34(b)(9)	Pressurized thermal shock	Not applicable to areas and facilities outside the NF. Pertains to the reactor vessel, which would be part of the NF.
50.34(b)(10)	Earthquake engineering criteria	Potentially applicable to areas and facilities outside the NF. Could be applicable to AFs for which integrity must be assured to protect parts of the NF.
50.34(b)(11)	Description and safety assessment of the site and of the facility [see 50.34(a)(1)(ii)]	Potentially applicable to areas and facilities outside the NF. See 50.34(a)(1)(ii) (A–E) for potential impacts from: (A) Intended use of the reactor and nature and inventory of radioactive materials, and (D) Evaluation of safety features and engineered barriers.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.34(b)(12)	Aircraft impact assessment [refers to 10 CFR 50.150(b)]	Not applicable to areas and facilities outside the NF. Requirements in 50.150(b) are on design features and functional capabilities required for core cooling, spent fuel cooling, and spent fuel integrity, which should be associated with the NF.
50.34(c)	Physical security plan	Potentially applicable to areas and facilities outside the NF. The physical security plan addresses compliance with 10 CFR Part 73. The security plan could address SSCs located outside the NF and activities conducted outside the NF.
50.34(d)	Safeguards contingency plan	Potentially applicable to areas and facilities outside the NF. Procedures in the plan could involve areas outside the NF.
50.34(e)	Protection against unauthorized disclosure	Administrative requirement.
50.34(f)	Additional TMI-related requirements	Not applicable to areas and facilities outside the NF. Requirements apply only to certain applicants that had applications pending as of February 16, 1982.
50.34(g)	Combustible gas control	Administrative requirement. Actual requirements for combustible gas control are in 10 CFR 50.44 and will be addressed in that context.
50.34(h)	Conformance with SRP	Administrative requirement. The SRP is not a regulation, and conformance to it is not a requirement. 10 CFR 50.34(h) simply requires applicants to provide an assessment of their designs against the SRP criteria.
50.34(i)	Mitigation of beyond-design-basis events	Administrative requirement. Actual requirements for mitigation of beyond-design-basis events are in 10 CFR 50.155 and will be addressed in that context.
50.34a	Design objectives for equipment to control radioactive effluents	Not applicable to areas and facilities outside the NF. Such equipment will be in the NF per SC1.
50.35	Issuance of construction permits	Administrative requirement.
50.36	Tech specs	Addresses the tech spec requirements. Specific sections are addressed below.
50.36(a)(1)	Tech specs required for operating license	Administrative requirement.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.36(a)(2)	Tech specs required for Part 52 design certification or manufacturing license	Administrative requirement.
50.36(b)	Tech specs required for Class 103 or 104 production or utilization facility	Administrative requirement.
50.36(c)(1)	Safety limits, limiting safety system settings, and limiting control settings	Not applicable to areas and facilities outside the NF. Safety limits and limiting safety system settings relate to SSCs that guard against the uncontrolled release of radioactivity or have significant safety functions. SC2 requires that all such SSCs would be in the NF.
50.36(c)(2)	Limiting conditions of operations	Not applicable to areas and facilities outside the NF. Limiting conditions of operations pertain to SSCs required for safe operation of the facility, which will be in the NF per the SC.
50.36(c)(3)	Surveillance requirements	Not applicable to areas and facilities outside the NF. Surveillance requirements needed for safe operation of the facility would be in the NF per the SC.
50.36(c)(4)	Design features	Not applicable to areas and facilities outside the NF. Features with a potential for significant effect on safety would be in the NF per the SC.
50.36(c)(5)	Administrative controls	Administrative requirement.
50.36(c)(6)	Decommissioning	Not applicable to initial licensing and operation because the regulation is not in force until permanent cessation of power operations (i.e., entry into the decommissioning phase). At that point, technical specifications for safety limits, limiting safety system settings and limited control system settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls should be associated with the NF per the rationale of 50.36(c)(1) through 50.36(c)(5).
50.36(c)(7)	Notification	Administrative requirement.
50.36(c)(8)	Written reports	Administrative requirement.
50.36(d)	Licenses issued prior to 1/16/1969	Administrative requirement.
50.36(e)	Applicability to licensees without authority to operate	Administrative requirement.
50.36a	Tech specs on effluents	Administrative requirement.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.36b	Conditions to protect the environment during construction, operation, and decommissioning	Potentially applicable to areas and facilities outside the NF. Any such conditions would be based on the environmental report submitted pursuant to 10 CFR 51.50 and 51.53. Conditions of this type would be specific to the site and technology in question.
50.37	Access to classified Information	Administrative requirement.
50.38	Ineligibility of certain applicants	Administrative requirement.
50.39	Public inspection of applications	Administrative requirement.
50.40	Common standards	Administrative requirement.
50.41	Additional standards for Class 104 licenses	Administrative requirement.
50.42	Additional standards for Class 103 licenses	Administrative requirement.
50.43(a)–(d)	Additional standards for Class 103 licenses and certifications for commercial power	Administrative requirement.
50.43(e)	Designs that differ significantly from LWRs or use simplified, inherent, passive, or other innovative means to accomplish safety functions	Not applicable to areas and facilities outside the NF. The requirements are focused on having sufficient testing and analysis to support the use of such features to ensure adequate protection of public health and safety. Such features would be part of the NF per SC2.
50.44	Combustible gas control	Not applicable to areas and facilities outside the NF. The requirements derive from the potential for generation of hydrogen from overheating LWR fuel cladding, although elements apply to non-LWRs as well. These are concerns associated with the generation of combustible gas in the NF, not AFs. While AFs may involve the generation, storage, or use of combustible gases for their own purposes, the implications on the NF would be addressed through the NF design envelope per SC2.
50.45	Standards for construction permits, operating licenses, and combined licenses	Administrative requirement.
50.46	Acceptance criteria for ECCSs	Not applicable to areas and facilities outside the NF. All SSCs ensuring ECCS criteria are met would be part of the NF per SC2.
50.46a	Acceptance criteria for reactor coolant system venting systems	Not applicable to areas and facilities outside the NF. Venting systems would be part of the NF.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.47	Emergency plans <i>(For applicants not able to or choosing not to follow the approach provided by the 2023 emergency preparedness rule as covered in 10 CFR 50.160)</i>	Potentially applicable to areas and facilities outside the NF. Some aspects of emergency planning will be outside the NF (e.g., an emergency operations facility or backup emergency operations facility). See also 50.34(a)(10) and 50.34(b)(6)(v).
50.48	Fire protection	Potentially applicable to areas and facilities outside the NF. Depends on characteristics of the site and design.
50.49	Environmental qualification	Not applicable to areas and facilities outside the NF. The regulation applies to electrical equipment that is 1) safety-related and meeting certain criteria, 2) nonsafety-related whose failure could prevent the satisfactory accomplishment of safety functions, or 3) certain post-accident monitoring equipment [see 10 CFR 50.49(b)(1)–(3)]. Consistent with SC2, all such equipment would be in the NF.
50.50	Issuance of licenses and construction permits	Administrative requirement.
50.51	Continuation of license	Administrative requirement.
50.52	Combining licenses	Administrative requirement.
50.53	Jurisdictional limitations	Administrative requirement.
50.54	Conditions of licenses	Administrative requirement.
50.55	Conditions of construction permits, combined licenses, and manufacturing licenses	Administrative requirement.
50.55a(a)	Codes and standards approved for incorporation by reference	Administrative requirement.
50.55a(b)	Use and conditions on the use of standards	Not applicable to areas and facilities outside the NF. The conditions would be applicable to SSCs in the NF only, per SC2.
50.55a(c)	Reactor coolant pressure boundary	Not applicable to areas and facilities outside the NF. The reactor coolant pressure boundary would be in the NF.
50.55a(d)	Quality Group B components	Not applicable to areas and facilities outside the NF. Quality Group B components would be in the NF. See RG 1.26.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.55a(e)	Quality Group C components	Not applicable to areas and facilities outside the NF. Quality Group C components would be in the NF. See RG 1.26.
50.55a(f)	Preservice and inservice testing requirements	Potentially applicable to areas and facilities outside the NF. Applies the ASME BPV Code and the ASME OM Code to systems and components of boiling and pressurized water-cooled nuclear power reactors. These systems and components will most likely be in the NF; however, the use of the ASME BPV Code and the ASME OM Code outside the NF cannot categorically be ruled out.
50.55a(g)	Preservice and inservice inspection requirements	Potentially applicable to areas and facilities outside the NF. Applies the ASME BPV Code and the ASME OM Code to systems and components of boiling and pressurized water-cooled nuclear power reactors. These systems and components will most likely be in the NF; however, the use of the ASME BPV Code and the ASME OM Code outside the NF cannot categorically be ruled out.
50.55a(h)	Protection and safety system requirements	Not applicable to areas and facilities outside the NF. Those systems would be in the NF.
50.56	Conversion of construction permit to license or amendment of license	Administrative requirement.
50.57	Issuance of operating license	Administrative requirement.
50.58	Hearings and reports of the Advisory Committee on Reactor Safeguards	Administrative requirement.
50.59	Changes, tests, and experiments relating to the facility as described in the FSAR	Potentially applicable to areas and facilities outside the NF. The term “facility as described in the FSAR” is broad and could be construed to cover AFs mentioned in the SAR. However, when SC1 is satisfied, changes outside the NF should not require a reevaluation of public health and safety. The exception is a substantive change to an AF that impacts the NF design envelope. Such a change would require evaluation in accordance with 10 CFR 50.59, as described in Chapter 4 of this report.
50.60	Reactor coolant pressure boundary fracture prevention—normal operation	Not applicable to areas and facilities outside the NF. The reactor coolant pressure boundary would be in the NF.
50.61	Reactor coolant pressure boundary fracture prevention—pressurized thermal shock	Not applicable to areas and facilities outside the NF. The reactor coolant pressure boundary would be in the NF.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.61a	Reactor coolant pressure boundary fracture prevention—pressurized thermal shock—alternate requirements	Not applicable to areas and facilities outside the NF. The reactor coolant pressure boundary would be in the NF.
50.62	Requirements for reduction of risk from anticipated transients without scram for LWRs	Not applicable to areas and facilities outside the NF. The requirements pertain to reactor shutdown, emergency feedwater, and emergency boration, all of which are addressed inside the NF.
50.63	Loss of AC power (station blackout)	Potentially applicable to areas and facilities outside the NF. The regulation is impacted by factors most likely outside the AF, including the expected frequency of loss of offsite power and the probable time needed to restore offsite power.
50.64	Limitations on the use of highly enriched uranium	Administrative requirement.
50.65	Maintenance rule	Potentially applicable to areas and facilities outside the NF. The scope of the maintenance rule includes safety-related SSCs [10 CFR 50.65(b)(1)] and certain nonsafety-related SSCs [10 CFR 50.65(b)(2)]. Per SC2, the safety-related SSCs will be in the NF. 10 CFR 50.65(b)(2) sets forth three criteria for nonsafety-related SSCs to be covered by the maintenance rule. The first two, relied upon to mitigate accidents or transients or used in plant emergency procedures, should not be met per SC2. However, compliance with SC1 and SC2 are not sufficient to demonstrate that the third criterion—failure of the SSC could cause a reactor trip or actuation of a safety system—would not be satisfied. Therefore, it is possible some nonsafety-related SSCs in the AF would meet the criteria for inclusion in the maintenance rule. As a result, a specific evaluation with respect to 10 CFR 50.65 will be required. <i>Note that this regulation was also addressed in the TerraPower topical report NATD-LIC-RPRT-0001 [2].</i>
50.66	Requirements for thermal annealing of the reactor vessel	Not applicable to areas and facilities outside the NF. The reactor vessel will be in the NF.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.67	Accident source term	Not applicable to areas and facilities outside the NF. Accident doses will meet limits without reliance on AF SSCs, per SC2.
50.68	Criticality accident requirements	Not applicable to areas and facilities outside the NF. All fissile material will be stored in the NF.
50.69	Risk-informed categorization of SSCs	Not applicable to areas and facilities outside the NF. If the licensee chooses to follow 50.69, it will categorize SSCs as RISC-1, RISC-2, RISC-3, or RISC-4. Given SC2, the expectation is that all RISC-1, RISC-2, and RISC-3 SSCs will be in the NF.
50.70	Inspections	Administrative requirement.
50.71	Maintenance of records and making of reports	Administrative requirement.
50.72	Immediate notification requirements	Administrative requirement.
50.73	Licensee event reports	Administrative requirement.
50.74	Notification of change in any operator or senior operator status	Administrative requirement.
50.75	Reporting and recordkeeping for decommissioning planning	Administrative requirement.
50.76	Licensee's change of status; financial qualifications	Administrative requirement.
50.78	Facility information and verification (pursuant to International Atomic Energy Agency safeguards)	Administrative requirement.
50.80	Transfer of licenses	Administrative requirement.
50.81	Creditor regulations	Administrative requirement.
50.82	Termination of licenses	Administrative requirement.
50.83	Release of part of a power reactor facility for unrestricted use	Administrative requirement.
50.90	Amendment of license or permit	Administrative requirement.
50.91	Procedures for license amendment	Administrative requirement.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
50.92	Issuance of amendment to license or permit	Administrative requirement.
50.100	Revocation, suspension, and modification of licenses, permits, and approvals	Administrative requirement.
50.101	Retaking possession of special nuclear material	Administrative requirement.
50.102	Commission order for operation after revocation	Administrative requirement.
50.103	Suspension and operation in war or national emergency	Administrative requirement.
50.109	Backfitting	Administrative requirement.
50.110	Violations	Administrative requirement.
50.111	Criminal penalties	Administrative requirement.
50.120	Training and qualification of personnel	Administrative requirement.
50.150	Aircraft impact assessment	Not applicable to areas and facilities outside the NF. Requirements in 50.150(b) are on design features and functional capabilities required for core cooling, spent fuel cooling, and spent fuel integrity, which should be associated with the NF.
50.155	Mitigation of beyond-design-basis events	Potentially applicable to areas and facilities outside the NF. 10 CFR 50.155(c) imposes requirements on equipment that may be relied upon for mitigation of beyond-design-basis events. Such equipment may be portable and stored outside the NF. The regulation requires that any such equipment be “reasonably protected from the effects of natural phenomena.”
50.160	Emergency preparedness for small modular reactors, non-LWRs, and non-power production or utilization facilities <i>(Optional should licensees opt to follow the approach provided by the 2023 emergency preparedness rule)</i>	Potentially applicable to areas and facilities outside the NF. One example of where this regulation applies would be a plume exposure pathway that extends beyond the NF. Another would be the offsite emergency operations facility and backup facilities. In any event, 10 CFR 160(b)(2) requires conducting a “hazard analysis of any contiguous or nearby facility, such as industrial, military, and transportation facilities, and include any credible hazard into the licensee’s emergency preparedness program that would adversely impact the implementation of emergency plans.”

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Appendix A—General Design Criteria (GDC) PDC are required for all facilities licensed under 10 CFR Part 50 or Part 52. The GDC in Appendix A establish minimum requirements for PDC for water-cooled nuclear power reactors. The PDC also “provide guidance in establishing the principal design criteria” for non-water-cooled nuclear power reactors (see Introduction to 10 CFR Part 50, Appendix A). The GDC are addressed below, with the assumption that the facility applying NF separation is a water-cooled reactor similar to nuclear power reactors currently operating in the United States.		
Criterion 1	Quality standards and records	Not applicable to areas and facilities outside the NF. Criterion 1 applies to SSCs important to safety. The quality assurance program should be focused on the NF per SC2. See 10 CFR 50.34(a)(7).
Criterion 2	Design bases for protection against natural phenomena	Potentially applicable to areas and facilities outside the NF. The design bases for seismic hazards, for example, would be expected to be impacted by the evaluation of regions outside the NF and, indeed, the entire facility.
Criterion 3	Fire protection	Potentially applicable to areas and facilities outside the NF. Depends on the characteristics of the site and design. See 10 CFR 50.48.
Criterion 4	Environmental and dynamic effects design bases	Not applicable to areas and facilities outside the NF. See 10 CFR 50.49.
Criterion 5	Sharing of SSCs	Not applicable to areas and facilities outside the NF. Criterion 5 applies to SSCs important to safety. These should be in the NF.
Criterion 10	Reactor design	Not applicable to areas and facilities outside the NF. The reactor and associated systems would be in the NF.
Criterion 11	Reactor inherent protection	Not applicable to areas and facilities outside the NF. The reactor and associated systems would be in the NF.
Criterion 12	Suppression of reactor power oscillations	Not applicable to areas and facilities outside the NF. The reactor and associated systems would be in the NF.
Criterion 13	Instrumentation and control	Not applicable to areas and facilities outside the NF. Per SC2, all required instrumentation and control would be in the NF. Also see 10 CFR 50.34(b)(2)(i).

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Criterion 14	Reactor coolant pressure boundary	Not applicable to areas and facilities outside the NF. Per SC2, the primary pressure boundary would be in the NF.
Criterion 15	Reactor coolant system design	Not applicable to areas and facilities outside the NF. Per SC2, the primary pressure boundary and associated systems would be in the NF.
Criterion 16	Containment design	Not applicable to areas and facilities outside the NF. Per SC2, a containment system relied upon to limit radionuclide releases with regulatory limits would be in the NF.
Criterion 17	Electric power systems	Potentially applicable to areas and facilities outside the NF. The criterion requires onsite and offsite electrical power supplies with certain minimum capabilities. The offsite power supply would be located primarily or totally outside the NF.
Criterion 18	Inspection and testing of electrical power systems	Potentially applicable to areas and facilities outside the NF. Same rationale as Criterion 17.
Criterion 19	Control room	Potentially applicable to areas and facilities outside the NF. A control room is required, along with equipment outside the control room to maintain hot shutdown in the event the control room is not available. The control room would be in the NF, and the auxiliary shutdown equipment would likely be as well, but that cannot be stated with complete certainty absent information about the design of the reactor and the approach to NF separation.
Criterion 20	Protection system functions	Not applicable to areas and facilities outside the NF. Per SC2, equipment to accomplish protection system functions would be in the NF.
Criterion 21	Protection system reliability and testability	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 20.
Criterion 22	Protection system independence	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 20.
Criterion 23	Protection system failure modes	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 20.
Criterion 24	Separation of protection and control systems	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 20.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Criterion 25	Protection system requirements for reactivity control malfunctions	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 20.
Criterion 26	Reactivity control redundancy and capability	Not applicable to areas and facilities outside the NF. Per SC2, the reactivity control systems would be in the NF.
Criterion 27	Combined reactivity control systems capability	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 26.
Criterion 28	Reactivity limits	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 26.
Criterion 29	Protection against anticipated operational occurrences	Not applicable to areas and facilities outside the NF. Same rationale as Criteria 20 and 26.
Criterion 30	Quality of reactor coolant pressure boundary	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 14.
Criterion 31	Fracture prevention of reactor coolant pressure boundary	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 14.
Criterion 32	Inspection of reactor coolant pressure boundary	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 14.
Criterion 33	Reactor coolant makeup	Not applicable to areas and facilities outside the NF. Per SC2, equipment to deal with reactor coolant leaks or breaks would be in the NF.
Criterion 34	Residual heat removal	Potentially applicable to areas and facilities outside the NF. This would be determined by the design of the reactor and the approach to NF separation.
Criterion 35	Emergency core cooling	Not applicable to areas and facilities outside the NF. Per SC2, equipment to deal with reactor coolant leaks or breaks would be in the NF.
Criterion 36	Inspection of ECCS	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 35.
Criterion 37	Testing of ECCS	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 35.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Criterion 38	Containment heat removal	Not applicable to areas and facilities outside the NF. Per SC2, a containment system (and associated support systems) relied upon to limit radionuclide releases with regulatory limits would be in the NF.
Criterion 39	Inspection of containment heat removal system	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 38.
Criterion 40	Testing of containment heat removal system	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 38.
Criterion 41	Containment atmosphere cleanup	Not applicable to areas and facilities outside the NF. Per SC2, a system to reduce offsite doses due to containment leakage after an accident and a system to maintain containment integrity would be in the NF.
Criterion 42	Inspection of containment atmosphere cleanup systems	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 41.
Criterion 43	Testing of containment atmosphere cleanup systems	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 41.
Criterion 44	Cooling water	Potentially applicable to areas and facilities outside the NF. The cooling water system for normal operation and accident situations, including the ultimate heat sink, may have portions outside the NF.
Criterion 45	Inspection of cooling water system	Potentially applicable to areas and facilities outside the NF. Same rationale as Criterion 44.
Criterion 46	Testing of cooling water system	Potentially applicable to areas and facilities outside the NF. Same rationale as Criterion 44.
Criterion 50	Containment design basis	Not applicable to areas and facilities outside the NF. Per SC2, a containment system (and associated support systems) relied upon to limit radionuclide releases with regulatory limits would be in the NF.
Criterion 51	Fracture prevention of containment pressure boundary	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 50.
Criterion 52	Capability for containment leakage rate testing	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 50.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Criterion 53	Provision for containment testing and inspection	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 50.
Criterion 54	Piping systems penetrating containment	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 50.
Criterion 55	Reactor coolant pressure boundary penetrating containment	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 50.
Criterion 56	Primary containment isolation	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 50.
Criterion 60	Control of releases of radioactive materials to the environment	Not applicable to areas and facilities outside the NF. Per SC1 and SC2, the SSCs associated with meeting this GDC would be in the NF.
Criterion 61	Fuel storage and handling and radioactivity control	Not applicable to areas and facilities outside the NF. Per SC1 and SC2, the SSCs associated with meeting this GDC would be in the NF.
Criterion 62	Prevention of criticality in fuel storage and handling	Not applicable to areas and facilities outside the NF. Same rationale as Criterion 61.
Criterion 63	Monitoring fuel and waste storage	Not applicable to areas and facilities outside the NF. Per SC1 and SC2, the SSCs associated with meeting this GDC would be in the NF.
Criterion 64	Monitoring radioactivity releases	Not applicable to areas and facilities outside the NF. Per SC1 and SC2, the SSCs associated with meeting this GDC would be in the NF.
Appendix B—Quality Assurance Criteria Not applicable to areas and facilities outside the NF. The quality assurance program should be focused on the NF per SC2. See 10 CFR 50.34(a)(7). See Appendix B, Criterion 1. <i>Note that this regulation was also addressed in TerraPower topical report NATD-LIC-RPRT-0001 [2].</i>		
Appendix C—A Guide for the Financial Data and Related Information Required to Establish Financial Qualifications for Construction Permits and Combined Licenses The financial qualification information is administrative in nature.		

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Appendix D—Reserved		
Appendix E—Emergency Planning and Preparedness for Production and Utilization Facilities Potentially applicable to areas and facilities outside the NF. The rationale is the same as for 10 CFR 50.34(a)(10).		
Appendix F—Policy Relating to the Siting of Fuel Reprocessing Plants and Related Waste Management Facilities Not applicable to areas and facilities outside the NF. The appendix is for nonreactor facilities and is not applicable to an advanced reactor.		
Appendix G—Fracture Toughness Requirements Not applicable to areas and facilities outside the NF. This appendix pertains to the reactor coolant pressure boundary of LWRs. The reactor coolant pressure boundary would be in the NF.		
Appendix H—Reactor Vessel Material Surveillance Program Requirements Not applicable to areas and facilities outside the NF. The requirements are fundamentally administrative in nature. Also, they pertain to material specimens located inside the NF.		
Appendix I—Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion “As Low as Is Reasonably Achievable” for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents Not applicable to areas and facilities outside the NF. The appendix establishes radionuclide release limits for airborne and liquid effluents from nuclear power plants. The limits are essentially administrative. Also, per SC1, the limits should be met through controls and equipment in the NF.		
Appendix J—Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors Not applicable to areas and facilities outside the NF. The containment would be in the NF.		
Appendix K—ECCS Evaluation Models Not applicable to areas and facilities outside the NF. The ECCS would be in the NF per SC2.		
Appendices L–M—Reserved		
Appendix N—Standardization of Nuclear Power Plant Designs: Permits to Construct and Licenses to Operate Nuclear Power Reactors of Identical Design and Multiple Sites Not applicable to areas and facilities outside the NF. This appendix is administrative in nature.		
Appendices O–P—Reserved		
Appendix Q—Pre-application Early Review of Site Suitability Issues Potentially applicable to areas and facilities outside the NF because it addresses siting issues.		

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
	Appendix R—Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979	
	Not applicable to new reactor applications.	
	Appendix S—Earthquake Engineering Criteria for Nuclear Power Plants	
	Potentially applicable to areas and facilities outside the NF. SSCs outside the NF could be involved in the evaluation of the operating basis earthquake ground motion. SSCs required to withstand the safe shutdown earthquake should be inside the NF per SC2, but an evaluation of potential interactions with SSCs outside the NF must be made. See 10 CFR 50.34(a)(12).	

B EVALUATION OF 10 CFR PART 52 REQUIREMENTS FOR APPLICATION OUTSIDE NUCLEAR FACILITIES

The following table documents the evaluation of 10 CFR Part 52 requirements for the need to address SSCs and areas outside the NF in order to demonstrate compliance with the regulation.

Those parts of the regulation noted as “administrative requirements” are those that do not levy technical or quality requirements on the facility, but instead address administrative matters, such as information to be provided or processes to be followed. In general, administrative requirements apply only to SSCs within the NF, but a blanket statement that no administrative requirements apply to AFs cannot be made on a generic basis.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.1	General Provisions—Scope	Administrative requirement.
52.1	General Provisions—Definitions	Administrative requirement.
52.2	General Provisions—Interpretations	Administrative requirement.
52.3	General Provisions—Written communications	Administrative requirement.
52.4	General Provisions—Deliberate misconduct	Administrative requirement.
52.5	General Provisions—Employee protection	Administrative requirement.
52.6	General Provisions—Completeness and accuracy of information	Administrative requirement.
52.8	General Provisions—Combined licenses; elimination of repetition	Administrative requirement.
52.9	General Provisions—Jurisdictional limits	Administrative requirement.
52.10	General Provisions—Attacks and destructive acts	Administrative requirement.
52.11	General Provision—Information collection	Administrative requirement.
Subpart A—Early Site Permits 52.12–52.39 The purpose of early site permits is to document regulatory approval for a site. The concept of NF separation is not applicable to early site permits. The early site permit process does not consider a specific and detailed reactor design, so the principle of NF separation cannot be applied.		
Subpart B—Standard Design Certifications 52.41–52.63 The purpose of a design certification is to document regulatory approval for a nuclear power plant design. The applicant exercises the design certification without a specific site. However, the applicant provides a reference conceptual design for those portions of the plant for which the applicant does not seek certification [see 52.47(a)(24)]. The applicant also specifies interface requirements to allow completion of the FSAR [see 52.47(a)(25)]. The contents of Subpart B are administrative in nature, except for 52.47, which lays out technical information required in the application. To a great extent the content of 52.47 is the same as the content of 10 CFR 50.34, which addresses nuclear reactor applications submitted under Part 50. The applicant may choose to develop the nuclear plant design required for a design certification in a manner that enables the application of NF separation, and this would be reflected in the reference conceptual design and interface requirements. However, NF separation consistent with the NF separation criteria in EPRI 3002026499 cannot be demonstrated until there is an application with both a design and a site. In the interim, determining the extent to which the technical requirements are applicable to areas and facilities outside the NF should be informed by the evaluation of the Part 50 requirements corresponding to specific Part 52 requirements.		

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Subpart C—Combined Licenses		
The purpose of a combined license is to document regulatory approval for construction and operation of a nuclear power plant at a specific site. The combined license process does this in one step, as opposed to the two-step process (construction permit followed by operating license) of Part 50. The requirements of 10 CFR Part 52, Subpart C, are evaluated below relative to NF separation in a manner analogous to those of 10 CFR Part 50, Appendix B.		
52.71	Scope of subpart	Administrative requirement.
52.73	Relationship to other subparts	Administrative requirement.
52.75	Filing of applications	Administrative requirement.
52.77	Content of applications, general	Administrative requirement.
52.79	Content of applications, technical information in the FSAR	Addresses the types of information to be provided in an application. Specific sections are addressed individually below. <i>See 50.34.</i>
52.79(a)	Description and safety assessment of the site and a safety assessment of the facility	Specific characteristics are addressed individually below. <i>See 50.34(a)(1)(ii).</i>
52.79(a)(1)(i)	Boundaries of the site	Potentially applicable to areas and facilities outside the NF.
52.79(a)(1)(ii)	General location of each facility on the site	Potentially applicable to areas and facilities outside the NF.
52.79(a)(1)(iii)	Seismic, meteorological, hydrologic, and geologic characteristics of the site	Potentially applicable to areas and facilities outside the NF. <i>See 50.34(b)(1).</i>
52.79(a)(1)(iv)	Nearby industrial, military, or transportation facilities and routes	Potentially applicable to areas and facilities outside the NF. <i>See 50.34(b)(1).</i>
52.79(a)(1)(v)	Population profile around the site	Potentially applicable to areas and facilities outside the NF. <i>See 50.34(b)(1).</i>
52.79(a)(1)(vi)	Description and safety assessment of the site	Potentially applicable to areas and facilities outside the NF. Specifically, the site meteorology goes beyond the NF. <i>See 50.34(b)(1).</i>
52.79(a)(2)	Description and analysis of the SSCs of the facility; emphasis on showing safety functions will be accomplished	Not applicable to areas and facilities outside the NF. Such SSCs should be within the NF per SC1 and SC2. <i>See 50.34(b)(2)(i).</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(3)	Radioactive materials produced and means of controlling effluents	Not applicable to areas and facilities outside the NF. SC1 addresses radiological considerations associated with normal operations. <i>See 50.34(b)(3).</i>
52.79(a)(4)(i)	PDC	Not applicable to areas and facilities outside the NF. PDC should be applicable to NF SSCs per SC2. <i>See 50.34(a)(3)(i).</i>
52.79(a)(4)(ii)	Design bases and relation to PDC	Not applicable to areas and facilities outside the NF. The design bases should be associated with the NF. <i>See 50.34(a)(3)(ii).</i>
52.79(a)(5)	Analysis and evaluation of the design and performance of SSCs relative to risk to the public and margins of safety	Not applicable to areas and facilities outside the NF. Such SSCs should be within the NF per SC1 and SC2. <i>See 52.79(a)(2) and 50.34(b)(4).</i>
52.79(a)(6)	Description and analysis of fire protection design features	Potentially applicable to areas and facilities outside the NF. Depends on characteristics of the site and design. <i>See 50.48.</i>
52.79(a)(7)	Description and analysis of protection against pressurized thermal shock	Not applicable to areas and facilities outside the NF. The reactor coolant pressure boundary would be in the NF. <i>See 50.60, 50.61, and 50.61a.</i>
52.79(a)(8)	Description and analysis of equipment and systems for combustible gas control	Not applicable to areas and facilities outside the NF. The requirements derive from the potential for generation of hydrogen from overheating LWR fuel cladding, although elements apply to non-LWRs as well. These are concerns associated with the generation of combustible gas in the NF, not AFs. While AFs may involve the generation, storage, or use of combustible gases for their own purposes, the implications for the NF would be addressed through the NF design envelope per SC2. <i>See 50.44.</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(9)	Coping analyses and design features that address station blackout	Potentially applicable to areas and facilities outside the NF. The regulation is impacted by factors most likely outside the AFs, including the expected frequency of loss of offsite power and the probable time needed to restore offsite power. <i>See 50.63.</i>
52.79(a)(10)	Environmental qualification	Not applicable to areas and facilities outside the NF. The regulation applies to electrical equipment that is 1) safety-related and meeting certain criteria, 2) nonsafety-related whose failure could prevent the satisfactory accomplishment of safety functions, or 3) certain post-accident monitoring equipment [see 10 CFR 50.49(b)(1)–(3)]. Consistent with SC2, all such equipment would be in the NF. <i>See 50.49.</i>
52.79(a)(11)	Codes and standards	Elements are potentially applicable to areas and facilities outside the NF. The regulation invokes 10 CFR 50.55a. 10 CFR 50.55a(a) is an administrative requirement. 10 CFR 50.55a Subparts (b), (c), (d), (e), and (h) are not applicable to areas and facilities outside the NF. 10 CFR 50.55a Subparts (f) and (g) are potentially applicable to areas and facilities outside the NF. <i>See 50.55a, Subparts (a) through (h).</i>
52.79(a)(12)	Containment leakage rate testing	Not applicable to areas and facilities outside the NF. The containment would be inside the NF. <i>See 10 CFR Part 50, Appendix J.</i>
52.79(a)(13)	Reactor vessel material surveillance program	Not applicable to areas and facilities outside the NF. The requirements are fundamentally administrative in nature. Also, they pertain to material specimens located inside the NF. <i>See 10 CFR Part 50, Appendix H.</i>
52.79(a)(14)	Operator training program	Potentially applicable to areas and facilities outside the NF. Could impact AFs depending on the nature of the operator training program. <i>See 50.34(b)(8).</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(15)	Maintenance rule	Potentially applicable to areas and facilities outside the NF. The scope of the maintenance rule includes safety-related SSCs [10 CFR 50.65(b)(1)] and certain nonsafety-related SSCs [10 CFR 50.65(b)(2)]. Per SC2, the safety-related SSCs would be in the NF. 10 CFR 50.65(b)(2) sets forth three criteria for nonsafety-related SSCs to be covered by the maintenance rule. The first two, relied upon to mitigate accidents or transients or used in plant emergency procedures, should not be met per SC2. However, compliance with SC1 and SC2 is not sufficient to demonstrate that the third criterion—failure of the SSC could cause a reactor trip or actuation of a safety system—would not be satisfied. Therefore, it is possible some nonsafety-related SSCs in the AF would meet the criteria for inclusion in the maintenance rule. As a result, a specific evaluation with respect to 10 CFR 50.65 will be required. <i>See 50.65.</i>
52.79(a)(16)(i)	Equipment to maintain control over radioactive materials	Not applicable to areas and facilities outside the NF. Such equipment would be in the NF per SC1. <i>See 50.34a.</i>
52.79(a)(16)(ii)	Process and effluent sampling program required by 10 CFR 50, Appendix I	Not applicable to areas and facilities outside the NF. The Appendix I limits should be met by equipment and controls in the NF per SC1. <i>See 10 CFR Part 50, Appendix J.</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(17)	Compliance with TMI requirements	Potentially applicable to areas and facilities outside the NF. The TMI requirements are wide ranging, and they affect systems and components that may not even be present or safety-related for some advanced reactor designs. Some may be deemed to be “not technically relevant.” In other cases the applicant may wish to apply for an exemption to those specific requirements rather than address them. Many requirements are to perform evaluations or studies, and without knowledge of plant characteristics it is impossible to say that such evaluations or studies would not touch upon AFs. Rather than attempting to evaluate each requirement in detail for AF impact, the expectation is that the applicant will evaluate the applicable TMI requirements, determine which ones must be addressed, and factor in information from AFs if needed, with documentation provided in accordance with Section 4 of this report.
52.79(a)(18)	Risk-informed treatment of SSCs	Not applicable to areas and facilities outside the NF. If the licensee chooses to follow 50.69, it will categorize SSCs as RISC-1, RISC-2, RISC-3, or RISC-4. Given SC2, the expectation is that all RISC-1, RISC-2, and RISC-3 SSCs will be in the NF. <i>See 50.69.</i>
52.79(a)(19)	Compliance with earthquake engineering criteria	Potentially applicable to areas and facilities outside the NF. SSCs outside the NF could be involved in the evaluation of the operating basis earthquake ground motion. SSCs required to withstand the safe shutdown earthquake should be inside the NF per SC2, but an evaluation of potential interactions with SSCs outside the NF must be made. <i>See 50.34(a)(12) and 10 CFR 50, Appendix S.</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(20)	Unresolved Safety Issues and medium- and high-priority generic safety issues	Potentially applicable to areas and facilities outside the NF. Like the TMI requirements, the Unresolved Safety Issues and generic safety issues cover a wide range of issues. Moreover, they are moving targets—issues will be added to and removed from the lists over time. It is not feasible to state up front that some issues could involve information related to facilities outside the NF. It is expected that the applicant will evaluate the applicable issues, determine which ones must be addressed, and factor in information from AFs if needed, with documentation provided in accordance with Section 4 of this report.
52.79(a)(21)	Emergency plans	Potentially applicable to areas and facilities outside the NF. Some aspects of emergency planning will be outside the NF (e.g., an emergency operations facility or backup emergency operations facility). <i>See also 50.34(a)(10), 50.34(b)(6)(v), 50.47, 50.160, and 10 CFR 50, Appendix E.</i>
52.79(a)(22)	Emergency plan certifications	Administrative requirement.
52.79(a)(23)	Reserved	Not applicable.
52.79(a)(24)	Designs that differ significantly from LWRs licensed before 1997 and/or use simplified, inherent, passive, or innovative means to accomplish safety functions need a description of how they meet 10 CFR 50.43(e)	Not applicable to areas and facilities outside the NF. The requirements are focused on having sufficient testing and analysis to support the use of such features to ensure adequate protection of public health and safety. Such features would be part of the NF per SC2. <i>See 50.43(e).</i>
52.79(a)(25)	Quality assurance program	Not applicable to areas and facilities outside the NF. The quality assurance program should be focused on the NF per SC2. <i>See 50.34(a)(7) and 10 CFR 50, Appendix B.</i>
52.79(a)(26)	Organizational structure	Administrative requirement. <i>See 50.34(b)(6)(i).</i>
52.79(a)(27)	Managerial and administrative controls	Administrative requirement. <i>See 50.34(b)(6)(ii).</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(28)	Plans for pre-operational testing and initial operations	Potentially applicable to areas and facilities outside the NF. Some pre-operational testing may involve AFs that interface with the NF. Only portions of such testing that has the potential to impact the satisfaction of the separation criteria need be addressed in the SAR. Other AF testing and initial operation information should not be included in the SAR. <i>See 50.34(b)(6)(iii).</i>
52.79(a)(29)(i)	Plans for conduct of normal operations	Not applicable to areas and facilities outside the NF. Per the SC, AF normal operation should not impact public health and safety through impacts on the NF. <i>See 50.34(b)(6)(iv).</i>
52.79(a)(29)(ii)	Plans for coping with emergencies	Potentially applicable to areas and facilities outside the NF. Some aspects of emergency planning will be outside the NF (e.g., an emergency operations facility or backup emergency operations facility). <i>See also 50.34(a)(10), 50.34(b)(6)(v), and 10 CFR 50 Appendix E.</i>
52.79(a)(30)	Proposed tech specs	Not applicable to areas and facilities outside the NF. Tech specs should be focused on NF SSCs per SC2. <i>See 50.34(b)(6)(vi).</i>
52.79(a)(31)	Impact of onsite construction activities for multi-unit sites	Potentially applicable to areas and facilities outside the NF. Requires consideration. <i>See 50.34(b)(6)(vii).</i>
52.79(a)(32)	Technical qualifications of the applicant	Administrative requirement. <i>See 50.34(b)(7).</i>
52.79(a)(33)	Training and qualification of personnel	Administrative requirement. <i>See 50.120.</i>
52.79(a)(34)	Description and plans for operator requalification program.	Potentially applicable to areas and facilities outside the NF. Could impact AFs depending on the nature of the operator training program. <i>See 50.34(b)(8).</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(35)	Physical security plan and implementation thereof	Potentially applicable to areas and facilities outside the NF. The physical security plan addresses compliance with 10 CFR Part 73. The security plan could address SSCs located outside the NF and activities conducted outside the NF. <i>See 50.34(c).</i>
52.79(a)(36)	Safeguards contingency plan, training and qualification plan for security personnel, cyber security plan, and protection of safeguards information	Potentially applicable to areas and facilities outside the NF. Information in the plans could involve areas outside the NF. <i>See 50.34(d).</i>
52.79(a)(37)	Operating experience	Not applicable to areas and facilities outside the NF. The focus of operating experience is on information from the operation of other nuclear power plants that bears on protection of public health and safety. Thus, the focus would be on the NF per SC1 and SC2.
52.79(a)(38)	Design features for the prevention and mitigation of severe accidents	Not applicable to AFs. This requirement (applicable to light water reactors only) is focused on containment integrity. Per SC2, the containment and associated SSCs would be in the NF.
52.79(a)(39)	Radiation protection program	Potentially applicable to AFs. It is possible that aspects of the radiation protection program (e.g., monitoring) will extend beyond the NF.
52.79(a)(40)	Fire protection	Potentially applicable to areas and facilities outside the NF. Depends on characteristics of the site and design. <i>See 50.48.</i>
52.79(a)(41)	Evaluation against SRP	Potentially applicable to areas and facilities outside the NF. The SRP is wide ranging and, depending on the extent of the NF, the SRP may refer to AFs.
52.79(a)(42)	Anticipated transients without scram	Not applicable to areas and facilities outside the NF. The requirements pertain to reactor shutdown, emergency feedwater, and emergency boration, all of which are addressed inside the NF. <i>See 50.62.</i>

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.79(a)(43)	Criticality accident requirements	Not applicable to areas and facilities outside the NF. All fissile material will be stored in the NF. <i>See 50.68.</i>
52.79(a)(44)	Fitness-for-duty	Administrative requirement.
52.79(a)(45)	Minimization of contamination	Potentially applicable to areas and facilities outside the NF. While provisions for minimization of contamination (10 CFR 20.1406) will most likely focus on the NF, it is possible monitoring and control provisions could be applied to AFs.
52.79(a)(46)	Description of the plant specific PRA and its results	Potentially applicable to areas and facilities outside the NF. The PRA scope will be a function of the plant design and the approach taken for modeling it.
52.79(a)(47)	Aircraft impact	Not applicable to areas and facilities outside the NF. Adverse impacts would only be pertinent to the NF.
52.79(b)	Considerations for combined licenses referencing an early site permit	Potentially applicable to areas and facilities outside the NF, depending on the nature of the ESP and combined license application.
52.79(c)	Considerations for combined licenses referencing a standard design approval	Potentially applicable to areas and facilities outside the NF, depending on the nature of the standard design approval and combined license application.
52.79(d)	Considerations for combined licenses referencing a standard design certification	Potentially applicable to areas and facilities outside the NF, depending on the nature of the standard design certification and combined license application.
52.79(e)	Considerations for combined licenses using a reactor produced under a manufacturing license	Potentially applicable to areas and facilities outside the NF, depending on the nature of the manufacturing license and combined license application.
52.79(f)	Protection of safeguards information against disclosure	Administrative requirement.
52.80(a)	Inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria (ITAAC)	Potentially applicable to areas and facilities outside the NF because it includes emergency planning.
52.80(b)	Environmental report	Potentially applicable to areas and facilities outside the NF because it will address impacts outside the NF.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
52.80(c)	Information required for a limited work authorization.	Potentially applicable to areas and facilities outside the NF. <i>See 50.10.</i>
52.80(d)	Information related to mitigation of beyond-design-basis events	Potentially applicable to areas and facilities outside the NF. <i>See 50.155.</i>
52.81	Standards for review of applications	Administrative requirement.
52.83	Finality of NRC approvals	Administrative requirement.
52.85	Administrative review of applications; hearings	Administrative requirement.
52.87	Referral to the Advisory Committee on Reactor Safeguards	Administrative requirement.
52.89	Reserved	Not applicable.
52.91	Authorization to conduct limited work authorization activities	Administrative requirement.
52.93	Exemptions and variances	Administrative requirement.
52.97	Issuance of combined licenses	Administrative requirement.
52.98	Finality of combined licenses	Administrative requirement.
52.99	Inspection during construction; ITAAC schedules and notifications; NRC notices	Administrative requirement.
52.103	Operation under a combined license	Administrative requirement.
52.104	Duration of combined license	Administrative requirement.
52.105	Transfer of combined license	Administrative requirement.
52.107	Application for renewal	Administrative requirement.
52.109	Continuation of combined license	Administrative requirement.
52.110	Termination of license	Administrative requirement.

Regulation	Description of Regulation and Summary of Safety Objective, When Appropriate	Discussion
Subpart E—Standard Design Approvals		
The purpose of a standard design approval is to document regulatory approval for a major portion standard nuclear power plant design. The applicant exercises the standard design approval without a specific site, but it postulates site parameters to enable an analysis and evaluation of the design [see 52.137(a)(1)]. The contents of Subpart E are administrative in nature, except for 52.137, which lays out technical information required in the application. To a great extent the content of 52.137 is similar to portions of 10 CFR 50.34, which addresses the content of technical information required in nuclear reactor application submitted under Part 50. In developing the nuclear plant design required for a standard design approval, the applicant may choose to do so in a manner that enables the application of NF separation, and this would be reflected in the reference conceptual design. However, NF separation consistent with the NF separation criteria in EPRI 3002026499 cannot be demonstrated until there is an application with both a design and a site. In the interim, determining the extent to which the technical requirements are applicable to areas and facilities outside the NF should be informed by the evaluation of the Part 50 requirements corresponding to specific Part 52 requirements.		
Subpart F—Manufacturing Licenses		
The purpose of a manufacturing license is to document regulatory approval for the manufacturing of a nuclear power reactor to be installed at sites not identified in the manufacturing license application. a major portion standard nuclear power plant design. The applicant exercises the manufacturing license without a specific site, but it postulates site parameters to enable an analysis and evaluation of the design [see 52.157(d)]. The contents of Subpart F are administrative in nature, except for 52.157, which lays out technical information required in the application. To a great extent the content of 52.157 is similar to portions of 10 CFR 50.34, which addresses the content of technical information required in nuclear reactor application submitted under Part 50. In developing the nuclear plant design required for a manufacturing license, the applicant may choose to do so in a manner that enables the application of NF separation, and this would be reflected in the reference conceptual design. However, NF separation consistent with the NF separation criteria in EPRI 3002026499 cannot be demonstrated until there is an application with both a design and a site. In the interim, determining the extent to which the technical requirements are applicable to areas and facilities outside the NF should be informed by the evaluation of the Part 50 requirements corresponding to specific Part 52 requirements.		
Subpart H—Enforcement		
52.301	Violations	Administrative requirement.
Appendices A–F		
Appendices A–F document the design certifications for a number of standard designs: U.S. Advanced Boiling Water Reactor, System 80+, AP600, AP1000, ESBWR, and APR1400, respectively. The information in the certifications is administrative in nature.		
Appendix N		
Standardization of Nuclear Power Plant Designs: Combined Licenses to Construct and Operate Nuclear Power Reactors of Identical Designs at Multiple Sites Appendix N addresses the approach to processing concurrent applications for multiple reactors of the same design at different sites. The subpart is entirely administrative in nature, and does not relate to NF separation.		

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PROGRAM

Advanced Nuclear Technology, P41.08.01

For more information, contact:

EPRI Customer Assistance Center
800.313.3774 • askepri@epri.com



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3420 Hillview Avenue, Palo Alto, California 94304-1338 USA • 650.855.2121 • www.epri.com

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