EVR-LIC-RL-001-NP, Revision 0
"Principal Design Criteria Topical Report"
(Non-Proprietary)

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REVISION SUMMARY

Revision	Revision Description
0	Initial Issue

OPEN ITEMS

Open Item #	Section	Open Item Description	Status
None.			

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Acronyms and Trademarks

Acronyms used in the document are included below to ensure unambiguous understanding of their use within this document.

Acronym	Definition
AOO	Anticipated Operational Occurrence
ARDC	Advanced Reactor Design Criteria
BDBE	Beyond Design Basis Event
CDC	Complementary Design Criteria
CFR	Code of Federal Regulations
DBA	Design Basis Accident
DBE	Design Basis Event
DC	Design Criteria
DCA	Standard Design Certification Application
DG	Draft Regulatory Guide
DID	Defense-in-Depth
F-C	Frequency-Consequence
FSAR	Final Safety Analysis Report
GDC	General Design Criteria
HALEU	High-Assay, Low-Enriched Uranium
I&C	Instrumentation and Control
ICE	Instrumentation, Controls, and Electrical
IDP	Integrated Decision-Making Process
ITAAC	Inspections, Tests, Analyses, And Acceptance Criteria
LBE	Licensing Basis Event
LWR	Light Water Reactor
MHTGR	Modular High-Temperature Gas-Cooled Reactor
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
NSRST	Non-Safety-Related with Special Treatment
PCS	Power Conversion System
PDC	Principal Design Criteria
PHX	Primary Heat Exchanger
PRA	Probabilistic Risk Assessment
QA	Quality Assurance
REP	Regulatory Engagement Plan
RFDC	Required Functional Design Criteria
RG	Regulatory Guide
RSF	Required Safety Function
RXS	Reactor System
SAR	Safety Analysis Report
[	][a,c]
SFR	Sodium-Cooled Fast Reactor
SR	Safety-Related
SSC	Structure, System, or Component
TICAP	Technology-Inclusive Content of Application Project
TI-RIPB	Technology-Inclusive, Risk-Informed, and Performance-Based
TRISO	Tristructural Isotropic

Glossary of Terms

Standard terms used in the document are defined below to ensure unambiguous understanding of their use within this document.

Term	**Definition**
Anticipated Operational Occurrence (AOO)	Event sequences with mean frequencies of 1×10^{-2}/facility-year and greater are classified as AOOs. AOOs take into account the expected response of all structures, systems, and components (SSCs) within the facility, regardless of safety classification.
Beyond Design Basis Event (BDBE)	Event sequences with mean frequencies of 5×10^{-7}/facility-year to 1×10^{-4}/facility-year are classified as BDBEs. BDBEs take into account the expected response of all SSCs within the facility regardless of safety classification.
Design Basis Accident (DBA)	Postulated accidents that are used to set design criteria and performance objectives for the design of safety-related (SR) SSCs. DBAs are derived from design basis events (DBEs) based on the capabilities and reliabilities of SR SSCs needed to mitigate and prevent accidents, respectively. DBAs are derived from the DBEs by prescriptively assuming that only SR SSCs classified are available to mitigate postulated accident consequences to within the frequency-consequence (F-C) limits.
Design Basis Event	Event sequences with mean frequencies of 1×10^{-4}/facility-year to 1×10^{-2}/facility-year are classified as DBEs. DBEs take into account the expected response of all SSCs within the facility regardless of safety classification.
Licensing Basis Event (LBE)	The entire collection of event sequences considered in the design and licensing basis of the facility, which may include one or more reactor modules. LBEs include AOOs, DBEs, BDBEs, and DBAs.
Non-Safety-Related with Special Treatment (NSRST) SSCs	Non-safety-related SSCs that perform risk-significant functions or perform functions that are necessary for defense-in-depth adequacy.
Required Functional Design Criteria (RFDC)	Reactor design-specific functional criteria that are necessary and sufficient to meet the Required Safety Functions (RSFs). For the eVinci microreactor design, the RFDC are synonymous with the Principal Design Criteria developed using NEI 21-07.
Required Safety Function	A function that is required to be fulfilled to maintain the consequence of one or more DBEs or the frequency of one or more high-consequence BDBEs inside the F-C Target.
Safety-Related SSCs	SSCs that are credited in the fulfillment of RSFs and are capable to perform their RSFs in response to any design basis hazard level.

Safety Significant SSCs	SSCs that perform a safety-related function or a function whose performance is necessary to achieve adequate defense-in-depth or is classified as risk-significant. Safety significant encompasses both SR and NSRST SSCs.

References

Following is a list of references used throughout this document.

1. 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, August 2007.
2. EVR_LTR_220214, Revision 0, "Submittal of Westinghouse **eVinci™** Microreactor 2022 Pre-Application Regulatory Engagement Plan," Westinghouse Electric Company LLC, December 21, 2022.
3. EVR_LTR_210076, Revision 0, "Submittal of Westinghouse **eVinci™** Micro-Reactor Group 1 White Papers for Pre-Application Engagement," Westinghouse Electric Company LLC, December 9, 2021.
4. EVR_LTR_220032, Revision 0, "Submittal of the Westinghouse **eVinci™** Micro-Reactor Group 2 White Papers for Pre-Application Engagement," Westinghouse Electric Company LCC, March 31, 2022.
5. EVR_LTR_220074, Revision 0, "Submittal of Westinghouse **eVinci™** Micro-Reactor White Paper for Pre-Application Engagement (TRISO Fuel Qualification and Testing)," Westinghouse Electric Company LLC, May 31, 2022.
6. EVR_LTR_220092, Revision 0, "Submittal of the Westinghouse **eVinci™** Micro-Reactor Wave 3 White Papers for Pre-Application Engagement," Westinghouse Electric Company LLC, June 30, 2022.
7. EVR_LTR_220151, Revision 0, "Submittal of the Westinghouse **eVinci™** Microreactor Wave 4 White Papers for Pre-Application Engagement," Westinghouse Electric Company LLC, September 28, 2022.
8. EVR_LTR_220164, Revision 0, "Submittal of Westinghouse **eVinci™** Microreactor White Paper for Pre-Application Engagement (Operations and Remote Monitoring)," Westinghouse Electric Company LLC, October 26, 2022.
9. EVR_LTR_230074, Revision 0, "Submittal of the Westinghouse **eVinci™** Microreactor Wave 5 White Papers for Pre-Application Engagement," Westinghouse Electric Company LLC, March 30, 2023.
10. Regulatory Guide 1.232, Revision 0, "Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors," U.S. Nuclear Regulatory Commission, April 2018.
11. NEI 18-04, Revision 1, "Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development," Nuclear Energy Institute, August 2019.
12. 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," Nuclear Energy Institute February 2022.
13. 10 CFR Part 50, "Domestic Licensing of Productions and Utilization Facilities," U.S. Nuclear Regulatory Commission, January 1956.
14. Regulatory Guide 1.233, Revision 0, "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," U.S. Nuclear Regulatory Commission, June 2020.
15. Draft Regulatory Guide 1404 (Proposed RG 1.253, Revision 0), "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," U.S. Nuclear Regulatory Commission, May 2023.
16. "Acceptability of the Industry-Led Technology Inclusive Content of Application Project (TICAP) Proposal for Non-LWR Principal Design Criteria," July 2021. (ADAMS Accession Number ML21214A008)
17. "Westinghouse eVinci™ Micro-Reactor Tabletop Exercise Report," U.S. Nuclear Regulatory Commission, September 2021. (ADAMS Accession Number ML21272A303).
18. "Quality Management System (QMS)-A," Revision 8.0 (Non-Proprietary), Westinghouse Electric Company LLC May 31, 2020. (ADAMS Accession Number ML20140A289)

Executive Summary

Westinghouse Electric Company LLC (Westinghouse) is pursuing standard design certification for the **eVinci™** microreactor under Title 10 of the Code of Federal Regulations (CFR) Part 52 (Reference 1) Subpart B. To date, Westinghouse has engaged the U.S. Nuclear Regulatory Commission (NRC) in pre-application activities as described in the previously submitted Regulatory Engagement Plan (REP) EVR_LTR_220214 (Reference 2) and pursued pre-license application engagement through several white paper submittals including EVR_LTR_210076 (Reference 3), EVR_LTR_220032 (Reference 4), EVR_LTR_200074 (Reference 5), EVR_LTR_220092 (Reference 6), EVR-LTR_220151 (Reference 7), EVR_LTR_220164 (Reference 8), and EVR_LTR_230074 (Reference 9). As documented in the REP, Westinghouse is also preparing several topical reports to support eVinci microreactor licensing. Accordingly, this topical report is being submitted for NRC review and approval in support of the future standard design certification application (DCA) for the eVinci microreactor.

This topical report documents the principal design criteria (PDC) for the eVinci microreactor. The eVinci microreactor PDC have been derived based on the design criteria (DC) documented in U.S. NRC Regulatory Guide (RG) 1.232 (Reference 10) and the General Design Criteria (GDC) in 10 CFR Part 50 (Reference 13) Appendix A. Each of the GDC and DC contained in RG 1.232 were reviewed for applicability to the design and were either kept as-is, edited, or determined not to be applicable in its entirety. The guidance in Nuclear Energy Institute (NEI) 18-04 (Reference 11) and NEI 21-07 (Reference 12) was then used to risk-inform the PDC, which led to removal or revision of some PDC. The NEI 18-04 and NEI 21-07 guidance was also used to confirm that the PDC developed using RG 1.232 cover PDC for the RSFs identified for the eVinci microreactor.

This topical report specifically documents how PDC were modified from RG 1.232, if changes were identified, and the basis for those changes. Additionally, this topical report documents the basis for why certain GDC were determined not to be applicable for the eVinci microreactor.

Westinghouse is requesting NRC review and approval on the set of PDC for the eVinci microreactor provided herein, including the list of, and justification for, the GDC identified as not applicable to the eVinci microreactor.

1.0 Introduction

1.1 Purpose

This topical report documents the PDC for the eVinci microreactor design and the basis for their selection. The PDC include the DC for SR and NSRST SSCs for the eVinci microreactor design. Westinghouse is submitting this topical report for NRC review and approval in support of the future DCA for the eVinci microreactor.

1.2 Scope

This topical report documents the PDC for the eVinci microreactor, including how the PDC were derived. The set of PDC that has been developed for the eVinci microreactor is based on the design, as described in Section 2.0. As expressed in Section 3.0, the derivation of eVinci microreactor PDC is based on the guidance for DC provided in RG 1.232 (Reference 10), the GDC in 10 CFR Part 50 (Reference 13) Appendix A, and also incorporates the safety case for the eVinci microreactor developed based on NEI 18-04 (Reference 11) and NEI 21-07 (Reference 12).

1.3 Applicable Regulations and Regulatory Guidance

The requirement for including PDC and guidance for development of the PDC for the eVinci microreactor come from a collection of regulatory requirements and guidance, including the following:

- 10 CFR Part 50 (Reference 13) provides regulations for licensing production and utilization facilities.
    - 10 CFR Part 50 Appendix A contains the GDC that establish the minimum requirements for the PDC for water-cooled nuclear power plants. Appendix A also establishes that the GDC are generally applicable to other types of nuclear power units and are intended to provide guidance in determining the PDC for such other units.
- 10 CFR Part 52 (Reference 1) governs the issuance of early site permits, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses for nuclear power facilities.
    - 10 CFR 52.47(a)(3)(i) requires that an application for a standard design certification include the PDC for a proposed facility.
- RG 1.232, “Developing Principal Design Criteria for Non-Light Water Reactors” (Reference 10) describes the NRC’s proposed guidance on how the GDC in 10 CFR Part 50 Appendix A may be adapted for non-light water reactor (non-LWR) designs. This guidance may be used by non-LWR reactor designers, applicants, and licensees to develop PDC for any non-LWR designs, as required by the applicable NRC regulations, for nuclear power plants. The RG also describes the NRC’s proposed guidance for modifying and supplementing the GDC to develop PDC that address two specific non-LWR design concepts: sodium-cooled fast reactors (SFRs), and modular high-temperature gas-cooled reactors (MHTGRs).
- NEI 18-04, “Risk-Informed Performance-Based Guidance for Non-Light-Water Reactors” (Reference 11) presents a modern, technology-inclusive, risk-informed, and performance-based (TI-RIPB) process for selection of LBEs; safety classification of SSCs and associated risk-informed special treatments; and determination of defense-in-depth (DID) adequacy for non-LWRs.
- 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, Certification, and Approvals for Non-Light-Water Reactors” (Reference 14) provides the NRC staff’s guidance on using a technology-inclusive, risk-informed, and performance-based approach to inform the licensing basis and content of applications for non-LWRs. This guidance provides NRC’s endorsement of use of NEI 18-04.
- NEI 21-07, “Technology Inclusive Guidance for Non-Light Water Reactors: Safety Analysis Report Content for Applicants Using the NEI 18-04 Methodology” (Reference 12) describes one acceptable means of developing portions of the Safety Analysis Report (SAR) content for advanced reactor

applicants that utilize NEI 18-04. The guidance focuses on the portions of the SAR that are generated by the application of NEI 18-04. The goal of the standardized content structure and formulation is to facilitate efficient preparation by the applicant, review by the regulator, and maintenance by the licensee.

- Draft Regulatory Guide (DG)-1404, "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" (Reference 15) describes an approach that is acceptable to the NRC staff for using a technology-inclusive content-of-application approach to inform specific portions of the SAR included as part of a non-LWR license application. Specifically, this guidance endorses NEI 21-07 with clarifications and additions, where applicable, as one acceptable process for use in developing certain portions of the SAR for an application for a non-LWR. This guidance is currently in draft form and has been issued for public comment.

1.4 Request for NRC

Westinghouse is requesting NRC review and approval on the set of PDC for the eVinci microreactor provided in Section 4.0, including the list of, and justification for, the GDC identified as not applicable to the eVinci microreactor as described in Table 4.1-1.

Section 2.0 is provided as background information on the eVinci microreactor design.

2.0 Summary of the eVinci Microreactor Design and Facility Description

The eVinci microreactor is a 15 MW_t thermal neutron spectrum reactor that delivers high temperature heat from the reactor core, through heat pipes and a primary heat exchanger (PHX), to an open-air Brayton power conversion system (PCS). The reactor system (RXS) design is shown in Figure 2.0-1. The reactor core is enclosed within a canister filled with an inert gas just above atmospheric pressure to protect reactor components from oxidation while enhancing heat transfer. The core design consists of graphite blocks with repeated, segmented, hexagonal unit cells oriented horizontally along the length of the core. The unit cells contain channels for fuel, burnable absorbers, alkali metal heat pipes, and shutdown rods. The reactor uses high-assay, low-enriched uranium (HALEU) tristructural isotropic (TRISO) fuel. The core is surrounded by a thick radial reflector that houses the control drums. The core alone, without the radial reflector, is subcritical, requiring the radial reflector to achieve criticality. Shielding is used to attenuate gamma and neutron radiation to protect site personnel and the public during operation and transportation. The PCS receives reactor heat from the PHX and converts it from 15 MW_t to 5 MW_e with an open-air Brayton cycle.

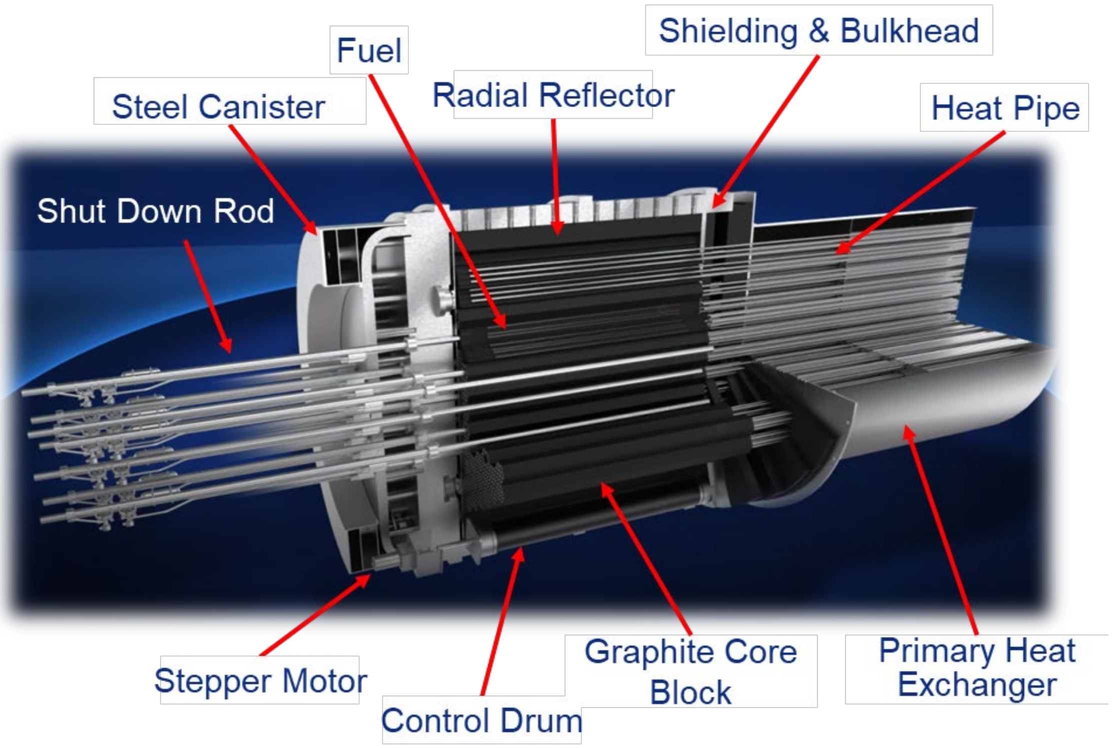

Figure 2.0-1 eVinci Microreactor Cutaway

The containment canister does not function as a pressure vessel but is instead an element of the functional containment. During normal operation the canister is pressurized just above atmospheric pressure with helium to prevent oxidation of core components and increase thermal gap conductance. The design of the microreactor allows for decay heat removal through the core block, radial reflector, canister containment system, and shielding. Several layers of the TRISO fuel and the canister together represent the physical barriers that exist to preclude the release of fission products to the environment and collectively represent the functional containment.

Reactivity control is accomplished using control drums located on the periphery of the core and burnable absorbers in the core. Reactivity is monitored using the power range and source range neutron detectors. Shutdown can be achieved by two diverse and independent means: the shutdown rods and the control drums. Additional shutdown rods are used to address hypothetical accident conditions and maintain a sub-critical reactor during transportation.

The reactor is installed in a transportation cask for transportation. The secondary system (i.e., the PCS) and support systems, including instrumentation, controls, and electrical (ICE) systems, are transported in separate shipping containers. The shipping containers can be transported to remote locations via truck, rail, or waterway.

The site will be prepared prior to shipment of the reactor and support systems. Prior to the reactor arriving to the site, construction and installation activities will commence and continue after the reactor's arrival to the site. Any necessary criticality testing will be performed after site construction and installation of the reactor. The site layout and connection between containers are designed to enable quick deployment. An illustration of the site layout is shown in Figure 2.0-2.

Figure 2.0-2 eVinci Microreactor Site Layout Rendering

Limited on-site staff is needed to perform the necessary site activities such as operations, maintenance, and security. A remote monitoring station will be used to allow remote personnel to monitor reactor power operations.

A replacement reactor will be shipped to, and installed at, the site as the operating reactor reaches its end of fuel life. Once the primary reactor reaches its end of fuel life, it is shut down and the replacement reactor will begin operation and become the new primary reactor. The shutdown reactor is allowed to cool before being transported off site for refurbishment and refueling or for decommissioning. Spent fuel is not required to be stored onsite.

3.0 PDC Development

3.1 PDC Development Summary

eVinci microreactor PDC are based on the DC documented in RG 1.232 (Reference 10) and GDC in 10 CFR Part 50 (Reference 13) Appendix A. To derive the PDC, each of the GDC and DC contained in RG 1.232 were reviewed for applicability to the design and were either kept as-is, edited, or determined to not be applicable in its entirety. The guidance in NEI 18-04 and NEI 21-07 was then used to risk-inform the PDC, which led to removal or revision of some PDC. The NEI 18-04 and NEI 21-07 guidance was also used to confirm that the PDC developed using RG 1.232 provide PDC for the RSFs identified for the eVinci microreactor. The PDC for the eVinci microreactor developed using this process are documented in Section 4.0.

3.2 PDC Development Overview

This section describes the process used to develop the PDC. The following were used as inputs for developing the eVinci microreactor PDC:

- 10 CFR Part 50 (Reference 13) Appendix A
- RG 1.232 (Reference 10)
- NEI 18-04 (Reference 11)
- NEI 21-07 (Reference 12)
- RG 1.233 (Reference 14)
- DG-1404 (Reference 15)

The GDC documented in 10 CFR Part 50 (Reference 13) Appendix A, “General Design Criteria for Nuclear Power Plants,” are not applicable to non-LWRs. However, several regulations in 10 CFR Part 52 (Reference 1) provide a link to 10 CFR Part 50 Appendix A. Specifically, the requirements for content of application for a DCA included in 10 CFR 52.47(a)(3)(i) state that the application must contain a final safety analysis report (FSAR) that describes the facility, presents the design bases and the limits on its operation, and presents a safety analysis of the structures, systems, and components and of the facility as a whole, and must include, in part, the following information:

> *The principal design criteria for the facility. Appendix A to 10 CFR part 50, general design criteria (GDC), establishes minimum requirements for the principal design criteria for watercooled nuclear power plants similar in design and location to plants for which construction permits have previously been issued by the Commission and provides guidance to applicants in establishing principal design criteria for other types of nuclear power units.*

Additional design criteria for the eVinci microreactor associated with establishing design, fabrication, construction, testing, and performance requirements for SSCs are expected. However, these additional criteria are not considered to be PDC unless they are directly related to ensuring the safe operation of the microreactor (i.e., are related to safety significant SSCs) and are explicitly identified in this document.

The GDC in 10 CFR Part 50 Appendix A and the DC in RG 1.232 were reviewed and analyzed to ensure a comprehensive set of PDC were considered for the eVinci microreactor design. NEI 18-04 and RG 1.233 were used to develop the RSFs for the eVinci microreactor, which were then used to ensure that the set of PDC includes DC to address these RSFs. Finally, NEI 21-07 was used to eliminate unnecessary PDC, revise overly restrictive PDC, confirm the need for PDC developed using RG 1.232, and revise PDC text to use RIPB language.

This process was used for several reasons. First, NEI 18-04 and NEI 21-07 do not fully address all areas that need consideration for PDC development, such as fabrication, construction, and testing. In addition, the activities that need to be performed to develop PDC using the NEI 18-04 guidance are dependent on results from the probabilistic risk assessment (PRA); however, the PRA results for the eVinci microreactor are still under development. Lastly, NRC endorsement of NEI 21-07 has recently been issued in draft form for public comment (Reference 15). Because this guidance document has not been finally approved, there is some regulatory uncertainty surrounding use of NEI 21-07 for PDC development. Westinghouse has chosen to use the NRC-approved process in RG 1.232 as part of the eVinci microreactor PDC development process to ensure the DC as described in 10 CFR 50 Appendix A is addressed, as applicable.

3.3 PDC Development Using RG 1.232

This section documents the development of PDC using the guidance provided in RG 1.232 (Reference 10).

3.3.1 Overview of 10 CFR Part 50 Appendix A and RG 1.232

The GDC in 10 CFR Part 50 (Reference 13) Appendix A were specifically developed to address LWR technology. RG 1.232 provides DC for non-LWR technologies that correlate to the GDC. Because the eVinci microreactor design is a non-LWR technology, the supplemental guidance provided in RG 1.232 is employed to meet the intent of the GDC.

10 CFR Part 50 Appendix A, Introduction, states in applicable part:

> These General Design Criteria establish minimum requirements for the principal design criteria for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission. The General Design Criteria are also considered to be generally applicable to other types of nuclear power units and are intended to provide guidance in establishing the principal design criteria for such other units.

Section B, Discussion, of RG 1.232 reiterates the role of GDC in the development of PDC for non-LWRs as follows:

> The non-LWR design criteria developed by the NRC staff and included in Appendices A to C of this regulatory guide are intended to provide stakeholders with insight into the staff's views on how the GDC could be interpreted to address non-LWR design features.

These statements allow for use of the DC as written, if applicable, or for editing of the DC as appropriate for applicability to a specific design.

3.3.2 Application of RG 1.232 for PDC Development

[ ][a,c]

The eVinci microreactor design employs features that align to all, some, or none of a particular criterion as it is written in the three RG 1.232 appendices. [ ][a,c]

Determine RG 1.232 Criteria Applicability

[ ][a,c]

The details of how this was determined for each PDC can be found in the "basis" for each PDC in Section 4.0.

[

]a,c

Where the review concluded a criterion could be directly applied for the PDC based on the eVinci design, with no change to the criterion wording, that criterion was selected. If necessary, the criterion was revised to support the eVinci microreactor design. The description and basis for any changes are documented in Section 4.0 for each PDC.

Because RG 1.232 considers a broad range of technologies, there are criteria in the RG that the review concluded are not applicable to the eVinci microreactor design.

Table 3.2-1 documents a summary of how each of the 10 CFR 50 Appendix A GDC apply to the eVinci microreactor. For each GDC, Table 3.2-1 documents which RG 1.232 appendix was used to develop the PDC and whether the eVinci microreactor PDC is identical to or modified from the RG 1.232 or GDC wording or determined to be not applicable. The justification for why the review concluded certain GDC are not applicable can be found in Table 4.1-1.

Table 3.2-1. Summary of the eVinci Microreactor PDC Relationships to Regulatory Guide 1.232 Principal Design Criteria for Non-LWR Reactors

10 CFR 50 Appendix A GDC	Applicable RG 1.232 Appendices	eVinci Microreactor PDC Text Compared RG 1.232 PDCs
1	A	Modified from RG
2	A	Modified from RG
3	N/A	N/A
4	A	Modified from RG
5	A	Modified from RG
N/A (PDC 6 newly defined)	N/A	Reactor-specific PDC
10	C	Modified from RG
11	A	Modified from RG
12	A, C	Modified from RG
13	A	Modified from RG
14	C	Identical to RG
15	C	Modified from RG
16	C	Modified from RG
17	C	Modified from RG
18	N/A	N/A
19	A	Modified from RG
20	C	Modified from RG
21	N/A	N/A
22	A	Modified from RG
23	A	Identical to RG
24	A	Identical to RG
25	C	Identical to RG
26	C	Modified from RG
27	N/A	N/A
28	A	Modified from RG
29	A	Identical to RG
30	N/A	N/A
31	N/A	N/A
32	N/A	N/A
33	N/A	N/A
34	C	Modified from RG
35	N/A	N/A
36	N/A	N/A
37	N/A	N/A
38	N/A	N/A
39	N/A	N/A
40	N/A	N/A
41	N/A	N/A
42	N/A	N/A
43	N/A	N/A
44	N/A	N/A
45	N/A	N/A
46	N/A	N/A
50	N/A	N/A
51	N/A	N/A
52	N/A	N/A

Table 3.2-1. Summary of the eVinci Microreactor PDC Relationships to Regulatory Guide 1.232 Principal Design Criteria for Non-LWR Reactors

10 CFR 50 Appendix A GDC	Applicable RG 1.232 Appendices	eVinci Microreactor PDC Text Compared to RG 1.232 PDCs
53	N/A	N/A
54	N/A	N/A
55	N/A	N/A
56	N/A	N/A
57	N/A	N/A
60	A	Identical to RG
61	A	Modified from RG
62	A	Modified from RG
63	A	Modified from RG
64	A	Modified from RG
N/A	B (Criterion 71)	Modified from RG
N/A	B (Criterion 73)	Modified from RG
N/A	B (Criterion 74)	Modified from RG
N/A	B (Criterion 78)	Modified from RG

3.4 Use of NEI 18-04 and NEI 21-07 to Inform PDC Development

This section documents how the PDCs developed from RG 1.232 (Reference 10) were supplemented by using the NEI 18-04 (Reference 11) and NEI 21-07 (Reference 12) process.

3.4.1 Overview of NEI 18-04 and NEI 21-07 Process

NEI 18-04 provides a foundation upon which a more fully RIPB technical licensing environment can be developed within existing regulatory framework. The process described in NEI 18-04 allows for PRA to be used to define a reactor design's LBEs, RSFs, classification of SSCs, and RFDC. Following this process, NEI 21-07 provides guidance on how the PDC can be developed for a reactor design using the RSFs defined through the NEI 18-04 process. In addition, Westinghouse considered the industry-issued guidance, "Acceptability of the Industry-Led Technology Inclusive Content of Application Project (TICAP) Proposal for Non-LWR Principal Design Criteria" (Reference 16), when developing the PDC for the eVinci microreactor.

3.4.2 Application of NEI 18-04 and NEI 21-07 to Inform PDC Development

Westinghouse is using the guidance described in NEI 18-04 in a confirmatory manner for the eVinci microreactor PDC development. This means that the NEI 18-04 process was used to define the RSFs for the design, and it was confirmed that PDC are included based on RG 1.232 that cover the RSFs. There are several tasks that must be completed, as described in NEI 18-04, to develop the PDC. The details of how these tasks have been applied to the eVinci microreactor design based on the PRA are contained in the eVinci microreactor TICAP tabletop report (Reference 17). [ ][a,c] this guidance was used in a confirmatory manner to support PDC development based on RG 1.232 as described in Section 3.2. As documented in Reference 17, the RSFs for the eVinci microreactor design have been defined as:

- Reactivity control
- Decay heat removal
- Containment of radioactive material

As described in the eVinci microreactor TICAP tabletop report, the PDC are derived by starting with the initial list of LBEs for the eVinci microreactor design. From these LBEs, a set of safety functions have been determined to be necessary to keep the sequences that represent the LBEs within the regions that represent DBEs and high-consequence BDBEs on the Westinghouse F-C curve. LBE sequences that fall inside of these regions need to be considered for PDC because they include safety functions necessary to maintain acceptable frequency and consequence results. Based on performing these activities using the eVinci microreactor PRA, as described in Reference 17, PDC are needed for reactivity control, decay heat removal, and containment of radioactive material to address the RSFs. The PDC derived using RG 1.232 have been compared against the PDC needed to address the RSFs using the NEI 18-04 and NEI 21-07 process. Because PDC already exist for the eVinci microreactor that address the RSFs, no additional PDC are necessary through use of the NEI 18-04 and NEI 21-07 guidance for PDC development. The PDC that address the RSFs are PDC 16, 26, and 34 in Section 4.0.

Because of the simplicity of the eVinci microreactor design, it is not anticipated that additional RSFs will be identified as design work progresses.

NEI 21-07, Section C, 5.3 provides guidance on the scope of proposed PDC and additionally provides guidance on how PDC can be documented in a RIPB license application for non-LWRs. The guidance states:

> PDC establish the necessary design, fabrication, construction, testing, and performance requirements for safety significant SSCs. As such, the PDC are composed of three types of criteria:
>
> - The Quality Assurance Principal Design Criterion (discussed in Section 5.3.1 of this guidance) addresses the graded approach to special treatments for those SSCs performing safety significant functions, including design, fabrication, construction, and testing quality standards.
> - Principal Design Criteria – Required Functional Design Criteria (PDC-RFDC, discussed in Section 5.3.2 of this guidance) establish the functional requirements of a plant that are required to meet the performance objectives of the FSFs and are satisfied by SR SSCs.
> - Principal Design Criteria – Complementary Design Criteria (PDC-CDC, discussed in Section 5.6 of this guidance) establish requirements for SSCs that are identified as NSRST because they perform risk-significant functions or are identified as necessary for DID.

Additional guidance on the three types of PDC provided for in NEI 21-07 is available in the sections indicated above. As documented in NEI 21-07, the guidance for the Quality Assurance (QA) PDC is generically applicable to any reactor design, but the guidance for PDC-RFDC and PDC-CDC directs the user to develop PDC that are specific to a design's SSCs. Westinghouse has chosen to take a different approach for PDC development for the eVinci microreactor design. Because the eVinci microreactor PDC have been defined based on function and are therefore SSC-independent, there is no need to develop separate PDC for RFDC and CDC. The PDC described in Section 4.0 are meant to be applied to both SR and NSRST SSCs as the design dictates through the DID evaluation. The SSC classification was used in some instances to justify why some criteria were not needed as PDC (as documented in Table 4.1-1).

Finally, NEI 18-04 (Reference 11) and NEI 21-07 (Reference 12) are used in some instances to revise PDC language to be consistent with the RIPB licensing language. For example, the term "postulated event" has been revised throughout the PDC. A description of the new chosen terminology and the basis for the change is contained in Section 4.0 for each PDC where the terminology was changed. Additionally, consistent with RG 1.232 and the GDC, some of the PDC use the term AOOs. The terminology has been retained, but since Westinghouse is pursuing a RIPB license application for the eVinci microreactor, the definition used for the eVinci microreactor is based on the AOO definition found in NEI 18-04 (Reference 11). The specific definition of AOO used for the eVinci microreactor can be found in the Glossary section of this topical report.

4.0 eVinci Microreactor Principal Design Criteria

4.1 Criteria Not Included as PDC for the eVinci Microreactor

As documented in Table 3.2-1, several of the GDC are not applicable to the eVinci microreactor or have been addressed by other criteria or regulatory requirements. These criteria are not included as PDC for the eVinci microreactor. Table 4.1-1 includes the rationale for not including these criteria as PDC for the eVinci microreactor design.

Table 4.1-1. Criteria Not Included as PDC for the eVinci Microreactor

Criterion	Screening Rationale from the GDC
3	[ ]a,c
18	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
21	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6. Equipment reliability and independence needs will be defined through use of the NEI 18-04 and NEI 21-07 processes.
27	The objective of this requirement is satisfied by PDC 26 for reactivity control.
30	[ ]a,c
31	[ ]a,c
32	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
33	[ ]a,c

Table 4.1-1. Criteria Not Included as PDC for the eVinci Microreactor

Criterion	Screening Rationale from the GDC
35	[ ]a,c
36	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
37	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
38	[ ]a,c
39	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
40	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
41	[ ]a,c
42	[ ]a,c
43	[ ]a,c
44	[ ]a,c

Table 4.1-1. Criteria Not Included as PDC for the eVinci Microreactor

Criterion	Screening Rationale from the GDC
45	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
46	All monitoring, inspection, and testing requirements for SR and NSRST SSCs for the eVinci microreactor are covered in PDC 6.
50	[ ]a,c
51	[ ]a,c
52	[ ]a,c
53	[ ]a,c
54	[ ]a,c
55	[ ]a,c
56	[ ]a,c
57	[ ]a,c

4.2 eVinci Microreactor PDC

This section documents the eVinci microreactor PDC. These PDC are presented in the subsections 4.2.1 through 4.2.32. Each subsection includes the following information for the respective PDC:

Title: Provides the number and the title of the PDC. In most cases, the title is from 10 CFR Part 50 Appendix A and/or RG 1.232; however, in some cases the title has been changed to reflect specific aspects of the eVinci microreactor design.

eVinci microreactor PDC: Provides the eVinci microreactor wording.

Position: Provides a determination of whether a given ARDC, SFR-DC, or MHTGR-DC from RG 1.232 (or other source, as applicable) is adopted with or without changes. Where changes are determined necessary, this content identifies the modifications made to the underlying criteria to derive the eVinci microreactor PDC. Wording removed is shown in red with a strikethrough and wording added in is shown in blue text with underline. The source DC is provided adjacent to the modifications for convenience.

Basis: Provides justification and rationale for why a certain DC (or portion of a certain DC) has been determined to be applicable to the eVinci microreactor design. Also describes and justifies changes in text from the underlying criteria to develop the eVinci microreactor PDC. Note: The basis does not explain how the eVinci microreactor meets the PDC; the demonstration that the eVinci microreactor design satisfies these PDC will be provided within the DCA for the facility.

Source: Provides the particular ARDC, SFR-DC, or MHTGR-DC from RG 1.232 (or other source, as applicable).

4.2.1 Quality Standards and Records

Title:	1. Quality standards and records	
eVinci microreactor PDC	Safety significant structures, systems, and components shall be designed, fabricated, erected, and tested to quality standards commensurate with the safety significance of the functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the safety significant function. A quality assurance program shall be established and implemented in order to provide reasonable assurance that these structures, systems, and components will satisfactorily perform their safety significant functions. Appropriate records of the design, fabrication, erection, and testing of safety significant structures, systems, and components shall be maintained by or under the control of the nuclear power unit licensee for an appropriate period of time.	
Position:	PDC 1 for the eVinci microreactor design uses the language in RG 1.232, ARDC 1 with changes to be consistent with the Quality Assurance PDC text in NEI 21-07, Section C, 5.3.1.	
	RG 1.232, Appendix A, Criterion 1	eVinci microreactor PDC 1
	Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function. A quality assurance program shall be established and implemented in order to provide adequate assurance that these structures, systems, and components will satisfactorily perform their safety functions. Appropriate records of the design, fabrication, erection, and testing of structures, systems, and components important to safety shall be maintained by or under the control of the nuclear power unit licensee throughout the life of the unit.	<u>Safety significant</u> structures, systems, and components ~~important to safety~~ shall be designed, fabricated, erected, and tested to quality standards commensurate with the ~~importance~~ <u>safety significance</u> of the ~~safety~~ functions to be performed. Where generally recognized codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the ~~required~~ safety <u>significant</u> function. A quality assurance program shall be established and implemented in order to provide ~~adequate~~ <u>reasonable</u> assurance that these structures, systems, and components will satisfactorily perform their safety <u>significant</u> functions. Appropriate records of the design, fabrication, erection, and testing of <u>safety significant</u> structures, systems, and components ~~important to safety~~ shall be maintained by or under the control of the nuclear power unit licensee ~~throughout the life~~ <u>for an appropriate period</u> of ~~the unit~~ <u>time</u>.

Basis:	This requirement is applicable, because the eVinci microreactor contains safety significant SSCs that are designed, fabricated, erected, and tested to quality standards that correspond with the importance of the safety functions that need to be performed. The eVinci microreactor will follow the Westinghouse Quality Management System (Reference 18). The phrase “important to safety” is changed to “safety significant” to align with the terminology in the proposed Quality Assurance PDC in NEI 21-07, Section C, 5.3.1. The phrase “throughout the life of the unit” was changed to “for an appropriate period of time” to account for the application of quality assurance special treatments to NSRST SSCs. Again, this aligns the PDC text with NEI 21-07, Section C, 5.3.1.
Source:	RG 1.232, Appendix A, Criterion 1 and NEI 21-07, Section 5.3.1

4.2.2 Design Bases for Protection Against Natural Phenomena

<table>
<tr><td>Title:</td><td colspan="2">2. Design bases for protection against natural phenomena</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Safety significant structures, systems, and components shall be designed to withstand the effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated; (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and (3) the importance of the safety functions to be performed.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 2 for the eVinci microreactor design uses the language in RG 1.232, ARDC 2 with one change.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 2</td><td>eVinci microreactor PDC 2</td></tr>
<tr><td>Structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated; (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and (3) the importance of the safety functions to be performed.</td><td>Safety significant structures, systems, and components ~~important to safety~~ shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. The design bases for these structures, systems, and components shall reflect: (1) Appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated; (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena; and (3) the importance of the safety functions to be performed.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable since the microreactor will be sited in locations that potentially can experience natural phenomena identified in the requirement. As such, this requirement is not unique to LWRs and is applicable to the design.

The phrase “important to safety” is changed to “safety significant” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 2</td></tr>
</table>

4.2.3 Environmental and Dynamic Effects Design Bases

Title:	4. Environmental and dynamic effects design bases	
eVinci microreactor PDC	Safety significant structures, systems, and components shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and licensing basis events. These structures, systems, and components, shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.	
Position:	PDC 4 for the eVinci microreactor design uses the language in RG 1.232, ARDC 4 with changes.	
	RG 1.232, Appendix A, Criterion 4	eVinci microreactor PDC 4
	Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents. These structures, systems, and components, shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.	Safety significant structures, systems, and components ~~important to safety~~ shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and licensing basis events ~~postulated accidents~~. These structures, systems, and components, shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit. However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the design basis when analyses reviewed and approved by the Commission demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping.
Basis:	The first shall statement in the PDC text is applicable because the microreactor design is intended to be applicable to multiple locations where the environmental conditions are variable, and the conditions could potentially have an impact on the performance of SSCs to provide their safety function. The second shall statement in the PDC text is applicable because SSCs could potentially fail in a manner that disables the safety function of another SSC. As such, this requirement is not unique to the non-LWR technologies represented in RG 1.232, Appendix A and is applicable to the design. The phrase "important to safety" is changed to "safety significant" and the phrase "postulated accidents" is changed to "licensing basis events" to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.	
Source:	RG 1.232, Appendix A, Criterion 4	

4.2.4 Sharing of Structures, Systems, and Components

<table>
<tr><td>Title:</td><td colspan="2">5. Sharing of structures, systems, and components</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Safety significant structures, systems, and components shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 5 for the eVinci microreactor design uses the language in RG 1.232, ARDC 5 with one change.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 5</td><td>eVinci microreactor PDC 5</td></tr>
<tr><td>Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.</td><td>Safety significant structures, systems, and components ~~important to safety~~ shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because customers may require more than one microreactor to satisfy their power needs and the potential negative impact on safety functions of SSCs will need to be considered to ensure the configuration does not impair the ability to perform their safety functions. As such, this requirement is not unique to LWRs and is applicable to the design.

The phrase “important to safety” is changed to “safety significant” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 5</td></tr>
</table>

4.2.5 Monitoring, Inspection and Testing

Title:	6. Monitoring, inspection, and testing	
eVinci microreactor PDC	Safety significant structures, systems, and components shall be designed to permit monitoring, surveillance, periodic inspection, and/or testing as necessary to ensure functional capability commensurate with the safety significance of the functions to be performed. Functional testing shall ensure the operability and performance of the system components, and the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including associated systems, for licensing basis events.	
Position:	PDC 6 of the eVinci microreactor design uses the language from RG 1.232, MHTGR-DCs 18, 21, 32, 36, 37, 39, 40, 45, and 46 into a single PDC for monitoring, inspection, and testing.	
	RG 1.232, Appendix C	eVinci microreactor PDC 6
	No generic monitoring, inspection, and testing PDC in RG 1.232.	Safety significant structures, systems, and components shall be designed to permit monitoring, surveillance, periodic inspection, and/or testing as necessary to ensure functional capability commensurate with the safety significance of the functions to be performed. Functional testing shall ensure the operability and performance of the system components, and the operability of the system as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system into operation, including associated systems, for licensing basis events.
Basis:	Generic wording is used to support a single monitoring, testing, and inspection PDC, which replaces the need for RG 1.232, MHTGR-DCs 18, 21, 32, 36, 37, 39, 40, 45, and 46. Monitoring, surveillance, periodic inspection, and/or testing will be established as special treatments in accordance with the NEI 18-04 integrated decision-making process (IDP) and will meet the performance intent of the eVinci microreactor. Accordingly, the eVinci microreactor inservice inspection and inservice testing programs will be developed to support inspection and testing needs that are identified through the NEI 18-04 process. Additionally, the Inspections, Tests, Analyses, And Acceptance Criteria (ITAAC), to be defined in the DCA will inform what is required in terms of testing and inspection prior to operation. The phrase “safety significant” is used in this PDC to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.	
Source:	RG 1.232, Appendix C, Criteria 18, 21, 32, 36, 37, 39, 40, 45, and 46	

4.2.6 Reactor Design

<table>
<tr><td>Title:</td><td colspan="2">10. Reactor design</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The reactor system and associated heat removal, control, and protection systems (along with any structures, systems, and components supporting the reactor system and associated heat removal control, and protection system’s safety function(s)) shall be designed with appropriate margin to ensure that specified acceptable system radionuclide release design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 10 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 10 with one change.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 10</td><td>eVinci microreactor PDC 10</td></tr>
<tr><td>The reactor system and associated heat removal, control, and protection systems shall be designed with appropriate margin to ensure that specified acceptable system radionuclide release design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.</td><td>The reactor system and associated heat removal, control, and protection systems <u>(along with any structures, systems, and components supporting the reactor system and associated heat removal control, and protection system’s safety function(s))</u> shall be designed with appropriate margin to ensure that specified acceptable system radionuclide release design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.</td></tr>
<tr><td>Basis:</td><td colspan="2">[ ]a,c</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 10</td></tr>
</table>

4.2.7 Reactor Inherent Protection

<table>
<tr><td>Title:</td><td colspan="2">11. Reactor inherent protection</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The reactor core and associated structures, systems, and components that contribute to reactivity feedback shall be designed so that, in the power operating range, the net effect of the prompt inherent nuclear feedback characteristics tends to compensate for a rapid increase in reactivity.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 11 for the eVinci microreactor design uses the language in RG 1.232, ARDC 11 with one change.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 11</td><td>eVinci microreactor PDC 11</td></tr>
<tr><td>The reactor core and associated systems that contribute to reactivity feedback shall be designed so that, in the power operating range, the net effect of the prompt inherent nuclear feedback characteristics tends to compensate for a rapid increase in reactivity.</td><td>The reactor core and associated structures, systems, and components that contribute to reactivity feedback shall be designed so that, in the power operating range, the net effect of the prompt inherent nuclear feedback characteristics tends to compensate for a rapid increase in reactivity.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because a reactor design that provides nuclear feedback to compensate for rapid increases in reactivity can help control the reactor power. As such, this requirement is not unique to the non-LWR technologies represented in RG 1.232, Appendix A and is applicable to the design.

Text is added to the PDC text to expand “systems” to associated SSCs that contribute to reactivity feedback (such as I&C, etc.).</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 11</td></tr>
</table>

4.2.8 Suppression of Reactor Power Oscillations

<table>
<tr><td>Title:</td><td colspan="2">12. Suppression of reactor power oscillations</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The reactor core; associated structures; and associated coolant, control, and protection systems shall be designed to ensure that power oscillations that can result in conditions exceeding specified acceptable system radionuclide release design limits are not possible or can be reliably and readily detected and suppressed.</td></tr>
<tr><td rowspan="4">Position:</td><td colspan="2">PDC 12 for the eVinci microreactor design uses the language in RG 1.232, ARDC 12 and MHTGR-DC 12 with changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 12
RG 1.232, Appendix C, Criterion 12</td><td>eVinci microreactor PDC 12</td></tr>
<tr><td>The reactor core; associated structures; and associated coolant, control, and protection systems shall be designed to ensure that power oscillations that can result in conditions exceeding specified acceptable fuel design limits are not possible or can be reliably and readily detected and suppressed.</td><td rowspan="2">The reactor core; associated structures; and associated coolant, control, and protection systems shall be designed to ensure that power oscillations that can result in conditions exceeding specified acceptable ~~fuel~~ system radionuclide release design limits are not possible or can be reliably and readily detected and suppressed.</td></tr>
<tr><td>The reactor core and associated control and protection systems shall be designed to ensure that power oscillations that can result in conditions exceeding specified acceptable system radionuclide release design limits are not possible or can be reliably and readily detected and suppressed.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the microreactor design must ensure power oscillations are sufficiently controlled to ensure design limits are not exceeded. As such, this requirement is not unique to the non-LWR technologies represented in RG 1.232, Appendices A and C and is applicable to the design.

[

]a,c</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 12
RG 1.232, Appendix C, Criterion 12</td></tr>
</table>

4.2.9 Instrumentation and Control

<table>
<tr><td>Title:</td><td colspan="2">13. Instrumentation and control</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions, as appropriate, to ensure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor system, and the functional containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 13 for the eVinci microreactor design uses the language in RG 1.232, ARDC 13 with changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 13</td><td>eVinci microreactor PDC 13</td></tr>
<tr><td>Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions, as appropriate, to ensure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.</td><td>Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions, as appropriate, to ensure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor system ~~coolant boundary~~, and the functional containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the eVinci microreactor design includes I&C equipment. As such, this requirement is not unique to the non-LWR technologies represented in RG 1.232, Appendix A and is applicable to the design.

“Reactor coolant boundary” is replaced with “reactor system,” as it better aligns to the technology used in the design.

“Functional” was also added to “containment” more accurately reflect the eVinci microreactor design.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 13</td></tr>
</table>

4.2.10 Reactor Helium Pressure Boundary

<table>
<tr><td>Title:</td><td colspan="2">14. Reactor helium pressure boundary</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The reactor helium pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, of gross rupture, and of unacceptable ingress of moisture, air, secondary coolant, or other fluids.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 14 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 14 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 14</td><td>eVinci microreactor PDC 14</td></tr>
<tr><td>The reactor helium pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, of gross rupture, and of unacceptable ingress of moisture, air, secondary coolant, or other fluids.</td><td>The reactor helium pressure boundary shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, of gross rupture, and of unacceptable ingress of moisture, air, secondary coolant, or other fluids.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the eVinci microreactor has a helium environment in the reactor canister. This PDC addresses the need to consider leakage of contaminants into the helium in the reactor canister.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 14</td></tr>
</table>

4.2.11 Reactor Helium Pressure Boundary Design

<table>
<tr><td>Title:</td><td colspan="2">15. Reactor helium pressure boundary design</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">All structures, systems, and components that are part of the reactor helium pressure boundary and the associated auxiliary, control, and protection structures, systems, and components, shall be designed with sufficient margin to ensure that the design conditions of the reactor helium pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 15 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 15 with changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 15</td><td>eVinci microreactor PDC 15</td></tr>
<tr><td>All systems that are part of the reactor helium pressure boundary, such as the reactor system, vessel system, and heat removal systems, and the associated auxiliary, control, and protection systems, shall be designed with sufficient margin to ensure that the design conditions of the reactor helium pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.</td><td>All structures, systems, and components, that are part of the reactor helium pressure boundary~~, such as the reactor system, vessel system, and heat removal systems,~~ and the associated auxiliary, control, and protection systems, shall be designed with sufficient margin to ensure that the design conditions of the reactor helium pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the eVinci microreactor has a helium environment in the reactor canister. The PDC addresses the need to ensure the reactor helium pressure boundary is designed to ensure design conditions are not exceeded during normal operation.

Changes are made to remove mention of specific SSCs for which the PDC may be applicable. This is consistent with how the eVinci microreactor PDC have been developed to be more focused on specific functions as opposed to the SSCs that will perform those functions.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 15</td></tr>
</table>

4.2.12 Functional Containment

Title:	16. Functional containment	
eVinci microreactor PDC	A functional containment shall be provided to control the release of radioactivity to the environment and to ensure that the safety significant functional containment design conditions are not exceeded for as long as licensing basis event conditions require.	
Position:	PDC 16 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 16 with changes.	
	RG 1.232, Appendix C, Criterion 16	eVinci microreactor PDC 16
	A reactor functional containment, consisting of multiple barriers internal and/or external to the reactor and its cooling system, shall be provided to control the release of radioactivity to the environment and to ensure that the functional containment design conditions important to safety are not exceeded for as long as postulated accident conditions require.	A ~~reactor~~ functional containment ~~consisting of multiple barriers internal and/or external to the reactor and its cooling system,~~ shall be provided to control the release of radioactivity to the environment and to ensure that the safety significant functional containment design conditions ~~important to safety~~ are not exceeded for as long as ~~postulated accident~~ licensing basis event conditions require.
Basis:	This requirement is applicable because the microreactor incorporates a functional containment-based-design. As such, this requirement is not unique to MHTGRs and is applicable to the design. This requirement wording differs from the RG in that it does not include the words “consisting of multiple barriers internal and/or external to the reactor and its cooling system.” The “consisting of multiple barriers…” language has been removed from the requirement as the remaining text stands on its own due to the inclusion of the requirements that the functional containment “control the release of radioactivity to the environment” and “ensure that the safety significant functional containment design conditions.” Use of NEI 18-04 and NEI 21-07 will include a DID evaluation, which will determine whether multiple barriers are needed. As documented in NEI 21-07, this PDC will apply to SR and NSRST SSCs determined necessary for the safety function. The phrase “important to safety” is changed to “safety significant” and the phrase “postulated accident” is changed to “licensing basis event” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.	
Source:	RG 1.232, Appendix C, Criterion 16	

4.2.13 Electric Power Systems

<table>
<tr><td>Title:</td><td colspan="2">17. Electric power systems</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Electric power systems shall be provided when required for a structure, system, and/or component to perform its required safety function. Each power system required by an SSC to perform a safety function shall provide sufficient capacity and capability to ensure that (1) the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded as a result of anticipated operational occurrences and (2) safety functions that rely on electric power are maintained in the event of design basis accidents.

Electric power systems that are required to perform a required safety function shall include an onsite power source and an additional independent power source. The onsite electric power system shall have sufficient independence, redundancy, and testability to perform its function. The additional power system shall have sufficient independence and testability to perform its function.

If electric power is needed for a safety significant function, the design shall demonstrate that power for safety significant functions is provided with suitable reliability.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 17 of the eVinci microreactor design uses the language of MHTGR-DC 17 with changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 17</td><td>eVinci microreactor PDC 17</td></tr>
<tr><td>Electric power systems shall be provided when required to permit functioning of structures, systems, and components. The safety function for each power system shall be to provide sufficient capacity and capability to ensure that (1) that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded as a result of anticipated operational occurrences and (2) safety functions that rely on electric power are maintained in the event of postulated accidents.</td><td>Electric power systems shall be provided when required<s> to</s> <u>for a</u> <s>permit functioning of</s> structure<s>s</s>, system<s>s</s>, and<u>/or</u> component<s>s</s> <u>to perform its required safety function</u>. <s>The safety function for</s> <u>E</u><s>e</s>ach power system <u>required by an SSC to perform a safety function</u> shall <s>be to</s> provide sufficient capacity and capability to ensure that (1) <s>that</s> the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded as a result of anticipated operational occurrences and (2) safety functions that rely on electric power are maintained in the event of <s>postulated</s> <u>design basis</u> accidents.</td></tr>
</table>

	The electric power systems shall include an onsite power system and an additional power system. The onsite electric power system shall have sufficient independence, redundancy, and testability to perform its safety functions, assuming a single failure. An additional power system shall have sufficient independence and testability to perform its safety function. If electric power is not needed for anticipated operational occurrences or postulated accidents, the design shall demonstrate that power for important to safety functions is provided.	~~The~~ ~~e~~Electric power systems that are required to perform a required safety function shall include an onsite power ~~system~~ source and an additional independent power source ~~system~~. The onsite electric power system shall have sufficient independence, redundancy, and testability to perform its ~~safety~~ function~~s, assuming a single failure~~. ~~An~~ The additional power system shall have sufficient independence and testability to perform its ~~safety~~ function. If electric power is ~~not~~ needed for a safety significant function ~~anticipated operational occurrences or postulated accidents~~, the design shall demonstrate that power for ~~important to~~ safety significant functions is provided with suitable reliability.
Basis:	[ ]a,c Phrases "safety significant" and "design basis accidents" are used in the PDC text to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.	
Source:	RG 1.232, Appendix C, Criterion 17	

4.2.14 Microreactor Control

Title:	19. Microreactor control	
eVinci microreactor PDC	Microreactor control capability shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection shall be provided to permit access and occupancy of microreactor control areas under accident conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent as defined in § 50.2 for the duration of the accident. Adequate habitability measures shall be provided to permit access and occupancy of the microreactor control areas during normal operations and under accident conditions. Equipment at locations outside of the microreactor control area shall be provided with a design capability for prompt hot shutdown of the reactor.	
Position:	PDC 19 for the eVinci microreactor design uses the language in RG 1.232, ARDC 19 with changes.	
	RG 1.232, Appendix A, Criterion 19	eVinci microreactor PDC 19
	A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent as defined in § 50.2 for the duration of the accident. Adequate habitability measures shall be provided to permit access and occupancy of the control room during normal operations and under accident conditions. Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.	~~A control room~~ Microreactor control capability shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection shall be provided to permit access and occupancy of microreactor control areas under accident conditions without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent as defined in § 50.2 for the duration of the accident. Adequate habitability measures shall be provided to permit access and occupancy of the microreactor control areas during normal operations and under accident conditions. Equipment at ~~appropriate~~ locations outside of the microreactor control area ~~room~~ shall be provided ~~(1)~~ with a design capability for prompt hot shutdown of the reactor. ~~,including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.~~

Basis:	[ ]a,c
Source:	RG 1.232, Appendix A, Criterion 19

4.2.15 Protection System functions

Title:	20. Protection system functions	
eVinci microreactor PDC	The protection system shall be designed (1) to initiate automatically the operation of appropriate systems, including the reactivity control systems, to ensure that the specified acceptable system radionuclide release design limits is not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of safety significant systems and components.	
Position:	PDC 20 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 20 with one change.	
	RG 1.232, Appendix C, Criterion 20	eVinci microreactor PDC 20
	The protection system shall be designed (1) to initiate automatically the operation of appropriate systems, including the reactivity control systems, to ensure that the specified acceptable system radionuclide release design limits is not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components important to safety.	The protection system shall be designed (1) to initiate automatically the operation of appropriate systems, including the reactivity control systems, to ensure that the specified acceptable system radionuclide release design limits is not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of safety significant systems and components ~~important to safety~~.
Basis:	[ ][a,c] The phrase “important to safety” is changed to “safety significant” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.	
Source:	RG 1.232, Appendix C, Criterion 20	

4.2.16 Protection System Independence

<table>
<tr><td>Title:</td><td colspan="2">22. Protection system independence</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and licensing basis event conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 22 for the eVinci microreactor design uses the language in RG 1.232, ARDC 22 with one change.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 22</td><td>eVinci microreactor PDC 22</td></tr>
<tr><td>The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and postulated accident conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.</td><td>The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and ~~postulated accident~~ licensing basis event conditions on redundant channels do not result in loss of the protection function, or shall be demonstrated to be acceptable on some other defined basis. Design techniques, such as functional diversity or diversity in component design and principles of operation, shall be used to the extent practical to prevent loss of the protection function.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because (1) the microreactor can be sited in locations that can potentially experience natural phenomenon that might challenge it and (2) the safety functions of the microreactor SSCs must have a low probability of failure during all modes of operation, including scenarios where a credible common cause failure can defeat redundant SSCs. As such, this requirement is not unique to LWRs and is applicable to the design.

The phrase “postulated accident” is changed to “licensing basis event” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 22</td></tr>
</table>

4.2.17 Protection System Failure Modes

<table>
<tr><td>Title:</td><td colspan="2">23. Protection system failure modes</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The protection system shall be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme heat or cold, fire, sodium and sodium reaction products, pressure, steam, water, and radiation) are experienced.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 23 for the eVinci microreactor design uses the language in RG 1.232, ARDC 23 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 23</td><td>eVinci microreactor PDC 23</td></tr>
<tr><td>The protection system shall be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme heat or cold, fire, sodium and sodium reaction products, pressure, steam, water, and radiation) are experienced.</td><td>The protection system shall be designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis if conditions such as disconnection of the system, loss of energy (e.g., electric power, instrument air), or postulated adverse environments (e.g., extreme heat or cold, fire, sodium and sodium reaction products, pressure, steam, water, and radiation) are experienced.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the SSCs of the microreactor design that provide a protective safety function must have a low probability of a failure mode occurring that credibly would defeat the protection function. Failing in a fail-safe or other acceptable state would mitigate the consequences of such a failure mode. As such, this requirement is not unique to LWRs and is applicable to the design.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 23</td></tr>
</table>

4.2.18 Separation of Protection and Control Systems

<table>
<tr><td>Title:</td><td colspan="2">24. Separation of protection and control systems</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel that is common to the control and protection systems, leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 24 for the eVinci microreactor design uses the language in RG 1.232, ARDC 24 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 24</td><td>eVinci microreactor PDC 24</td></tr>
<tr><td>The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel that is common to the control and protection systems leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.</td><td>The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel that is common to the control and protection systems leaves, intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Interconnection of the protection and control systems shall be limited so as to assure that safety is not significantly impaired.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because failure or removal of any control-related SSC in the microreactor design that defeats the ability of SSCs with a safety function to perform that function could potentially prevent the microreactor design from achieving high reliability of the safety functions. As such, this requirement is not unique to LWRs and is applicable to the design.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 24</td></tr>
</table>

4.2.19 Protection System Requirements for Reactivity Control Malfunctions

<table>
<tr><td>Title:</td><td colspan="2">25. Protection system requirements for reactivity control malfunctions</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The protection system shall be designed to ensure that specified acceptable system radionuclide release design limits are not exceeded during any anticipated operational occurrence, accounting for a single malfunction of the reactivity control systems.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 25 of the eVinci microreactor design uses the language of MHTGR-DC 25 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 25</td><td>eVinci microreactor PDC 25</td></tr>
<tr><td>The protection system shall be designed to ensure that specified acceptable system radionuclide release design limits are not exceeded during any anticipated operational occurrence, accounting for a single malfunction of the reactivity control systems.</td><td>The protection system shall be designed to ensure that specified acceptable system radionuclide release design limits are not exceeded during any anticipated operational occurrence, accounting for a single malfunction of the reactivity control systems.</td></tr>
<tr><td>Basis:</td><td colspan="2">[ ]a,c</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 25</td></tr>
</table>

4.2.20 Reactivity Control

Title:	26. Reactivity control	
eVinci microreactor PDC	Reactivity control shall be provided. Reactivity control shall provide: (1) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded and safe shutdown is achieved and maintained during normal operation, including anticipated operational occurrences. (2) A means, which is independent and diverse from the other(s), shall be capable of controlling the rate of reactivity changes resulting from planned, normal power changes to assure that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded. (3) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the capability to cool the core is maintained and a means of shutting down the reactor and maintaining, at a minimum, a safe shutdown condition following a licensing basis event. (4) A means for holding the reactor shutdown under conditions that allow for interventions such as fuel loading, inspection, and repair.	
Position:	PDC 26 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 26 with changes.	
	RG 1.232, Appendix C, Criterion 26	eVinci microreactor PDC 26
	A minimum of two reactivity control systems or means shall provide: (1) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded and safe shutdown is achieved and maintained during normal operation, including anticipated operational occurrences. (2) A means, which is independent and diverse from the other(s), shall be capable of controlling the rate of reactivity changes resulting from planned, normal power changes to assure that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded.	Reactivity control shall be provided. Reactivity control ~~A minimum of two reactivity control systems or means~~ shall provide: (1) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded and safe shutdown is achieved and maintained during normal operation, including anticipated operational occurrences. (2) A means, which is independent and diverse from the other(s), shall be capable of controlling the rate of reactivity changes resulting from planned, normal power changes to assure that the specified acceptable system radionuclide release design limits and the reactor helium pressure boundary design limits are not exceeded.

	(3) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the capability to cool the core is maintained and a means of shutting down the reactor and maintaining, at a minimum, a safe shutdown condition following a postulated accident. (4) A means for holding the reactor shutdown under conditions that allow for interventions such as fuel loading, inspection and repair shall be provided.	(3) A means of inserting negative reactivity at a sufficient rate and amount to assure, with appropriate margin for malfunctions, that the capability to cool the core is maintained and a means of shutting down the reactor and maintaining, at a minimum, a safe shutdown condition following a licensing basis event ~~postulated accident~~. (4) A means for holding the reactor shutdown under conditions that allow for interventions such as fuel loading, inspection and repair shall be provided.
Basis:	[ ]a,c This requirement wording differs from RG 1.232 in that the requirement has been changed to require “reactivity control” as opposed to a “reactivity control system,” to ensure that the PDC is SSC-independent and includes everything that provides reactivity control (such as I&C, etc.). Additionally, text related to the need for two independent, diverse systems has been removed as this is not a requirement for PDC, per the NEI 18-04 and NEI 21-07 guidance; rather, the PDC are defined based on what is needed for the safety case per the PRA. Use of NEI 18-04 and NEI 21-07 will include a DID evaluation that will determine whether multiple, diverse systems are needed. As documented in NEI 21-07, this PDC will apply to SR and NSRST SSCs determined necessary for the safety function. Finally, the phrase “postulated accident” is changed to “licensing basis event” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.	
Source:	RG 1.232, Appendix C, Criterion 26	

4.2.21 Reactivity Limits

<table>
<tr><td>Title:</td><td colspan="2">28. Reactivity limits</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Any structures, systems, and components that provide reactivity control shall be designed with appropriate limits on the potential amount and rate of reactivity increase to ensure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor system greater than limited local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor system components to significantly impair the capability to cool the core.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 28 for the eVinci microreactor design uses the language in RG 1.232, ARDC 28 with changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 28</td><td>eVinci microreactor PDC 28</td></tr>
<tr><td>The reactivity control systems shall be designed with appropriate limits on the potential amount and rate of reactivity increase to ensure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor coolant boundary greater than limited local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor vessel internals to significantly impair the capability to cool the core.</td><td>Any structures, systems, and components that provide~~The~~ reactivity control ~~systems~~ shall be designed with appropriate limits on the potential amount and rate of reactivity increase to ensure that the effects of postulated reactivity accidents can neither (1) result in damage to the reactor system ~~coolant boundary~~ greater than limited local yielding nor (2) sufficiently disturb the core, its support structures, or other reactor system components ~~vessel internals~~ to significantly impair the capability to cool the core.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the microreactor design margins and limits must be established and maintained such that core cooling and SSC conditions are adequate to protect the core from damage. As such, this requirement is not unique to the non-LWR technologies represented in RG 1.232, Appendix A and is applicable to the design.

“The reactivity control systems” has been revised to “Any structures, systems, and components that provide reactivity control” to ensure that the PDC is focused on function as opposed to a specific system.

“Reactor system,” which includes functional containment and associated heat removal, control, and protection systems, is used instead of “reactor coolant boundary.”

Reference to “reactor system” is used instead of “reactor vessel internals,” because the eVinci microreactor does not have a traditional reactor vessel or traditional reactor internals.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 28</td></tr>
</table>

4.2.22 Protection Against Anticipated Operational Occurrences

<table>
<tr><td>Title:</td><td colspan="2">29. Protection against anticipated operational occurrences</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The protection and reactivity control systems shall be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 29 for the eVinci microreactor design uses the language in RG 1.232, ARDC 29 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 29</td><td>eVinci microreactor PDC 29</td></tr>
<tr><td>The protection and reactivity control systems shall be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.</td><td>The protection and reactivity control systems shall be designed to assure an extremely high probability of accomplishing their safety functions in the event of anticipated operational occurrences.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the microreactor design must maintain reactivity control margins and limits to ensure they provide their safety functions. Highly reliable reactivity control systems are necessary to provide that assurance. As such, this requirement is not unique to LWRs and is applicable to the design.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 29</td></tr>
</table>

4.2.23 Residual Heat Removal

Title:	34. Residual heat removal	
eVinci microreactor PDC	A means to remove residual heat shall be provided. For normal operations and anticipated operational occurrences, the safety function shall be to transfer fission product decay heat and other residual heat from the reactor core to an ultimate heat sink at a rate such that specified acceptable system radionuclide release design limits and the design conditions of the reactor helium pressure boundary are not exceeded. During licensing basis events, the safety function shall provide effective cooling.	
Position:	PDC 34 for the eVinci microreactor design uses the language in RG 1.232, MHTGR-DC 34 with changes.	
	RG 1.232, Appendix C, Criterion 34	eVinci microreactor PDC 34
	A passive system to remove residual heat shall be provided. For normal operations and anticipated operational occurrences, the system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core to an ultimate heat sink at a rate such that specified acceptable system radionuclide release design limits and the design conditions of the reactor helium pressure boundary are not exceeded. During postulated accidents, the system safety function shall provide effective cooling. Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to ensure the system safety function can be accomplished, assuming a single failure.	A means ~~passive system~~ to remove residual heat shall be provided. For normal operations and anticipated operational occurrences, the ~~system~~ safety function shall be to transfer fission product decay heat and other residual heat from the reactor core to an ultimate heat sink at a rate such that specified acceptable system radionuclide release design limits and the design conditions of the reactor helium pressure boundary are not exceeded. During licensing basis events ~~postulated accidents~~, the ~~system~~ safety function shall provide effective cooling. ~~Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to ensure the system safety function can be accomplished, assuming a single failure.~~

Basis:	[ ]a,c The sentence "Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to ensure the system safety function can be accomplished, assuming a single failure" was deleted. Per the NEI 18-04 and NEI 21- 07 guidance, the PDC are defined based on what is needed for the safety case per the PRA. Use of NEI 18-04 and NEI 21-07 will include a DID evaluation, which will determine whether redundancy and/or multiple barriers are needed. As documented in NEI 21-07, this PDC will apply to SR and NSRST SSCs determined necessary for the safety function. Additionally, any reference to a "system" in the requirement has been deleted, to ensure that the PDC is SSC-independent and includes everything that provides heat removal (such as I&C, etc.). Finally, the phrase "postulated accident" is changed to "licensing basis event" to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.
Source:	RG 1.232, Appendix C, Criterion 34

4.2.24 Control of Releases of Radioactive Materials to the Environment

<table>
<tr><td>Title:</td><td colspan="2">60. Control of releases of radioactive materials to the environment</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">The nuclear power unit design shall include means to suitably control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 60 for the eVinci microreactor design uses the language in RG 1.232, ARDC 60 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 60</td><td>eVinci microreactor PDC 60</td></tr>
<tr><td>The nuclear power unit design shall include means to suitably control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.</td><td>The nuclear power unit design shall include means to suitably control the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable since the microreactor design will include air activation, which will need to be released. Such a release will need to be able to be controlled.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 60</td></tr>
</table>

4.2.25 Reactor Storage and Radioactive Control

Title:	61. Reactor storage and radioactivity control	
eVinci microreactor PDC	During storage, the reactor and other systems that may contain radioactivity shall be designed to ensure adequate safety under normal and licensing basis event conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of safety significant components; (2) with suitable shielding for radiation protection; (3) with appropriate containment, confinement, and filtering systems; (4) with a residual heat removal capability having reliability and testability that reflects the safety significance of decay heat and other residual heat removal; and (5) with the ability to prevent significant reduction in fuel storage cooling under accident conditions.	
Position:	PDC 61 for the eVinci microreactor design uses the language in RG 1.232, ARDC 61 with changes.	
	RG 1.232, Appendix A, Criterion 61	eVinci microreactor PDC 61
	The fuel storage and handling, radioactive waste, and other systems that may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety; (2) with suitable shielding for radiation protection; (3) with appropriate containment, confinement, and filtering systems; (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal; and (5) to prevent significant reduction in fuel storage cooling under accident conditions.	During ~~fuel~~ storage ~~and handling~~, the reactor ~~radioactive waste,~~ and other systems that may contain radioactivity shall be designed to ensure adequate safety under normal and ~~postulated accident~~ licensing basis event conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of safety significant components ~~important to safety~~, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the ~~importance to~~ safety significance of decay heat and other residual heat removal, and (5) with the ability to prevent significant reduction in fuel storage cooling under accident conditions.

Basis:	[ ]a,c Finally, the phrases “important to safety” and “importance to safety” are changed to “safety significant” and “safety significance” and the phrase “postulated accident” is changed to “licensing basis event” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.
Source:	RG 1.232, Appendix A, Criterion 61

4.2.26 Prevention of Criticality in Reactor Storage

<table>
<tr><td>Title:</td><td colspan="2">62. Prevention of criticality in reactor storage</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Criticality during reactor storage shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 62 for the eVinci microreactor design uses the language in RG 1.232, ARDC 62 with one change.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 62</td><td>eVinci microreactor PDC 62</td></tr>
<tr><td>Criticality in the fuel storage and handling system shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.</td><td>Criticality ~~in the fuel storage and handling system~~ during reactor storage shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.</td></tr>
<tr><td>Basis:</td><td colspan="2">[ ][a,c]</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 62</td></tr>
</table>

4.2.27 Monitoring Reactor Storage

<table>
<tr><td>Title:</td><td colspan="2">63. Monitoring reactor storage</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Appropriate systems shall be provided during reactor storage (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 63 for the eVinci microreactor design uses the language in RG 1.232, ARDC 63 with one change.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 63</td><td>eVinci microreactor PDC 63</td></tr>
<tr><td>Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.</td><td>Appropriate systems shall be provided <u>during reactor storage</u> <s>in fuel storage and radioactive waste systems and associated handling areas</s> (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.</td></tr>
<tr><td>Basis:</td><td colspan="2">[

]a,c</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 63</td></tr>
</table>

4.2.28 Monitoring Radioactive Releases

<table>
<tr><td>Title:</td><td colspan="2">64. Monitoring radioactivity releases</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Means shall be provided for monitoring sufficient to detect a barrier breach of radiological significance in the functional containment, as well as monitoring effluent discharge paths and facility environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from licensing basis events.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 64 for the eVinci microreactor design uses the language in RG 1.232, ARDC 64 with changes.</td></tr>
<tr><td>RG 1.232, Appendix A, Criterion 64</td><td>eVinci microreactor PDC 64</td></tr>
<tr><td>Means shall be provided for monitoring the reactor containment atmosphere, effluent discharge paths, and plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.</td><td>Means shall be provided for monitoring ~~the reactor containment atmosphere,~~ sufficient to detect a barrier breach of radiological significance in the functional containment, as well as monitoring effluent discharge paths and facility ~~plant~~ environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from ~~postulated accidents~~ licensing basis events.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the microreactor design must monitor radioactivity releases to mitigate the potential failure of SSCs that might lead to releases of radioactive material. As such, this requirement is not unique to the non-LWR technologies represented in RG 1.232, Appendix A and is applicable to the design.

This requirement has been revised from RG 1.232 to change the phrase “the reactor containment atmosphere” to reflect the eVinci microreactor design more accurately, which relies on a functional containment.

Additionally, “plant environs” has been revised to “facility environs” to reflect the fact that the eVinci microreactor is referred to as a facility, as opposed to a plant.

Finally, the phrase “postulated accident” is changed to “licensing basis events” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix A, Criterion 64</td></tr>
</table>

4.2.29 Cover Gas Purity Control

<table>
<tr><td>Title:</td><td colspan="2">71. Cover gas purity control</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Purity of cover gas shall be maintained within specified design limits. These limits shall be based on consideration of (1) chemical attack, (2) fouling and plugging of passages, (3) radionuclide concentrations, and (4) air or moisture ingress as a result of a leak of cover gas.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 71 for the eVinci microreactor design uses the language in RG 1.232, SFR-DC 71 with changes.</td></tr>
<tr><td>RG 1.232, Appendix B, Criterion 71</td><td>eVinci microreactor PDC 71</td></tr>
<tr><td>Systems shall be provided as necessary to maintain the purity of primary coolant sodium and cover gas within specified design limits. These limits shall be based on consideration of (1) chemical attack, (2) fouling and plugging of passages, and (3) radionuclide concentrations, and (4) air or moisture ingress as a result of a leak of cover gas.</td><td>~~Systems~~ Purity of cover gas shall be ~~provided as necessary to maintain the purity of primary coolant sodium and cover gas~~ maintained within specified design limits. These limits shall be based on consideration of (1) chemical attack, (2) fouling and plugging of passages, ~~and~~ (3) radionuclide concentrations, and (4) air or moisture ingress as a result of a leak of cover gas.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the microreactor design must ensure the integrity of any cover gas used as it prevents chemical attack of the graphite core block and aides heat transfer. As such, this requirement is not unique to SFRs and is applicable to the design.

References to “primary coolant sodium” were removed since they are not part of the design.

Additionally, any reference to a “system” in the requirement has been deleted to ensure that the PDC is SSC-independent and includes everything that supports purity of cover gas (such as I&C, etc.).</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix B, Criterion 71</td></tr>
</table>

4.2.30 Sodium Leakage Detection and Reaction Prevention and Mitigation

<table>
<tr><td>Title:</td><td colspan="2">73. Sodium leakage detection and reaction prevention and mitigation</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Means to: (1) detect and identify sodium leakage from any location as practical, (2) ensure passive heat removal system is available, (3) limit and control the extent of sodium-air reactions, and (4) mitigate the effects of fires resulting from these sodium-air reactions shall be provided to ensure that the safety functions of safety significant structures, systems, and components are maintained. Systems from which sodium leakage constitutes a significant safety hazard shall include measures for protection, such as inert enclosures or guard vessels.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 73 for the eVinci microreactor design uses the language in RG 1.232, SFR-DC 73 with changes.</td></tr>
<tr><td>RG 1.232, Appendix B, Criterion 73</td><td>eVinci microreactor PDC 73</td></tr>
<tr><td>Means to detect and identify sodium leakage as practical and to limit and control the extent of sodium-air and sodium-concrete reactions and to mitigate the effects of fires resulting from these sodium-air and sodium-concrete reactions shall be provided to ensure that the safety functions of structures, systems, and components important to safety are maintained. Systems from which sodium leakage constitutes a significant safety hazard shall include measures for protection, such as inerted enclosures or guard vessels.</td><td>Means to: (1) detect and identify sodium leakage from any location as practical, (2) ensure passive heat removal system is available, (3) ~~and to~~ limit and control the extent of sodium-air ~~and sodium-concrete~~ reactions, and (4) ~~to~~ mitigate the effects of fires resulting from these sodium-air ~~and sodium-concrete~~ reactions shall be provided to ensure that the safety functions of safety significant structures, systems, and components ~~important to safety~~ are maintained. Systems from which sodium leakage constitutes a significant safety hazard shall include measures for protection, such as inert~~ed~~ enclosures or guard vessels.</td></tr>
<tr><td>Basis:</td><td colspan="2">This requirement is applicable because the microreactor design includes the use of sodium material and hence interactions of sodium with other materials or fluids, which could lead to failure of a safety function, need to be considered. As such, this requirement is not unique to SFRs and is applicable to the design.

This requirement includes the following changes from the wording in RG 1.232. References to sodium-concrete reactions have been removed as no concrete interactions are anticipated in the design.

Additionally, the requirement for leakage detection and identification in the passive heat removal system has also been added. This was not explicitly the purpose of the requirement in RG 1.232, but it is a requirement for the eVinci microreactor design; therefore, the requirement has been added here.

Finally, the phrase “important to safety” has been changed to “safety significant” to align with the RIPB terminology used in NEI 18-04 and NEI 21-07.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix B, Criterion 73</td></tr>
</table>

4.2.31 Sodium/Water Reaction Prevention/Mitigation

<table>
<tr><td>Title:</td><td colspan="2">74. Sodium/water reaction prevention/mitigation</td></tr>
<tr><td>eVinci microreactor PDC</td><td colspan="2">Structures, systems, and components containing sodium shall be designed and located to avoid contact between sodium and water and to limit the adverse effects of chemical reactions between sodium and water on the capability of any structure, system, or component to perform any of its intended safety functions.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 74 for the eVinci microreactor design uses the language in RG 1.232, SFR-DC 74 with one change.</td></tr>
<tr><td>RG 1.232, Appendix B, Criterion 74</td><td>eVinci microreactor PDC 74</td></tr>
<tr><td>Structures, systems, and components containing sodium shall be designed and located to avoid contact between sodium and water and to limit the adverse effects of chemical reactions between sodium and water on the capability of any structure, system, or component to perform any of its intended safety functions. If steam-water is used for energy conversion, to prevent loss of any plant safety function, the sodium-steam generator system shall be designed to detect and contain sodium-water reactions and limit the effects of the energy and reaction products released by such reactions, including mitigation of the effects of any resulting fire involving sodium.</td><td>Structures, systems, and components containing sodium shall be designed and located to avoid contact between sodium and water and to limit the adverse effects of chemical reactions between sodium and water on the capability of any structure, system, or component to perform any of its intended safety functions. <s>If steam-water is used for energy conversion, to prevent loss of any plant safety function, the sodium-steam generator system shall be designed to detect and contain sodium-water reactions and limit the effects of the energy and reaction products released by such reactions, including mitigation of the effects of any resulting fire involving sodium.</s></td></tr>
<tr><td>Basis:</td><td colspan="2">The eVinci microreactor design uses sodium in heat pipes for heat removal from the core to the PCS. Air is used for power conversion, and moisture contained in the air could be sufficient to cause sodium-water reaction to occur. As such, this requirement is not unique to SFRs and is applicable to the design.

This requirement uses wording identical to RG 1.232 but only contains the applicable portion of the requirement (i.e., the first sentence). The second sentence of the requirement in RG 1.232 is not applicable to the design.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix B, Criterion 74</td></tr>
</table>

4.2.32 Sodium Heat Pipe Interfaces

Title:	78. Sodium heat pipe interfaces
eVinci microreactor PDC	When the sodium heat pipes interface with a structure, system, or component containing fluid that is chemically incompatible with the sodium used in the heat pipes, the interface location shall be designed to ensure that the sodium is separated from the chemically incompatible fluid commensurate with the safety significance of the fluid incompatibility.
Position:	PDC 78 for the eVinci microreactor design uses the language of SFR-DC 78 from RG 1.232 with changes.

RG 1.232, Appendix B, Criterion 78	eVinci microreactor PDC 78
When the primary coolant system interfaces with a structure, system, or component containing fluid that is chemically incompatible with the primary coolant, the interface location shall be designed to ensure that the primary coolant is separated from the chemically incompatible fluid by two redundant, passive barriers. When the primary coolant system interfaces with a structure, system, or component containing fluid that is chemically compatible with the primary coolant, then the interface location may be a single passive barrier provided that the following conditions are met: (1) postulated leakage at the interface location does not result in failure of the intended safety functions of structures, systems, or components important to safety or result in exceeding the fuel design limits (2) the fluid contained in the structure, system, or component is maintained at a higher pressure than the primary coolant during normal operation, anticipated operational occurrences, shutdown, and accident conditions.	When the ~~primary coolant system~~ sodium heat pipes interface~~s~~ with a structure, system, or component containing fluid that is chemically incompatible with the ~~primary coolant~~ sodium used in the heat pipes, the interface location shall be designed to ensure that the ~~primary coolant~~ sodium is separated from the chemically incompatible fluid commensurate with the safety significance of the fluid incompatibility ~~by two redundant, passive barriers. When the primary coolant system interfaces with a structure, system, or component containing fluid that is chemically compatible with the primary coolant, then the interface location may be a single passive barrier provided that the following conditions are met:~~ ~~(1) postulated leakage at the interface location does not result in failure of the intended safety functions of structures, systems or components important to safety or result in exceeding the fuel design limits~~ ~~(2) the fluid contained in the structure, system, or component is maintained at a higher pressure than the primary coolant during normal operation, anticipated operational occurrences, shutdown, and accident conditions~~.

Basis:	The design uses sodium as the heat transfer medium in the heat pipes for heat removal from the core to the PCS. Consideration of the interfacing materials is necessary when using sodium. This requirement is applicable because the microreactor design must ensure that interactions of materials and/or fluids that could potentially impact the ability of an SSC to perform its safety function must be considered. As such, this requirement is not unique to SFRs and is applicable to the design. This requirement has been edited using wording from RG 1.232 as a starting point. References to “primary coolant” have been revised to refer to the sodium in the heat pipes. Text “commensurate with the safety significance of the fluid incompatibility” was added to provide further clarification on how the interface should be designed. Additionally, discussion related to how many barriers are required has been removed as this is not a requirement for PDC per the NEI 18-04 and NEI 21-07 guidance; rather, the PDC are defined based on what is needed for the safety case per the PRA. Use of NEI 18-04 and NEI 21-07 will include a DID evaluation, which will determine whether multiple redundant barriers are needed. As documented in NEI 21-07, this PDC will apply to SR and NSRST SSCs determined necessary for the safety function.
Source:	RG 1.232, Appendix B, Criterion 78

5.0 Conclusion

This topical report documents the PDC for the eVinci microreactor and the basis for their selection. The PDC have been developed mainly from NRC RG 1.232 (Reference 10), NEI 18-04 (Reference 11), and NEI 21-07 (Reference 12). The eVinci microreactor design features directly align with some of the criteria from the RG 1.232 appendices. This topical report specifically documents how the PDCs selected were modified if change was necessary from the RG.