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Project No. 99902071

U.S. Nuclear Regulatory Commission
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Washington, DC 20555-0001

Submission of X Energy, LLC (X-energy) Xe-100 Principal Design Criteria Licensing Topical Report

The purpose of this letter is to submit the subject licensing topical report (LTR) to the U.S Nuclear Regulatory Commission (NRC) on behalf of X Energy, LLC ("X-energy"). This topical report describes the development of the principal design criteria (PDC) for the X-energy Xe-100 pebble-bed, high-temperature gas-cooled reactor (HTGR). The PDC are developed using guidance from Regulatory Guide (RG) 1.232, "Guidance for Developing Principal Design Criteria for Advanced (Non-Light Water) Reactors," NEI 21-07, "Technology Inclusive Guidance for Non-Light Water Reactor Safety Analysis Report: Content for Applicants Using the NEI 18-04 Methodology," Revision 1, and Xe-100-specific safety functions and design requirements. It is provided for NRC review and approval as indicated in the report and is expected to be referenced in future Xe-100 licensing applications. The specific review schedule will continue to be developed with X-energy's NRC project manager; however, we request that acceptance review and schedule planning occur within 60 days of commencement and a review duration of 12 months be considered.

This version replaces the previous version submitted on July 6, 2022.

This letter contains no commitments. If you have any questions or require additional information, please contact Ingrid Nordby at inordby@x-energy.com.

Sincerely,

DocuSigned by:
F053E736949E4C3...

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Xe-100 Principal Design Criteria Licensing Topical Report

Xe-100 Principal Design Criteria

Licensing Topical Report

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Project	:	**Xe-100**
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10 CFR 810 EXPORT-CONTROLLED INFORMATION DISCLAIMER

This document was reviewed by X-energy and determined to not contain information designated as export-controlled per Title 10 of the Code of Federal Regulations (CFR) Part 810 or 10 CFR 110.

DEPARTMENT OF ENERGY ACKNOWLEDGEMENT AND DISCLAIMER

This material is based upon work supported by the Department of Energy under Award Number DE-NE0008472.

SYNOPSIS

This topical report describes the development of the principal design criteria (PDC) for the X-energy Xe-100 pebble-bed, high-temperature gas-cooled reactor (HTGR). The PDC are developed using guidance from Regulatory Guide (RG) 1.232, "Guidance for Developing Principal Design Criteria for Advanced (Non-Light Water) Reactors," NEI 21-07, "Technology Inclusive Guidance for Non-Light Water Reactor Safety Analysis Report: Content for Applicants Using the NEI 18-04 Methodology," Revision 1, and Xe-100-specific safety functions and design requirements. The resulting PDC are specific to the Xe-100 design and support licensing bases development for future license applicants. X-energy is requesting review and approval of these PDC by the Nuclear Regulatory Commission for use by future applicants for permits, licenses, certifications, and/or approvals under Title 10 of the Code of Federal Regulations applicable regulations governing principal design criteria development.

CONFIGURATION CONTROL

Document Change History

Rev.	Date	Preparer	Changes
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1	08 Jul 22	P Loza	For approval

Document Approval

Action	Designation	Name	Signature	Date
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ABBREVIATIONS

This list contains the abbreviations used in this document.

Abbreviation or Acronym	Definition
AOO	Anticipated Operational Occurrences
ARDC	Advanced Reactor Design Criteria
CDC	Complementary Design Criteria
CFR	Code of Federal Regulations
CP	Construction Permit
DBHL	Design Basis Hazard Levels
DC	Design Criteria
DOE	Department of Energy
GDC	General Design Criteria
HTR	High Temperature Reactor
IDP	Integrated Decision-making Process
LBE	Licensing Basis Event
LWR	Light Water Reactor
MHTGR	Modular High Temperature Gas Reactor
NEI	Nuclear Energy Institute
PDC	Principal Design Criteria
PRA	Probabilistic Risk Assessment
PSAR	Preliminary Safety Analysis Report
PSF	PRA Safety Function
RFDC	Required Functional Design Criteria
RG	Regulatory Guide
RIM	Reliability and Integrity Management
RSF	Required Safety Function
SAR	Safety Analysis Report
SARRDL	Specified Acceptable System Radionuclide Release Design Limit
SAFDL	Specified Acceptable Fuel Design Limit
SRDC	Safety Related Design Criteria
SSC	Structures, Systems, and Components

Abbreviation or Acronym	Definition
TBC	To be Confirmed
TBD	To be Determined
TRISO	Tri-structural Isotropic

1. INTRODUCTION

X energy, LLC (X-energy) is designing the Xe-100, a pebble-bed high-temperature gas-cooled reactor, and has developed Principal Design Criteria (PDC) to support both the design and licensing process and compliance with pertinent regulatory requirements of Title 10 of the Code of Federal Regulation (10 CFR) Parts 50 and 52. The PDC described in this report were developed using the guidance in Regulatory Guide (RG) 1.232, "Guidance for Developing Principal Design Criteria for Non-Light Water Reactors" [8], NEI 21-07, "Technology Inclusive Guidance for Non-Light Water Reactor Safety Analysis Report: Content for Applicants Using the NEI 18-04 Methodology" Revision 1 [7], and Xe-100-specific PRA safety functions (PSFs) and design features.

X-energy requests NRC review and approval of these PDC to be used in applications based on the Xe-100 design for limited work authorizations, construction permits, and operating licenses under 10 CFR 50; or limited work authorizations, standard design certifications, combined licenses, standard design approvals, and manufacturing licenses under the applicable regulations in 10 CFR 52. The demonstration that the Xe-100 design bases satisfies these PDC will be provided within the safety analysis reports (SARs) of each application.

1.1. REGULATORY ANALYSIS

The NRC provides rules for the design, licensing, construction, operation, and decommissioning of reactors in order to provide reasonable assurance of adequate protection of public health and safety and to provide for the common defense and security. The majority of regulations associated with reactors are found in 10 CFR Parts 1-199, with a principle set of requirements found in Parts 50 and 52. The NRC also provides guidance to prospective applicants in the form of Regulatory Guides that provide acceptable methods and approaches to demonstrate compliance with the regulations. Regulatory Guides may be stand-alone documents or issued as acceptance of a code, standard, or other non-NRC document as an acceptable means of demonstrating conformance. Prospective applicants are allowed to propose alternative approach to meeting regulatory requirements if appropriately justified. The following sections provide a brief analysis of requirements associated with the development of PDC for a reactor facility.

1.1.1. Title 10 of the Code of Federal Regulations, Parts 50 and 52

The regulations under 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," provides general design criteria (GDCs) for water-cooled nuclear power plants similar to those historically licensed by the NRC. Under the provisions of 10 CFR Parts 50 and 52, applicants for a construction permit (CP), operating license (OL), design certification (DC), combined license (COL), standard design approval (SDA), or manufacturing license (ML) must submit PDCs for the proposed facility and described how the design bases for the facility conform to those PDC (typically in the associated application's SAR).

The following NRC regulations pertain specifically to the development of PDCs:

- 10 CFR 50.34(a)(3)(i), which requires, in part, that applications for a CP include PDCs for the facility. An OL would reference a CP, which would include PDCs.
- 10 CFR 52.47(a)(3)(i), which requires, in part, that applications for a DC include PDCs for the facility.
- 10 CFR 52.79(a)(4)(i), which requires, in part, that applications for a COL include PDCs for the facility.

- 10 CFR 52.137(a)(3)(i), which requires, in part, that applications for an SDA include PDCs for the facility.
- 10 CFR 52.157(a), which requires, in part, that applications for an ML include PDCs for the reactor to be manufactured.

The regulations under 10 CFR 50.34(a)(3)(i) state that 10 CFR Part 50, Appendix A, establishes the minimum requirements for the PDCs for water-cooled nuclear power plants similar in design and location to plants for which CPs have previously been issued by the Commission and provide guidance to applicants in establishing PDCs for other types of nuclear power plants. Since HTGRs are not water-cooled nuclear power plants, PDCs are required to be provided, but do not necessarily need to align with, the minimum requirements in the GDCs in 10 CFR Part 50, Appendix A.

1.1.2. RG 1.232, Revision 0

The GDC in 10 CFR 50, Appendix A, provide a minimum set of requirements to establish the PDC for a nuclear power plant. These PDC establish necessary design, fabrication, construction, testing, and inspection requirements for structures, systems, and components (SSCs) that have a significant impact on public health and safety. The NRC and U.S. Department of Energy (DOE) implemented a joint initiative to review the GDC for applicability to non-LWR designs and to propose amended and/or additional design criteria that address non-LWR design features, resulting in the issuance of RG 1.232, Revision 0 in 2018. While GDC are not regulatory requirements for non-LWR designs, they do provide guidance in establishing the PDC for non-LWR designs and would not warrant the need for an exemption request from the GDC.

RG 1.232 provides a set of advanced reactor design criteria (ARDC) that serve the same purpose for non-LWRs as the GDC serve for LWRs. In addition to the technology-inclusive ARDC, RG 1.232 provides two sets of technology-specific, non-LWR design criteria, one of which is for the modular high-temperature gas-cooled reactor (MHTGR) and is described in Appendix C of the guide. The PDC provided for the MHTGR design are referred to as the MHTGR design criteria (MHTGR-DC). Because RG 1.232 provides the necessary regulatory ties between the GDC, ARDC, and MHTGR-DC, the Xe-100 PDC are derived, in part, directly from the MHTGR-DC as described in Appendix C of the guide.

RG 1.232 determined that some of the GDC contained in 10 CFR Part 50 Appendix A were not applicable to HTGR technology and developed modified mHTGR design criteria (mHTGR-DCs) as guidance for developing non-LWR PDCs. These GDCs are screened in Table 5 with the same basis described in RG 1.232.

1.1.3. NEI 21-07, Revision 1

NEI 21-07 provides guidance on developing safety analysis report content using the risk-informed and performance-based approach to design and licensing bases development described in NEI 18-04, “Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development” Revision 1 [3]. Chapter 5 of NEI 21-07, entitled “Safety Functions, Design Criteria, and SSC Classification” focuses on identifying the required safety functions (RSFs) and other PRA safety functions (PSFs) that support SSC classification and are associated with different types of PDC. For example, an SSC that is credited in fulfilling a particular RSF is classified as safety-related (SR) and the associated PDC is referred to as required functional design criteria (RFDC.) Likewise, an SSC that performs a PSF necessary for DID adequacy is classified as non-safety-related with special treatments (NSRST) and the associated PDC is referred to as complementary design criteria (CDC.)

Some proposed PDC based on the MHTGR-DC do not provide an RSF or PSF, as such, and are more akin to a special treatment as defined in both NEI 18-04 and NEI 21-07. For example, PDC that focus on monitoring, testing, and/or inspection do not perform an RSF or PSF, rather these types of PDC ensure that system designs account for the impacts from programmatic requirements during the system lifecycle. In addition, some proposed PDC focus specifically on normal operations, while both the NEI 18-04 and NEI 21-07 scope considers only licensing basis events (LBEs.) As such, the set of Xe-100 PDC that is limited to normal operations is effectively outside the scope of the NEI 18-04 methodology and NEI 21-07 structure. However, PDC related to normal operations are necessary to demonstrate that the Xe-100 will provide reasonable assurance of adequate protection during normal operations.

2. XE-100 PDC DEVELOPMENT PROCESS

PDC development for the Xe-100 design is a two-pronged approach. The MHTGR-DC from Appendix C of RG 1.232 and Xe-100 RFDC and CDC identified from implementing the NEI 18-04 and NEI 21-07 guidance were both used to derive the Xe-100 PDC. While both of these approaches to develop PDC are different, they can be used in concert to develop a set of Xe-100 PDC that can be further categorized based on their alignment with three main objectives:

1. Perform RSFs and PSFs with supporting RFDC and CDC respectively
2. Support the identification and implementation of special treatments
3. Support normal operations

Starting with the MHTGR-DC in Appendix C of RG 1.232, each PDC is reviewed for applicability and alignment to the Xe-100 design. In cases where there is sufficient alignment between a particular MHTGR-DC and Xe-100 design, no suggested changes to the MHTGR-DC are provided. In cases where the Xe-100 design does not align well with a particular MHTGR-DC, suggested changes to the MHTGR-DC and associated bases are provided. Each of the Xe-100 PDC are characterized further as to whether there are any RFDC supporting an RSF, a CDC supporting a PSF, support the identification and implementation of a special treatment, or support normal operations. In some cases, more than one of these characterizations could apply to a single PDC.

3. XE-100 PDC STRUCTURE

The structure of the Xe-100 PDC closely follows the seven-section layout below as described in Appendix C of RG 1.232 to facilitate the traceability from the MHTGR-DC to the Xe-100 PDC. As such, the Xe-100 PDC retains the MHTGR-DC numbering scheme for accounting purposes.

Section I—Overall Requirements (Criteria 1–6[1])

Section II—Multiple Barriers (Criteria 10–19)

Section III—Reactivity Control (Criteria 20–29)

Section IV—Heat Transport Systems (Criteria 30-46)

Section V—Reactor Containment (Criteria 50–57)

Section VI—Fuel and Radioactivity Control (Criteria 60–64)

Section VII—Additional MHTGR-DC (Criteria 70–72)

The results of the Xe-100 PDC development are provided in Appendix A of this report. The detailed evaluation results are organized in a tabular form for each PDC as follows:

Title: Provides the number and the title of the PDC. In most cases, the title is from Appendix C of RG 1.232, however, in some cases the title is changed to reflect relevant aspects of the Xe-100 design.

Xe-100 PDC: Provides the Xe-100 PDC wording. Where RFDC and CDC are identified, the PDC is either split into RFDC and CDC if the wording is different or it is noted that the PDC language covers both RFDC and CDC.

Position: Provides a determination of whether a given MHTGR-DC is adopted with or without changes. Where changes are determined necessary, this content identifies the modifications made to the underlying criteria to derive the Xe-100 PDC. Wording removed is shown in **red** text with a strikethrough and wording added is shown in **blue** text with underline. The source MHTGR-DC is provided adjacent to any modifications for convenience.

Basis: Provides any justification and rationale for the Xe-100 PDC and any additional characterizations as described in Section 2 of this report. Note: The basis does not explain how the Xe-100 meets the PDC; the demonstration that the Xe-100 design satisfies these PDC will be provided within the safety analysis reports (SARs) of each plant application.

Source: Provides the particular MHTGR-DC from Appendix C of RG 1.232.

[1] A new criterion "PDC 6" is created to replace PDC within multiple sections regarding monitoring, inspection, and testing, which is the only deviation from the sections defined in RG 1.232

4. REFERENCES

The following documents are referenced within this document.

	Document Title	Preparer/ Author	Document Number	Revision or Date of Issue	Classification
[1]	Xe-100 Technical Report Technology Description	XE	XE00-P-G1ZZ-RDZZ-D-001118	Apr 2021	Guide
[2]	"Functional Containment Performance Criteria for Non-Light-water-Reactors" [ML18114A546]	NRC	SECY-18-096	Sept 2018	Guide
[3]	Risk-Informed Performance-Based Technology Inclusive Guidance for Non-Light Water Reactor Licensing Basis Development	NEI	18-04	Aug 2019	Guide
[4]	Non-Light Water Review Strategy Staff White Paper	NRC	ADAMS Accession Number ML19275F299	Sept 2019	Guide
[5]	Xe-100 White Paper Licensing Application Content and Regulatory Analysis	XE	XE00-R-R1ZZ-RDZZ-X-000715	Apr 2021	Analysis
[6]	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	NRC	Regulatory Guide 1.233	June 2020	Guide

	Document Title	Preparer/ Author	Document Number	Revision or Date of Issue	Classification
[7]	Technology Inclusive Guidance for Non-Light Water Reactor Safety Analysis Report: Content for Applicants Using the NEI 18-04 Methodology	NEI	NEI 21-07 [Rev 1]	Aug 2021	Guide
[8]	Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors	NRC	RG 1.232	Apr 2018	Guide
[9]	Xe-100 Reactor Pressure Vessel Construction Code Assessment White Paper	XE	XE00-R-R1ZZ-MZZ-X-000574	June 2020	Analysis
[10]	Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs	NRC	SECY-94-084	March 1994	Policy

5. APPENDIX A: XE-100 PRINCIPAL DESIGN CRITERIA

Xe-100 PRINCIPAL DESIGN CRITERIA (PDC)

Each of the Xe-100 PDC are described using the structure from Section 3 of this report. Tables 1 and 2 briefly describe the RSFs and PSFs respectively and provide the associated PDC that they accommodate. Tables 3 and 4 describe which PDC are associated with normal operations and special treatments respectively. Table 5 shows the gaps in the sequential numbering of the Xe-100 PDC. Table 6 provides the Xe-100 Principal Design Criteria.

Table 1: PDC Accommodating RSFs

RSF #	Addressed in PDC
1 - Retain Radionuclides in Fuel Particles and Pebbles	10, 16
1.1 - Control Reactivity	20
1.1.1 - Ensure Inherent Reactivity Feedback	11, 12, 26, 28
1.1.2 - Support Inherent Reactivity Feedback by Removing Primary Heat Transport	13, 20
1.1.3 - Ensure Reactor Shutdown Capability	13, 20, 26, 28
1.1.4 - Maintain Geometry to Support Adequate Negative Reactivity	14, 70
1.2 - Control Heat Removal	34
1.2.1 - Transfer Heat from Fuel to Vessel Wall	34
1.2.2 - Radiate Heat from Vessel Wall to Reactor Cavity	34
1.2.3 - Transfer Heat from Reactor Cavity to Ultimate Heat Sink	34
1.2.4 - Maintain Geometry for Conduction and Radiation	14, 28, 34, 70, 71
1.3 - Control Water/Steam Ingress	30, 31
1.3.1 - Control Water/Steam Ingress from the Steam Generator	13, 14, 20
1.3.2 - Control Primary System Pressure	14

Table 2: PDC Accommodating Safety-Significant PSFs

PSF #	Addressed in PDC
1 - Control Radionuclide Transport from the Primary Boundary	10, 13, 15, 17, 30, 31
2 - Control reactivity with insertion of moveable poisons	13, 17, 19, 26, 28
3 - Actively Remove Heat via forced circulation	13, 17, 19, 34, 44
4 - Prevent and Mitigate Steam Generator Tube Ruptures	13, 17, 30, 31

Table 3: PDC Associated with Normal Operations

PDC
4
10

13
15
19
26
34
64

Table 4: PDC Associated with Special Treatments

PDC
1
2
3
4
5
6
14
18
30
31
32
34
36
37
44
45
46
72

Table 5: GDC and ARDC Screened as Not Applicable for MHTGRs based on RG 1.232

Criterion	Screening Rationale from RG 1.232
27	Combined reactivity control systems capability. Same as ARDC DELETED—Information incorporated into MHTGR-DC 26
33	The MHTGR does not require reactor coolant inventory maintenance for small leaks to meet the SARRDLs, which replaces the concept of the specified acceptable fuel design limits, as discussed in GDC 10. Therefore, ARDC 33 is not applicable to the MHTGR design.
35	In the MHTGR design maintaining the helium inventory is not necessary to maintain effective cooling. Postulated accident heat removal is accomplished by the residual heat removal system described in MHTGR DC 34.
38	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR DC 16 rationale.
39	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
40	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
41	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.

Criterion	Screening Rationale from RG 1.232
42	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
43	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
50	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
51	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
52	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
53	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
54	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a “pressure retaining reactor containment structure” but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.

Criterion	Screening Rationale from RG 1.232
55	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a "pressure retaining reactor containment structure" but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
56	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a "pressure retaining reactor containment structure" but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.
57	This criterion is not applicable to the MHTGR. The MHTGR designs do not have a "pressure retaining reactor containment structure" but instead rely on a multibarrier functional containment configuration to control the release of radionuclides. See the MHTGR-DC 16 rationale.

Table 6: Xe-100 Principal Design Criteria

Title:	*1. Quality standards and records*	
Xe-100 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 of the Xe-100 design uses the language of MHTGR-DC 1 of RG 1.232 with the following changes:	
	RG 1.232, Appendix C, Criterion 1	Xe-100 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.	~~Structures~~ Safety-significant structures, systems, and components ~~important to safety~~ shall be designed, fabricated, erected, and tested to quality standards commensurate with the ~~importance~~ safety significance 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-significant function. A quality assurance program shall be established and implemented in order to provide ~~adequate~~ 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 ~~important to safety~~

		shall be maintained by or under the control of the nuclear power unit licensee ~~throughout the life~~ for an appropriate period of ~~the unit~~ time.
Basis:	Xe-100 PDC 1 is based on the language in NEI 21-07, Revision 1, Section 5.3.1. The phrase "throughout the life" was changed to "for an appropriate period of time" to account for the application of quality assurance special treatments to NSRST SSCs. The phrase "important to safety" is changed to "safety-significant" to align with NEI 18-04 terminology. Quality assurance measures are a special treatment in accordance with the NEI 18-04 methodology.	
Source:	RG 1.232, Appendix C, Criterion 1	

Title:	*2. Design bases for protection against natural phenomena.*
Xe-100 PDC RFDC	Structures, systems, and components that are required to perform required safety functions 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, (3) the importance of the safety functions to be performed
Xe-100 PDC CDC	Structures, systems, and components that are required to perform non-safety-related with special treatment PRA safety functions 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 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, (3) the importance of the safety functions to be performed.
Position:	PDC 2 of the Xe-100 design uses the language of MHTGR-DC 2 of RG 1.232 with the following changes:

RG 1.232, Appendix C, Criterion 2	Xe-100 PDC - RFDC 2
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	Structures, systems, and components that are required to perform required safety functions ~~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

	and (3) the importance of the safety functions to be performed	the effects of the natural phenomena and (3) the importance of the safety functions to be performed
	RG 1.232, Appendix C, Criterion 2	Xe-100 PDC - CDC 2
	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	Structures, systems, and components that are required to perform non-safety-related with special treatment PRA safety functions ~~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, (3) the importance of the safety functions to be performed.
Basis:	The Xe-100 SSCs that are required to perform RSFs are designed to withstand the effects of Design Basis Hazard Levels (DBHLs) without loss of capability to perform their safety functions or are designed such that their response or failure will be in a safe condition. The SR SSC design bases reflect appropriate consideration of the most severe of the historical natural phenomena, and include sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated. These will be defined in Chapter 6.1 of the SAR as DBHLs. The CDC clarifies that the NSRST SSCs may not have to withstand DBHLs and their design against hazards will ensure their capability targets identified under the NEI 18-04 IDP shall be met. The phrase "important to safety" is changed to "safety-significant" as described in the basis for PDC 1. For PDC 2 safety-significant is categorized into the SSCs that perform required safety functions for the RFDC and SSCs that perform NSRST PRA safety functions for the CDC. Capability targets identified through the IDP will include the hazard levels under which SSCs must perform their RSFs and NSRST PSFs. Hazard analysis will drive special	

	treatments through the NEI 18-04 IDP.
Source:	RG 1.232, Appendix C, Criterion 2

Title:	*3. Fire protection*
Xe-100 PDC	Safety-significant structures, systems, and components shall be designed and located to minimize, consistent with other safety requirements and the safety significance of the functions to be performed, the probability and effect of fires and explosions. Noncombustible and fire-resistant materials shall be used wherever practical throughout the unit, particularly in locations with safety-significant structures, systems, or components. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on safety-significant structures, systems, and components commensurate with the safety significance of the functions to be performed. Firefighting systems shall be designed to ensure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.
Position:	PDC 3 of the Xe-100 design uses the language of MHTGR-DC 3 of RG 1.232 with the following changes:

RG 1.232, Appendix C, Criterion 3	Xe-100 PDC 3
Structures, systems, and components important to safety shall be designed and located to minimize, consistent with other safety requirements, the probability and effect of fires and explosions. Noncombustible and fire-resistant materials shall be used wherever practical throughout the unit, particularly in locations with structures, systems, or components important to safety. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on structures, systems, and components important to safety. Firefighting systems shall be designed to ensure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.	Safety-significant structures, systems, and components ~~important to safety~~ shall be designed and located to minimize, consistent with other safety requirements and the safety significance of the functions to be performed, the probability and effect of fires and explosions. Noncombustible and fire-resistant materials shall be used wherever practical throughout the unit, particularly in locations with safety-significant structures, systems, or components ~~important to safety~~. Fire detection and fighting systems of appropriate capacity and capability shall be provided and designed to minimize the adverse effects of fires on safety-significant structures, systems, and components commensurate with the safety significance to ~~safety~~ be performed. Firefighting systems shall be designed to ensure that their rupture or inadvertent operation does not significantly impair the safety capability of these structures, systems, and components.

Basis:	The phrase "Commensurate with the safety-significance of the functions to be performed" allows NSRST SSCs to have capability targets less than DBHLs but

	sufficient for DID adequacy as assessed by the IDP. SR SSCs will have design requirements to protect against DBHLs as described in NEI 18-04 and NEI 21-07. The phrase "important to safety" is changed to "safety-significant" as described in the basis for PDC 1. Capability targets identified through the IDP will include the hazard levels under which SSCs must perform their RSFs and NSRST PSFs. Hazard analysis will drive special treatments through the NEI 18-04 IDP.
Source:	RG 1.232, Appendix C, Criterion 3

Title:	*4. Environmental and dynamic effects design bases*
Xe-100 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 commensurate with the safety-significance of the functions to be performed. These structures, systems, and components shall be appropriately protected commensurate with the safety-significance of the functions to be performed against dynamic effects, including the effects of missiles originating both inside and outside the reactor helium pressure boundary, 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 of the Xe-100 design uses the language of MHTGR-DC 4 of RG 1.232 with the following changes:

RG 1.232, Appendix C, Criterion 4	Xe-100 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 originating both inside and outside the reactor helium pressure boundary, pipe whipping, and discharging fluids, that may result from equipment failures andfrom 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 ~~postulated accidents~~ licensing basis events commensurate with the safety-significance of the functions to be performed. These structures, systems, and components shall be appropriately protected commensurate with the safety-significance of the functions to be performed against dynamic effects, including the effects of missiles originating both inside and outside the reactor helium pressure boundary, 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 phrase “Commensurate with the safety-significance of the functions to be performed” allows NSRST SSCs to have capability targets less than DBHLs but sufficient for DID adequacy as assessed by the IDP. SR SSCs will have design requirements to protect against DBHLs as described in NEI 18-04 and NEI 21-07. The phrase “important to safety” is changed to “safety-significant” as described in the basis for PDC 1. Capability targets identified through the IDP will include the hazard levels under which SSCs must perform their RSFs and NSRST PSFs. Hazard analysis will drive special treatments through the NEI 18-04 IDP.	
Source:	RG 1.232, Appendix C, Criterion 4	

<table>
<tr><td>Title:</td><td colspan="2">5. Sharing of structures, systems, and components</td></tr>
<tr><td>Xe-100 PDC RFDC</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 required safety functions, including, in the event of an accident in one unit, an orderly shutdown of the remaining units.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 5 of the Xe-100 design uses the language of MHTGR-DC 5 of RG 1.232 with the following changes:</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 5</td><td>Xe-100 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 <s>important to safety</s> 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 required safety functions, including, in the event of an accident in one unit, an orderly shutdown <s>and cooldown</s> of the remaining units.</td></tr>
<tr><td>Basis:</td><td colspan="2">Added “required” to “safety functions” to align with NEI 18-04 terminology.

Removed “and cooldown” to align with Appendix C of RG 1.232, in particular MHTGR-DC 26 “Reactivity Control Systems” and the column labeled “NRC Rationale for Adaptions to GDC.”

The phrase “important to safety” is changed to “safety-significant” as described in the basis for PDC 1.

Reliability targets for safety-significant systems will demonstrate that “sharing will not significantly impair their ability to perform their safety functions.”</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 5</td></tr>
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<table>
<tr><td>Title:</td><td colspan="2">6. Monitoring, Inspection, and Testing</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 6 of the Xe-100 design uses language from MHTGR-DCs 18, 32, 36, 37, 45, and 46 into a single PDC for monitoring, inspection, and testing.</td></tr>
<tr><td>RG 1.232, Appendix C</td><td>Xe-100 PDC 6</td></tr>
<tr><td>No generic monitoring inspection and testing PDC in RG 1.232.</td><td>Safety-significant structures, systems, and components shall be designed to permit appropriate monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td>Basis:</td><td colspan="2">Generic wording is used to support a single testing and inspection PDC for MHTGR-DC 18, 32, 36, 37, 45 and 46.

Monitoring, periodic inspection and/or testing will be established as special treatments in accordance with the NEI 18-04 IDP and will meet the functional performance intent of the MHTGR-DC.

The phrase “important to safety” is changed to “safety-significant” as described in the basis for PDC 1.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criteria 18, 32, 36, 37, 45, and 46</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">10. Reactor design</td></tr>
<tr><td>Xe-100 PDC
RFDC
CDC</td><td colspan="2">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></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 10 of the Xe-100 design uses the language of MHTGR-DC 10 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 10</td><td>Xe-100 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 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">No changes are proposed to the existing MHTGR-DC 10 language.

The Xe-100 reactor core and associated heat transport, control, and protection systems are designed with appropriate margin such that specified acceptable system radionuclide release design limits (SARRDLs) are not exceeded during any condition of normal operation, including the effects of AOOs. The SARRDL development and associated methodologies will be outlined in future reports.

The PDC accommodates RSF 1 Retain Radionuclides in Fuel Particles and Pebbles, and Safety-Significant PSF 1 Control Radionuclide Transport from the Primary Boundary.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 10</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">11. Reactor inherent protection</td></tr>
<tr><td>Xe-100 PDC RFDC</td><td colspan="2">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 will control heat generation and compensate for increase in reactivity.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 11 of the Xe-100 design uses the language of MHTGR-DC 11 of RG 1.232 with the following changes:</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 11</td><td>Xe-100 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 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~~ will control heat generation and compensate for a rapid increase in reactivity.</td></tr>
<tr><td>Basis:</td><td colspan="2">Modifications to MHTGR-DC 11 better reflect Xe-100 design and required safety functions.

The modified PDC accommodates RSF 1.1.1 Ensure Inherent Reactivity Feedback.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 11</td></tr>
</table>

Title:	*12. Suppression of reactor power oscillations*	
Xe-100 PDC RFDC	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.	
Position:	PDC 12 of the Xe-100 design uses the language of MHTGR-DC 12 of RG 1.232 with the following changes:	
	RG 1.232, Appendix C, Criterion 12	Xe-100 PDC 12
	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.	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~~.
Basis:	Modifications to MHTGR-DC 12 better reflect Xe-100 design and required safety functions. The Xe-100 reactor core and associated systems are designed to ensure that power oscillations causing SARRDL to be exceeded are not possible. The Xe-100 design has a negative temperature coefficient providing a means of reactivity control that dampens oscillations. The modified PDC accommodates RSF 1.1.1 Ensure Inherent Reactivity Feedback.	
Source:	RG 1.232, Appendix C, Criterion 12	

Title:	*13. Instrumentation and control*
Xe-100 PDC RFDC CDC	Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation and licensing basis events, as appropriate, to ensure functions that safety-significant structures, systems, and components perform are met, including those variables and systems that can affect the fission process and the integrity of the reactor core, reactor helium pressure boundary, and functional containment. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.
Position:	PDC 13 of the Xe-100 design uses the language of MHTGR-DC 13 of RG 1.232 with the following changes. **RG 1.232, Appendix C, Criterion 13:** 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 and the integrity of the reactor core, reactor helium pressure boundary, and functional containment. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges. **Xe-100 PDC 13:** Instrumentation shall be provided to monitor variables and systems over their anticipated ranges for normal operation~~, for anticipated operational occurrences, and for accident conditions~~ and licensing basis events, as appropriate, to ensure functions that ~~adequate~~ safety-significant structures, systems, and components perform are provided, including those variables and systems that can affect the fission process and the integrity of the reactor core, reactor helium pressure boundary, and functional containment. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.
Basis:	Changed “anticipated operational occurrences and accident conditions” to “licensing basis events” and changed “adequate safety” to “functions that safety-significant systems, structures, and components perform are provided” to align with the NEI 18-04 terminology. The modified PDC accommodates RSF 1.1.2 Support Inherent Reactivity Feedback by Removing Primary Heat Transport, RSF 1.1.3 Ensure Reactor Shutdown Capability, and RSF 1.3.1 Control Water/Steam Ingress from the SG. The modified PDC also accommodates Safety-Significant PSF 1 Control Radionuclide Transport from the Primary Boundary, PSF 2 Control reactivity with insertion of moveable poisons, PSF 3 Actively Remove Heat via forced circulation, and PSF 4 Prevent and Mitigate Steam Generator Tube Ruptures.
Source:	RG 1.232, Appendix C, Criterion 13

<table>
<tr><td>Title:</td><td colspan="2">14. Reactor helium pressure boundary</td></tr>
<tr><td>Xe-100 PDC RFDC</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 that may cause changes in core geometry.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 14 of the Xe-100 design uses the language of MHTGR-DC 14 of RG 1.232 with the following changes:</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 14</td><td>Xe-100 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 that may cause changes in core geometry.</td></tr>
<tr><td>Basis:</td><td colspan="2">Monitoring, periodic inspection and/or testing will be established as special treatments in accordance with the NEI 18-04 IDP and will meet the functional performance intent of the MHTGR-DC.

The modified PDC accommodates RSF 1.1.4 Maintain Geometry to Support Adequate Negative Reactivity, RSF 1.2.4 Maintain Geometry for Conduction and Radiation, RSF 1.3.1 Control Water/Steam Ingress from the SG, and RSF 1.3.2 Control Primary System Pressure.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 14</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">15. Reactor helium pressure boundary design</td></tr>
<tr><td>Xe-100 PDC CDC</td><td colspan="2">All systems that are part of the reactor helium pressure boundary 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 of the Xe-100 design uses the language of MHTGR-DC 15 of RG 1.232 with the following changes:</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 15</td><td>Xe-100 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 systems that are part of the reactor helium pressure boundary<s>, such as the reactor system, vessel system, and heat removal systems, and the associated auxiliary, control, and protection systems,</s> 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">Modifications to MHTGR-DC 15 removes references to structures, systems, and components that are not reflective of Xe-100 nomenclature and design of the Xe-100 helium pressure boundary.

The modified PDC accommodates Safety-Significant PSF 1 Control Radionuclide Transport from the Primary Boundary.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 15</td></tr>
</table>

<table>
<tr><td>Title:</td><td>16. Containment design</td></tr>
<tr><td>Xe-100 PDC RFDC</td><td>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 that are required to perform safety-significant functions are not exceeded for as long as licensing basis event conditions require.</td></tr>
<tr><td>Position:</td><td>PDC 16 of the Xe-100 design uses the language of MHTGR-DC 16 of RG 1.232 with the following changes:
<table>
<tr><td>RG 1.232, Appendix C, Criterion 16</td><td>Xe-100 PDC 16</td></tr>
<tr><td>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.</td><td>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 that are required to perform safety-significant functions <s>important to safety</s> are not exceeded for as long as licensing basis event <s>postulated accident</s> conditions require.</td></tr>
</table></td></tr>
<tr><td>Basis:</td><td>Changed “postulated accident” to “licensing basis event” to align with NEI 18-04 terminology. The phrase “control the release of radioactivity to the environment” will be demonstrated via the Frequency-Consequence Target described in NEI 18-04. The Retain Radionuclides in Fuel Particles and Pebbles RSF is identified as an RSF for all licensing basis events under the NEI 18-04 methodology.

The modified PDC accommodates RSF 1 Retain Radionuclides in Fuel Particles and Pebbles.

The phrase “important to safety” is changed to “safety-significant” as described in the basis for PDC 1.</td></tr>
<tr><td>Source:</td><td>RG 1.232, Appendix C, Criterion 16</td></tr>
</table>

Title:	*17. Electric power systems*
Xe-100 PDC CDC	Electric power systems shall be provided to permit functioning of safety-significant structures, systems, and components. Each power system shall provide sufficient capacity and capability commensurate with the safety significance of the functions to be performed to ensure 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.
Position:	PDC 17 of the Xe-100 design uses the language of MHTGR-DC 17 of RG 1.232 with the following changes:

RG 1.232, Appendix C, Criterion 17	Xe-100 PDC 17
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. 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.	Electric power systems shall be provided when required to permit functioning of safety-significant structures, systems, and components. ~~The safety function for each~~ Each power system shall ~~be to~~ provide sufficient capacity and capability commensurate with the safety significance of the functions to be performed 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.~~ ~~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.~~

Basis:	There are no risk-significant functions or required safety functions that rely on electrical power in the Xe-100 design. Portions of the MHTGR-DC that are applicable to the NSRST safety-significant functions that electric power supports are retained. Removed “An additional power system shall have sufficient independence and testability to perform its safety function” because the requirement for redundancy and independence is not needed to meet the safety-significant PSFs and testability is covered in PDC 6, which replaces PDC 18. The single failure criterion language is deleted consistent with the guidance in NEI 18-04 as endorsed by RG 1.233. The modified PDC accommodates Safety-Significant PSF 1 Control Radionuclide Transport from the Primary Boundary, PSF 2 Control reactivity with insertion of moveable poisons, PSF 3 Actively Remove Heat via forced circulation, and PSF 4 Prevent and Mitigate Steam Generator Tube Ruptures.
Source:	RG 1.232, Appendix C, Criterion 17

<table>
<tr><td>Title:</td><td colspan="2">18. Inspection and testing of electric power systems (replaced by Xe-100 PDC 6, Monitoring Inspection and Testing)</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 6 of the Xe-100 design uses language from MHTGR-DCs 18, 32, 36, 37, 45, and 46 into a single PDC for monitoring, inspection, and testing.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 18</td><td>Xe-100 PDC 6</td></tr>
<tr><td>Electric power systems important to safety shall be designed to permit appropriate periodic inspection and testing of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1) the operability and functional performance of the components of the systems, such as onsite power sources, relays, switches, and buses, and (2) the operability of the systems as a whole and, under conditions as close to design as practical, the full operation sequence that brings the systems into operation, including operation of applicable portions of the protection system, and the transfer of power among systems.</td><td>~~Electric power~~ Safety-significant structures, systems ~~important to safety~~, and components shall be designed to permit ~~appropriate~~ monitoring, periodic inspection and/or testing ~~of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components. The systems shall be designed with a capability to test periodically (1)~~ to ensure functional capability commensurate with the safety-significance of the functions to be performed. Functional testing shall ensure the operability and ~~functional~~ performance of the ~~systems, such as onsite power sources, relays, switches, and buses,~~ system components, and ~~(2)~~ the operability of the systems 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 ~~operation of applicable portions of the protection system, and the transfer of power among systems~~.</td></tr>
</table>

Basis:	Generic wording is used to support a single testing and inspection PDC for MHTGR-DC 18, 32, 36, 37, 45 and 46. The phrase "of important areas and features, such as wiring, insulation, connections, and switchboards, to assess the continuity of the systems and the condition of their components" is addressed by "functional capability" to be clearly defined as capability targets under NEI 18-04 through the IDP. Monitoring, periodic inspection and/or testing will be established as special treatments in accordance with the NEI 18-04 IDP and will meet the functional performance intent of the MHTGR-DC. The phrase "important to safety" is changed to "safety-significant" as described in the basis for PDC 1.
Source:	RG 1.232, Appendix C, Criterion 18

Title:	*19. Control room*
Xe-100 PDC CDC	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 anticipated operational occurrences and design basis events. Adequate radiation protection shall be provided to permit access and occupancy of the control room under anticipated operational occurrences and design basis events without personnel receiving radiation exposures in excess of 5 rem total effective dose equivalent as defined in § 50.2 for the duration of the anticipated operational occurrence or design basis event. Adequate habitability measures shall be provided to permit access and occupancy of the control room during normal operations and under anticipated operational occurrences and design basis events. Equipment at appropriate locations outside the control room shall be provided with a design capability for prompt safe shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe shutdown condition.
Position:	PDC 19 of the Xe-100 design uses the language of ARDC 19 of RG 1.232 with the following changes.

RG 1.232, Appendix C, Criterion 19	Xe-100 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	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 anticipated operational occurrences and design basis events ~~accident conditions~~. Adequate radiation protection shall be provided to permit access and occupancy of the control room under anticipated operational occurrences and design basis events ~~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 anticipated operational occurrence or design basis event ~~accident~~. Adequate habitability measures shall be provided to permit access and occupancy of the control room during normal operations and under anticipated operational occurrences and design basis events ~~accident conditions~~. Equipment at appropriate locations outside the control

	use of suitable procedures.	room shall be provided ~~(1)~~ with a design capability for prompt ~~hot~~ safe shutdown of the reactor, including any necessary instrumentation and controls to maintain the unit in a safe shutdown condition. ~~during hot shutdown, and (2) with a potential capability for subsequent cold safe shutdown of the reactor through the use of suitable procedures.~~
Basis:	Changed "hot shutdown" and "cold safe shutdown" to "safe shutdown" to align with Appendix C of RG 1.232, in particular MHTGR-DC 26 "Reactivity Control Systems" and the column labeled "NRC Rationale for Adaptions to GDC." Replaced "accident conditions" with "anticipated operational occurrences and design basis events," as the operators and control room equipment are not necessary to reach prompt safe shutdown conditions and do not perform any required safety functions. Added the word "any" to "including any necessary instrumentation and controls to maintain the unit in a safe shutdown condition" and deleted "through the use of suitable procedures" given that the only operator action outside of the control room is to support prompt safe shutdown of the reactor. The modified PDC accommodates Safety-Significant PSF 2 Control Reactivity with Insertion of Moveable Poisons and PSF 3 Actively Remove Heat via forced circulation.	
Source:	RG 1.232, Appendix C, Criterion 19	

<table>
<tr><td>Title:</td><td colspan="2">20. Protection system functions</td></tr>
<tr><td>Xe-100 PDC RFDC</td><td colspan="2">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 are not exceeded as a result of anticipated operational occurrences and (2) to sense conditions to initiate the operation of systems and components that are to perform required safety-significant functions.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 20 of the Xe-100 design uses the language of MHTGR-DC 20 with the following changes:</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion</td><td>Xe-100 PDC</td></tr>
<tr><td>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.</td><td>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 are not exceeded as a result of anticipated operational occurrences and (2) to sense ~~accident~~ conditions ~~and~~ to initiate the operation of systems and components to perform required safety functions ~~important to safety~~.</td></tr>
<tr><td>Basis:</td><td colspan="2">Deleted “accident” and added “to perform required safety functions” to clarify that the conditions that need to be sensed are those that support RSFs.

The modified PDC accommodates RSF 1.1 Control Reactivity, RSF 1.1.2 Support Inherent Reactivity Feedback by Removing Primary Heat Transport, RSF 1.1.3 Ensure Reactor Shutdown Capability, and RSF 1.3.1 Control Water/Steam Ingress from the SG.

For this PDC, the phrase “important to safety” is changed to “to perform required safety functions” because the protection system function accommodates the RSFs mentioned above.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 20</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">21. Protection system reliability and testability</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">The protection system shall be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) no single failure results in loss of the protection function and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 21 of the Xe-100 design uses the language of GDC 21 of RG 1.232 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 21</td><td>Xe-100 PDC 21</td></tr>
<tr><td>The protection system shall be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) no single failure results in loss of the protection function and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred.</td><td>The protection system shall be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) no single failure results in loss of the protection function and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. The protection system shall be designed to permit periodic testing of its functioning when the reactor is in operation, including a capability to test channels independently to determine failures and losses of redundancy that may have occurred.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 21 language.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 21</td></tr>
</table>

Title:	*22. Protection system independence*	
Xe-100 PDC	The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and design basis 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.	
Position:	PDC 22 of the Xe-100 design uses the language of MHTGR-DC 22 with minor changes.	
	RG 1.232, Appendix C, Criterion 22	Xe-100 PDC 22
	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.	The protection system shall be designed to assure that the effects of natural phenomena, and of normal operating, maintenance, testing, and design basis ~~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.
Basis:	Changed "postulated accident" to "design basis accident" to align with NEI 18-04 terminology.	
Source:	RG 1.232, Appendix C, Criterion 22	

<table>
<tr><td>Title:</td><td colspan="2">23. Protection system failure modes</td></tr>
<tr><td>Xe-100 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, pressure, steam, water, and radiation) are experienced.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 23 of the Xe-100 design uses the language of MHTGR-DC 23 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 23</td><td>Xe-100 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, 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, pressure, steam, water, and radiation) are experienced.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 23 language.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 23</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">24. Separation of protection and control systems</td></tr>
<tr><td>Xe-100 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 which 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 of the Xe-100 design uses the language of MHTGR-DC 24 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 24</td><td>Xe-100 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 which 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 which 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">No changes are proposed to the existing MHTGR-DC 24 language.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 24</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">25. Protection system requirements for reactivity control malfunctions</td></tr>
<tr><td>Xe-100 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 Xe-100 design uses the language of MHTGR-DC 25 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 25</td><td>Xe-100 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">No changes are proposed to the existing MHTGR-DC 25 language.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 25</td></tr>
</table>

Title:	*26. Reactivity control systems*
Xe-100 PDC CDC	A means which is independent and diverse from the required functional design criteria in Xe-100 principal design criteria 26, 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 and safe shutdown is achieved and maintained during normal operations, including anticipated operational occurrences. A means for holding the reactor shutdown under conditions that allow for interventions such as inspection and repair shall be provided.
Xe-100 PDC RFDC	At least two reactivity control systems or means shall insert 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 design basis events, beyond design basis events, and design basis accidents.
Position:	PDC 26 of the Xe-100 design covers the intent of MHTGR-DC 26 with an CDC and RFDC with minor changes:

RG 1.232, Appendix C, Criterion 26	Xe-100 PDC 26 CDC
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	~~(2)~~ A means which is independent and diverse from the required functional design criteria in Xe-100 principal design criteria 26 ~~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 and safe shutdown is achieved and maintained during normal operations, including anticipated operational occurrences. ~~(4)~~ A means for holding the reactor shutdown under conditions ~~which~~ that allow for interventions such as ~~fuel loading,~~ inspection and repair shall be provided.

	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 which allow for interventions such as fuel loading, inspection and repair shall be provided.	Xe-100 PDC 26 RFDC ~~A minimum of~~ At least two reactivity control systems or means shall ~~provide:~~ ~~A means of~~ insert~~ing~~ 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 design basis events, beyond design basis events, and design basis accidents ~~a postulated accident~~.
Basis:	This PDC was rearranged to categorize the design criteria into CDC and RFDC. Changed “postulated accident” to “design basis events, beyond design basis events, and design basis accidents” to align with NEI 18-04 terminology. The modified PDC accommodates RSF 1.1.1 Ensure Inherent Reactivity Feedback, RSF 1.1.3 Ensure Reactor Shutdown Capability, and Safety-Significant PSF 2 Control Reactivity with Insertion of Moveable Poisons.	
Source:	RG 1.232, Appendix C, Criterion 26	

<table>
<tr><td>Title:</td><td colspan="2">28. Reactivity limits</td></tr>
<tr><td>Xe-100 PDC
RFDC
CDC</td><td colspan="2">The reactor core, including 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 helium pressure boundary greater than limited local yielding, nor (2) sufficiently disturb the core, its support structures, or other reactor vessel internals to impair significantly the capability to cool the core.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 28 of the Xe-100 design uses the language of MHTGR-DC 28 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 28</td><td>Xe-100 PDC 28</td></tr>
<tr><td>The reactor core, including 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 helium pressure boundary greater than limited local yielding, nor (2) sufficiently disturb the core, its support structures, or other reactor vessel internals to impair significantly the capability to cool the core.</td><td>The reactor core, including 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 helium pressure boundary greater than limited local yielding, nor (2) sufficiently disturb the core, its support structures, or other reactor vessel internals to impair significantly the capability to cool the core.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 28 language.

The PDC accommodates RSF 1.1.1 Ensure Inherent Reactivity Feedback and RSF 1.1.3 Ensure Reactor Shutdown Capability, RSF 1.2.4 Maintain Geometry for Conduction and Radiation and Safety-Significant PSF 2 Control Reactivity with Insertion of Moveable Poisons</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 28</td></tr>
</table>

Title:	*29. Protection against anticipated operational occurrences*	
Xe-100 PDC	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.	
Position:	PDC 29 of the Xe-100 design uses the language of GDC 29 of RG 1.232 with no changes.	
	RG 1.232, Appendix C, Criterion 29	Xe-100 PDC 29
	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.	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.
Basis:	No changes are proposed to the existing MHTGR-DC 29 language. The phrase "assure an extremely high probability of accomplishing their safety functions" will be addressed in the reliability targets for the protection and reactivity control systems commensurate with the frequency and consequences associated with the Xe-100 AOOs.	
Source:	RG 1.232, Appendix C, Criterion 29	

<table>
<tr><td>Title:</td><td colspan="2">30. Quality of reactor helium pressure boundary</td></tr>
<tr><td>Xe-100 PDC
RFDC
CDC</td><td colspan="2">Components that are part of the reactor helium pressure boundary shall be designed, fabricated, erected, and tested to quality standards commensurate with the safety significance of the functions to be performed. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor helium leakage. Means shall be provided for detecting ingress of moisture, air, secondary coolant, or other fluids to within the reactor helium pressure boundary.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 30 of the Xe-100 design uses the language of MHTGR-DC 30 with minor changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 30</td><td>Xe-100 PDC 30</td></tr>
<tr><td>Components that are part of the reactor helium pressure boundary shall be designed, fabricated, erected, and tested to the highest quality standards practical. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor helium leakage. Means shall be provided for detecting ingress of moisture, air, secondary coolant, or other fluids to within the reactor helium pressure boundary.</td><td>Components that are part of the reactor helium pressure boundary shall be designed, fabricated, erected, and tested to <s>the highest</s> quality standards commensurate with the safety significance of the functions to be performed <s>practical</s>. Means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor helium leakage. Means shall be provided for detecting ingress of moisture, air, secondary coolant, or other fluids to within the reactor helium pressure boundary.</td></tr>
<tr><td>Basis:</td><td colspan="2">Deleted “the highest” and “practical” and added “commensurate with the safety significance of the functions to be performed” because this PDC accommodates both RSFs and Safety-Significant PSFs. As such, quality standards should be graded commensurate with the safety significance of the functions to be performed.

Designed, fabricated, erected, and tested to the quality standards will be established as special treatments in accordance with the NEI 18-04 IDP and will meet the functional performance intent of the MHTGR-DC 30.

The PDC accommodates RSF 1.3, Control Water/Steam Ingress.

The PDC also accommodates Safety-Significant PSF 1 Control Radionuclide Transport from Primary Boundary and PSF 4 Prevent and Mitigate Steam Generator Tube Ruptures.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 30</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">31. Fracture prevention of reactor helium pressure boundary</td></tr>
<tr><td>Xe-100 PDC
RFDC
CDC</td><td colspan="2">The reactor helium pressure boundary shall be designed with sufficient margin to ensure that, when stressed under operating, maintenance, testing, and postulated accident conditions, (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures, service degradation of material properties, creep, fatigue, stress rupture, and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation and helium composition, including contaminants and reaction products, on material properties, (3) residual, steady-state, and transient stresses, and (4) size of flaws.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 31 of the Xe-100 design uses the language of MHTGR-DC 31 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 31</td><td>Xe-100 PDC 31</td></tr>
<tr><td>The reactor helium pressure boundary shall be designed with sufficient margin to ensure that, when stressed under operating, maintenance, testing, and postulated accident conditions, (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures, service degradation of material properties, creep, fatigue, stress rupture, and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation and helium composition, including contaminants and reaction products, on material properties, (3) residual, steady--state, and transient stresses, and (4) size of flaws.</td><td>The reactor helium pressure boundary shall be designed with sufficient margin to ensure that, when stressed under operating, maintenance, testing, and postulated accident conditions, (1) the boundary behaves in a nonbrittle manner and (2) the probability of rapidly propagating fracture is minimized. The design shall reflect consideration of service temperatures, service degradation of material properties, creep, fatigue, stress rupture, and other conditions of the boundary material under operating, maintenance, testing, and postulated accident conditions and the uncertainties in determining (1) material properties, (2) the effects of irradiation and helium composition, including contaminants and reaction products, on material properties, (3) residual, steady-state, and transient stresses, and (4) size of flaws.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 31 language.

Appropriate capability targets, reliability targets, and special treatments will be established in accordance with the NEI 18-04 IDP and will meet the functional performance intent of the MHTGR-DC 31.

The PDC accommodates RSF 1.3, Control Water/Steam Ingress.

The PDC also accommodates Safety-Significant PSF 1 Control Radionuclide Transport</td></tr>
</table>

	from Primary Boundary and PSF 4 Prevent and Mitigate Steam Generator Tube Ruptures.
Source:	RG 1.232, Appendix C, Criterion 31

Title:	*32. Inspection of reactor helium pressure boundary (replaced by Xe-100 PDC 6, Monitoring Inspection and Testing)*	
Xe-100 PDC	Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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 Xe-100 design covers the intent of MHTGR-DC 32 of RG 1.232 by meeting the special treatment criteria in line with RG 1.233 guidance.	
	RG 1.232, Appendix C, Criterion 32	Xe-100 PDC 6
	Components that are part of the reactor helium pressure boundary shall be designed to permit (1) periodic inspection and functional testing of important areas and features to assess their structural and leak-tight integrity, and (2) an appropriate material surveillance program for the reactor vessel.	Safety-significant structures, systems, and components ~~that are part of the reactor helium pressure boundary~~ shall be designed to permit ~~(1)~~ monitoring, periodic inspection and/or ~~functional~~ testing ~~of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor vessel.~~ 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 testing and inspection PDC for MHTGR-DC 18, 32, 36, 37, 45 and 46. The phrase "of important areas and features to assess their structural and leak-tight integrity, and (2) an appropriate material surveillance program for the reactor vessel" is addressed by "functional capability" to be clearly defined as capability targets under NEI 18-04 through the IDP. Monitoring, periodic inspection and/or testing will be established as special treatments in accordance with the NEI 18-04 IDP.	

Source:	RG 1.232, Appendix C, Criterion 32

<table>
<tr><td>Title:</td><td colspan="2">34. Residual heat removal</td></tr>
<tr><td>Xe-100 PDC RFDC</td><td colspan="2">A passive system to remove residual heat shall be provided. During postulated accidents, the passive system required 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 required safety function can be accomplished in such a manner that acceptable fuel, core components, reactor pressure vessel, and reactor building temperature limits are not exceeded.</td></tr>
<tr><td>Xe-100 PDC CDC</td><td colspan="2">For normal operations and anticipated operational occurrences, a safety-significant 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.</td></tr>
<tr><td>Position:</td><td colspan="2">PDC 34 of the Xe-100 design covers the intent of MHTGR-DC 34 with an RFDC and CDC.</td></tr>
<tr><td></td><td>RG 1.232, Appendix C, Criterion 34</td><td>Xe-100 PDC 34 RFDC</td></tr>
<tr><td></td><td>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.</td><td>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 passive 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.~~ in such a manner that acceptable fuel, core components, reactor pressure vessel, and reactor building temperature limits are not exceeded.</td></tr>
</table>

	RG 1.232, Appendix C, Criterion 34	Xe-100 PDC 34 CDC
	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 passive system to remove residual heat shall be provided.~~ For normal operations and anticipated operational occurrences, ~~the~~ a safety-significant function shall be to transfer fission product decay heat and other residual heat from the reactor core to a~~n 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.~~
Basis:	The title of this PDC was changed from “Passive residual heat removal” to “Residual heat removal” given the passive heat removal capability is tied to the RFDC and the active heat removal capability is tied to the CDC. The MHTGR-DC wording was split into a safety-related RFDC for DBEs, BDBEs and DBAs with a non-safety related but safety-significant CDC for normal operations and AOOs. In line with the DID guidelines from NEI 18-04, challenges to SR SSCs should be minimized during normal operation and AOOs. The single failure criterion language is deleted consistent with the guidance in NEI 18-04 as endorsed by RG 1.233. Reliability targets will be set for safety significant SSCs and special treatments will be applied to ensure those reliability targets are met in line with NEI 18-04 and RG 1.233. The PDC-RFDC accommodates RSF 1.2, Control Heat Removal. The stated RFDC “fuel performance limits” are considered the same as the previous used “fuel design limits” discussed in the PDC 10 NRC rationale in RG 1.232. The PDC-RFDC also accommodates RSF 1.2.1, Transfer Heat from Fuel to Vessel Wall, RSF 1.2.2, Radiate Heat from Vessel Wall, RSF 1.2.3, Transfer Heat from Vessel Wall to Ultimate Heat Sink, and RSF 1.2.4, Maintain Geometry for Conduction and Radiation. The PDC-CDC accommodates Safety-Significant PSF 3, Actively Remove Heat via	

	forced circulation
Source:	RG 1.232, Appendix C, Criterion 34

<table>
<tr><td>Title:</td><td colspan="2">36. Inspection of passive residual heat removal system (replaced by Xe-100 PDC 6, Monitoring Inspection and Testing)</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 6 of the Xe-100 design covers the intent of MHTGR-DC 36 of RG 1.232 by meeting the special treatment criteria in line with the RG 1.233 guidance.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 36</td><td>Xe-100 PDC 6</td></tr>
<tr><td>The passive residual heat removal system shall be designed to permit appropriate periodic inspection of important components to ensure the integrity and capability of the system.</td><td>~~The passive residual heat removal~~ Safety-significant structures, systems, and components shall be designed to permit ~~appropriate~~ monitoring, periodic inspection ~~of important components to ensure the integrity and capability of the system.~~ and/or testing 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.</td></tr>
<tr><td>Basis:</td><td colspan="2">Generic wording is used to support a single testing and inspection PDC for MHTGR-DC 18, 32, 36, 37, 45 and 46.

“Integrity and capability” will be addressed by functional capability to be clearly defined as capability targets under NEI 18-04 through the IDP. Monitoring, periodic inspection and/or testing will be established as special treatments in accordance with the NEI 18-04 IDP.

The passive heat removal system provides the capability to perform periodic pressure and functional testing that along with online monitoring ensures operability and performance of system components and the operability and performance of the system as a whole.</td></tr>
</table>

Source:	RG 1.232, Appendix C, Criterion 36

<table>
<tr><td>Title:</td><td colspan="2">37. Testing of passive residual heat removal system (replaced by Xe-100 PDC 6, Monitoring Inspection and Testing)</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 6 of the Xe-100 design covers the intent of MHTGR-DC 37 of RG 1.232 by meeting the special treatment criteria in line with the RG 1.233 guidance.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 37</td><td>Xe-100 PDC 6</td></tr>
<tr><td>The passive residual heat removal system shall be designed to permit appropriate periodic functional testing to ensure (1) the structural and leaktight integrity of its components, (2) the operability and performance of the system components, and (3) 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 AOO or postulated accident decay heat removal to the ultimate heat sink and, if applicable, any system(s) necessary to transition from active normal operation to passive mode.</td><td>~~The passive residual heat removal~~ Safety-significant structures, systems, and components shall be designed to permit ~~appropriate~~ monitoring, periodic inspection and/or functional testing to ensure ~~(1) the structural and leaktight integrity of its components, (2)~~ 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 ~~(3)~~ 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 ~~AOO or postulated accident decay heat removal to the ultimate heat sink and, if applicable, any system(s) necessary to transition from active normal operation to passive mode.~~ licensing basis events.</td></tr>
<tr><td>Basis:</td><td colspan="2">Generic wording is used to support a single testing and inspection PDC for MHTGR-DC 18, 32, 36, 37, 45 and 46.

The passive heat removal system provides the capability to perform periodic pressure and functional testing that along with online monitoring ensures operability and performance of system components and the operability and performance of the system as a whole.

“(1) the structural and leaktight integrity of its components, (2)” and “AOO or</td></tr>
</table>

	postulated accident decay heat removal to the ultimate heat sink and, if applicable, any system(s) necessary to transition from active normal operation to passive mode." are covered by functional capability to be clearly defined as capability targets under NEI 18-04 through the IDP. Monitoring, periodic inspection and/or testing will be established as special treatments in accordance with the NEI 18-04 IDP.
Source:	RG 1.232, Appendix C, Criterion 37

Title:	*44. Structural and equipment cooling*	
Xe-100 PDC CDC	In addition to the heat rejection capability of the passive residual heat removal system, systems to transfer heat from safety-significant structures, systems, and components to a heat sink shall be provided, as necessary, to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions.	
Position:	PDC 34 of the Xe-100 design covers the intent of MHTGR-DC 44 of RG 1.232 for the RFDC by providing adequate cooling for structures supporting the RSFs. PDC 44 is retained as a CDC since safety-significant, but not risk-significant, systems require cooling not covered by PDC 34.	
	RG 1.232, Appendix C, Criterion 44	Xe-100 PDC
	In addition to the heat rejection capability of the passive residual heat removal system, systems to transfer heat from structures, systems, and components important to safety to an ultimate heat sink shall be provided, as necessary, to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to ensure that the system safety function can be accomplished, assuming a single failure.	In addition to the heat rejection capability of the passive residual heat removal system, systems to transfer heat from ~~important to safety~~ safety-significant structures, systems, and components to a heat sink shall be provided, as necessary, to transfer the combined heat load of these structures, systems, and components under normal operating and accident conditions. ~~Suitable redundancy in components and features and suitable interconnections, leak detection, and isolation capabilities shall be provided to ensure that the system safety function can be accomplished, assuming a single failure.~~
Basis:	As the reactor cavity cooling system (RCCS) provides indefinite core cooling capability (see PDC #34), structural and equipment cooling systems are only required for DID adequacy. The single failure criterion language is deleted consistent with the guidance in NEI 18-04 as endorsed by RG 1.233. Reliability targets will be set for safety significant SSCs and special treatments will be applied to ensure those reliability targets are met in line with NEI 18-04 and RG 1.233. The PDC-CDC accommodates Safety-Significant PSF 3, Actively Remove Heat via forced circulation. The phrase “important to safety” is changed to “safety-significant” as described in the basis for PDC 1.	
Source:	RG 1.232, Appendix C, Criterion 44	

<table>
<tr><td>Title:</td><td colspan="2">45. Inspection of structural and equipment cooling systems (replaced by Xe-100 PDC 6, Monitoring Inspection and Testing)</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 6 of the Xe-100 design covers the intent of ARDC 45 of RG 1.232 by meeting the special treatment criteria in line with the RG 1.233 guidance.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 45</td><td>Xe-100 PDC 6</td></tr>
<tr><td>The structural and equipment cooling systems shall be designed to permit appropriate periodic inspection of important components, such as heat exchangers and piping, to assure the integrity and capability of the systems.</td><td>Safety-significant structures, ~~The structural and equipment cooling~~ systems, and components shall be designed to permit ~~appropriate~~ monitoring, periodic inspection ~~of important components, such as heat exchangers and piping, to assure the integrity and capability of the systems.~~ and/or testing 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.</td></tr>
<tr><td>Basis:</td><td colspan="2">The passive heat removal system provides indefinite core cooling capability (see PDC 34), therefore PDC 44 is only required for DID cooling and the testing and inspection of equipment to support PDC 44 will be special treatments for those NSRST SSCs. PDC 6 covers the intent of MHTGR-DC 36 and 37 for structural cooling to support RSFs as well as MHTGR-DC 45 and 46 for structural cooling to support safety-significant PSFs.

Monitoring, periodic inspection and/or testing of SSC cooling to support safety-significant active cooling will be established as special treatments in accordance with the NEI 18-04 IDP.</td></tr>
</table>

Source:	RG 1.232, Appendix C, Criterion 45

<table>
<tr><td>Title:</td><td>46. Testing of structural and equipment cooling systems (replaced by Xe-100 PDC 6, Monitoring Inspection and Testing)</td></tr>
<tr><td>Xe-100 PDC</td><td>Safety-significant structures, systems, and components shall be designed to permit monitoring, periodic inspection and/or testing 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.</td></tr>
<tr><td>Position:</td><td>PDC 6 of the Xe-100 design covers the intent of ARDC 46 of RG 1.232 by meeting the special treatment criteria in line with the RG 1.233 guidance.
<table>
<tr><td>RG 1.232, Appendix C, Criterion 46</td><td>Xe-100 PDC 6</td></tr>
<tr><td>The structural and equipment cooling systems shall be designed to permit appropriate periodic functional testing to assure (1) the structural and leaktight integrity of their components, (2) the operability and the performance of the system components, and (3) the operability of the systems as a whole and, under conditions as close to design as practical, the performance of the full operational sequences that bring the systems into operation for reactor shutdown and postulated accidents, including operation of associated systems.</td><td>~~The structural and equipment cooling~~ Safety-significant structures, systems, and components shall be designed to permit ~~appropriate~~ monitoring, periodic inspection and/or testing to ~~as~~ensure ~~(1) the structural and leaktight integrity of their components, (2)~~ functional capability commensurate with the safety significance of the functions to be performed. ~~f~~Functional testing shall ensure the operability and ~~the~~ performance of the system components, and ~~(3)~~ the operability of the system~~s~~ as a whole and, under conditions as close to design as practical, the performance of the full operational sequence that brings the system~~s~~ into operation ~~for reactor shutdown and postulated accidents,~~ including ~~operation of~~ associated systems, for licensing basis events.</td></tr>
</table></td></tr>
<tr><td>Basis:</td><td>The passive heat removal system provides indefinite core cooling capability (see PDC 34), therefore PDC 44 is only required for DID cooling and the testing and inspection of equipment to support PDC 44 will be special treatments for those NSRST SSCs. PDC 6 covers the intent of MHTGRDC 36 and 37 for structural cooling to support RSFs as well as MHTGRDC 45 and 46 for structural cooling to support safety-significant PSFs.

Monitoring, periodic inspection and/or testing of SSC cooling to support safety-significant active cooling will be established as special treatments in accordance with the NEI 18-04 IDP.</td></tr>
</table>

Source:	RG 1.232, Appendix C, Criterion 46

Title:	*60. Control of releases of radioactive materials to the environment*	
Xe-100 PDC	The nuclear power unit design shall include means to control suitably 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.	
Position:	PDC 60 of the Xe-100 design uses the language of GDC 60 of RG 1.232 with no changes.	
	RG 1.232, Appendix C, Criterion 60	Xe-100 PDC 60
	The nuclear power unit design shall include means to control suitably 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.	The nuclear power unit design shall include means to control suitably 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.
Basis:	No changes are proposed to the existing GDC 60 language.	
Source:	RG 1.232, Appendix C, Criterion 60	

<table>
<tr><td>Title:</td><td colspan="2">61. Fuel storage and handling and radioactivity control</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">The fuel storage and handling, radioactive waste, and other systems which 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 that are required to perform safety-significant functions, (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) to prevent significant reduction in fuel storage cooling under postulated accident conditions.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 61 of the Xe-100 design uses the language of ARDC 61 of RG 1.232 with the following changes:</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 61</td><td>Xe-100 PDC 61</td></tr>
<tr><td>The fuel storage and handling, radioactive waste, and other systems which 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.</td><td>The fuel storage and handling, radioactive waste, and other systems which 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 that are required to perform safety-significant functions ~~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 safety-significance ~~importance to safety~~ of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage cooling under postulated accident conditions.</td></tr>
<tr><td>Basis:</td><td colspan="2">The phrases “important to safety” are changed to “safety-significance” and “that are required to perform safety-significant functions” as described in the basis for PDC 1.

Added “postulated” at the end of the PDC to remain consistent with the use of the phrase “postulated accident conditions” in the first sentence of the PDC.</td></tr>
</table>

Source:	RG 1.232, Appendix C, Criterion 61

<table>
<tr><td>Title:</td><td colspan="2">62. Prevention of criticality in fuel storage and handling</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Criticality in the fuel storage and handling system 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 of the Xe-100 design uses the language of GDC 62 of RG 1.232 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 62</td><td>Xe-100 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 shall be prevented by physical systems or processes, preferably by use of geometrically safe configurations.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing GDC 62 language.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 62</td></tr>
</table>

Title:	*63. Monitoring fuel and waste storage*	
Xe-100 PDC	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.	
Position:	PDC 63 of the Xe-100 design uses the language of GDC 63 of RG 1.232 with no changes.	
	RG 1.232, Appendix C, Criterion 63	Xe-100 PDC 63
	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.	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.
Basis:	No changes are proposed to the existing GDC 63 language.	
Source:	RG 1.232, Appendix C, Criterion 63	

<table>
<tr><td>Title:</td><td colspan="2">64. Monitoring radioactivity releases</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">Means shall be provided for monitoring the reactor building 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></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 64 of the Xe-100 design uses the language of MHTGR-DC 64 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 64</td><td>Xe-100 PDC 64</td></tr>
<tr><td>Means shall be provided for monitoring the reactor building 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 building 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></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing GDC 64 language.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 64</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">70. Reactor vessel and reactor system structural design basis</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">The design of the reactor vessel and reactor system shall be such that their integrity is maintained during postulated accidents (1) to ensure the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and (2) to permit sufficient insertion of the neutron absorbers to provide for reactor shutdown.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 70 of the Xe-100 design uses the language of MHTGR-DC 70 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 70</td><td>Xe-100 PDC 70</td></tr>
<tr><td>The design of the reactor vessel and reactor system shall be such that their integrity is maintained during postulated accidents (1) to ensure the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and (2) to permit sufficient insertion of the neutron absorbers to provide for reactor shutdown.</td><td>The design of the reactor vessel and reactor system shall be such that their integrity is maintained during postulated accidents (1) to ensure the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and (2) to permit sufficient insertion of the neutron absorbers to provide for reactor shutdown.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 70 language.

PDC 70 accommodates RSF 1.1.4, Maintain Geometry to Support Adequate Negative Reactivity, and RSF 1.2.4, Maintain Geometry for Conduction and Radiation.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 70</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">71. Reactor building design basis</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">The design of the reactor building shall be such that, during postulated accidents, it structurally protects the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and provides a pathway for the release of reactor helium from the building in the event of depressurization accidents.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 71 of the Xe-100 design uses the language of MHTGR-DC 71 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 71</td><td>Xe-100 PDC 71</td></tr>
<tr><td>The design of the reactor building shall be such that, during postulated accidents, it structurally protects the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and provides a pathway for the release of reactor helium from the building in the event of depressurization accidents.</td><td>The design of the reactor building shall be such that, during postulated accidents, it structurally protects the geometry for passive removal of residual heat from the reactor core to the ultimate heat sink and provides a pathway for the release of reactor helium from the building in the event of depressurization accidents.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 71 language.

PDC 71 accommodates RSF 1.2.4, Maintain Geometry for Conduction and Radiation.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 71</td></tr>
</table>

<table>
<tr><td>Title:</td><td colspan="2">72. Provisions for periodic reactor building inspection</td></tr>
<tr><td>Xe-100 PDC</td><td colspan="2">The reactor building shall be designed to permit (1) appropriate periodic inspection of all important structural areas and the depressurization pathway, and (2) an appropriate surveillance program.</td></tr>
<tr><td rowspan="3">Position:</td><td colspan="2">PDC 72 of the Xe-100 design uses the language of MHTGR-DC 72 with no changes.</td></tr>
<tr><td>RG 1.232, Appendix C, Criterion 72</td><td>Xe-100 PDC 72</td></tr>
<tr><td>The reactor building shall be designed to permit (1) appropriate periodic inspection of all important structural areas and the depressurization pathway, and (2) an appropriate surveillance program.</td><td>The reactor building shall be designed to permit (1) appropriate periodic inspection of all important structural areas and the depressurization pathway, and (2) an appropriate surveillance program.</td></tr>
<tr><td>Basis:</td><td colspan="2">No changes are proposed to the existing MHTGR-DC 72 language.

Monitoring, periodic inspection and/or testing will be identified as special treatments through the NEI 18-04 IDP.</td></tr>
<tr><td>Source:</td><td colspan="2">RG 1.232, Appendix C, Criterion 72</td></tr>
</table>