



# NRC Meeting on the Development of Xe-100 Principal Design Criteria

*U.S. Licensing Team*

April 27, 2022



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# Purpose and Objectives

- Purpose:
  - Support the Xe-100 design and licensing basis approach regarding Principal Design Criteria (PDC)
- Objectives:
  - Describe the Xe-100 iterative approach to developing PDC using:
    - Modular High-Temperature Gas-cooled Reactor Design Criteria (MHTGR-DC) from RG 1.232, Appendix C and NEI 18-04 and
    - NEI 21-07 guidance (Required Functional Design Criteria (RFDC) and Complementary Design Criteria (CDC))
  - Receive feedback from the NRC on the Xe-100 approach



# General Approach to Xe-100 PDC

- Current sources of Xe-100 functional requirements (i.e., design criteria)
  - MHTGR-DC from Appendix C of RG 1.232
  - NEI 18-04/NEI 21-07 RFDC (for SR SSCs) and CDC (for NSRST SSCs)
- Current approach:
  - Edit the MHTGR-DC for consistency with the Xe-100 design
  - Use the edited MHTGR-DC to revise the current Xe-100 RFDC and CDC
- Potential outcomes:
  - The RFDC and CDC are necessary and sufficient to perform the Required Safety Functions (RSFs) and PRA Safety Functions (PSFs)
  - The updated Xe-100 RFDC and CDC do not align well with the current set of RSFs and PSFs and thus require additional:
    - distilling and/or synthesis
    - RSFs and/or PSFs to effectively categorize the design criteria



# Consolidating MHTGR-DC for “Monitoring, Inspection and Testing”

## Changes from MHTGR-DC to Xe-100 PDC

- Combined 7 MHTGR-DC into one Xe-100 PDC
- Covers inspection and testing PDC 18, 32, 36, 37, 45, 46 and 72 for electric power, helium pressure boundary (HPB), passive residual heat removal (RCCS), structural and equipment cooling (NICWS), and reactor building (RB)
- Covers all other safety-significant SSC testing and inspection
- Added monitoring because it is credited for ensuring functional capability under ASME Section XI Division 2, Reliability and Integrity Management (RIM)

## Rationale

- Regardless of PDC wording these PDC will be met by inspection and testing requirements identified as special treatment by the Integrated Decision-making Process (IDP) following NEI 18-04 guidance
- Wording of proposed PDC covers all MHTGR-DC listed above and the testing and inspection requirements implicit in functional PDC for other MHTGR-DC, RFDC & CDC



# MHTGR-DC 18 “Inspection and testing of electric power systems”

Title:	18. Monitoring, Inspection and Testing
Xe-100 PDC 18	<p><b>Safety significant structures, systems, and components</b> shall be designed to permit appropriate <b>monitoring</b>, periodic inspection and testing <b>to ensure functional capability commensurate with the safety-significance of the functions to be performed</b>. <b>Functional testing shall ensure</b> 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 <b>associated systems, for LBEs</b>.</p>
RG 1.232, App C, Criterion 18:	<p><del>Electric power systems important to safety</del> shall be designed to permit appropriate periodic inspection and testing <del>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)</del> the operability and functional performance of the components of the systems, <del>such as onsite power sources, relays, switches, and buses, and (2)</del> 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 <del>operation of applicable portions of the protection system, and the transfer of power among systems</del>.</p>



# Other Testing & Inspection MHTGR-DC

Title:	18. Monitoring, Inspection and Testing
<b>Xe-100 PDC</b>	Safety significant structures, systems, and components shall be designed to permit appropriate monitoring, periodic inspection and 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 LBEs.
<b>RG 1.232, App C, Criterion 32:</b>	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 leaktight integrity, and (2) an appropriate material surveillance program for the reactor vessel.
<b>RG 1.232, App C, Criterion 36:</b>	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.
<b>RG 1.232, App C, Criterion 37:</b>	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.



# Other Testing & Inspection MHTGR-DC

Title:	18. Monitoring, Inspection and Testing
<b>Xe-100 PDC</b>	Safety significant structures, systems, and components shall be designed to permit appropriate monitoring, periodic inspection and 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 LBEs.
<b>RG 1.232, App C, Criterion 45:</b>	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.
<b>RG 1.232, App C, Criterion 46:</b>	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.
<b>RG 1.232, App C, Criterion 72:</b>	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.





# Xe-100 PDC for Normal Operations and LBEs

## Changes from MHTGR-DC to Xe-100 PDC

- Separate the PDC associated with normal operations from the PDC focused on LBEs because:
  - NEI 21-07 does not consider normal operations in scope
  - Design criteria for normal operations are needed to meet regulations
- Normal operations are part of the following MHTGR-DC:
  - 4, 10, 13, 15, 19, 20, 26, 34, 37, and 64
- Xe-100 PDC to support normal operations will be identified, however Chapter 5 of a NEI 21-07 structured PSAR may not be the appropriate location

## Rationale

- Aligned with the Part 53 effort to decouple requirements for normal operation from those for LBEs



## Next Steps

- Continue to develop the Xe-100 PDC by editing the MHTGR-DC and revising the associated RFDC and CDC
- Continue to draft a PDC Licensing Topical Report for NRC review and feedback



# Questions

