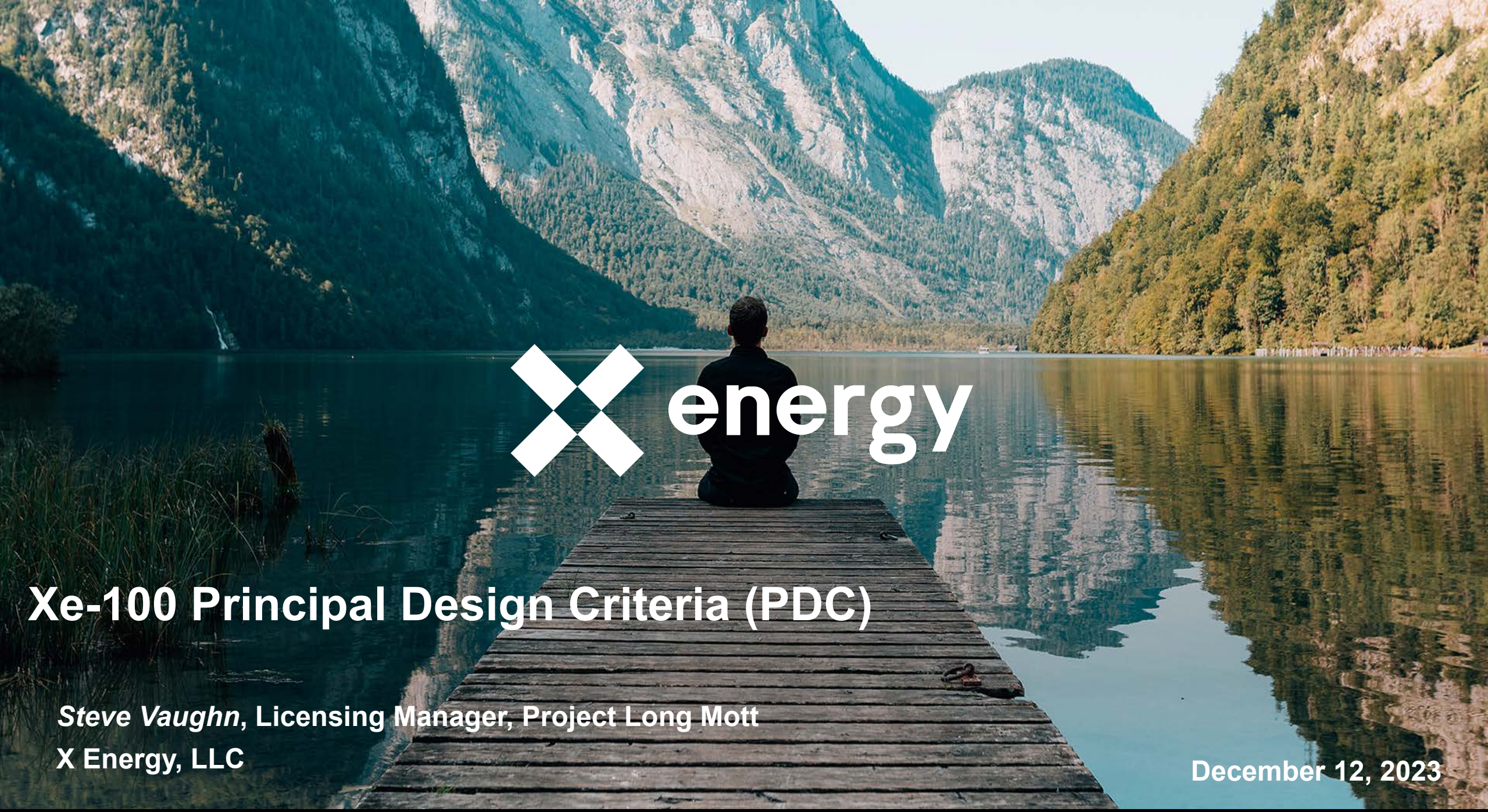

Xe-100 Principal Design Criteria (PDC)

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December 12, 2023

Department of Energy Acknowledgement and Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0009040.

Agenda & Objectives

Agenda:

- Introductions/Opening Remarks
- Background and Context
- Outside the Scope of PDC and Design Bases
  - Beyond Design Basis Events (BDBEs)
  - Normal Operations and NST SSCs
- Relation of PDC 1 “Quality Standards and Records” to PDC 14 “Reactor Helium Pressure Boundary”
- Questions/Closing Remarks

Objectives:

- Ensure the NRC staff preliminary questions regarding Revision 2 of the Xe-100 PDC Licensing Topical Report (LTR) are fully understood
- Accurately communicate the X-energy responses to the NRC staff preliminary questions
- Achieve a common understanding of the two main topics:
  - BDBEs and Normal Operations/NST SSCs are Outside the Scope of PDC and Design Bases
  - Relation of PDC 1 “Quality Assurance” to PDC 14 “Reactor Helium Pressure Boundary”

Background and Context

- The Xe-100 PDC LTR is developed based on the following:
  - RG 1.232 “Guidance for Developing Principal Design Criteria for Non-LWRs”
  - NEI 21-07 and DG-1404
  - X-energy implementation of NEI 18-04
- Revision 2 of the Xe-100 PDC LTR is currently under review by the NRC staff
- X-energy is in the process of drafting a Revision 3 of the Xe-100 PDC LTR and intends to address the NRC staff clarification questions on Revision 2

Background and Context

- The regulatory requirement to provide PDC is in 10 CFR 50.34(a) *Preliminary safety analysis report,* which states:
  - "Each application for a construction permit shall include a preliminary safety analysis report. The minimum information to be included shall consist of the following:"
  - A portion of the "minimum information to be included" is provided by 50.34(a)(3), which states "The preliminary design of the facility including:"
    - 50.34(a)(3)(i) – "The principal design criteria for the facility"
    - 50.34(a)(3)(ii) – "The design bases and the relation of the design bases to the principal design criteria"

Background and Context

- NEI 21-07, Section 5.3 “Principal Design Criteria” notes that:
  - “*…applicants could choose to specify a narrower set of PDC than discussed above, but that a reduced scope approach may require an exemption*.”
  - This reduced scope was described in a 12/14/2021 TICAP Public Meeting (ML21344A006) and was based on language in the Atomic Energy Act (AEA) Section 182 as:
    - “The principal design criteria establish the necessary design, fabrication, construction, testing and performance requirements for structures, systems, and components important to safety”
  - This reduced scope was then refined slightly and written in NEI 21-07, Section 5.3 as:
    - “PDC establish the necessary design, fabrication, construction, testing and performance requirements for safety significant SSCs”
- X-energy does not intend to reduce the scope of Xe-100 PDC as described above, and as such, does not intend to pursue an exemption from 50.34(a)(3)

Outside the Scope of PDC and Design Bases

BDBEs

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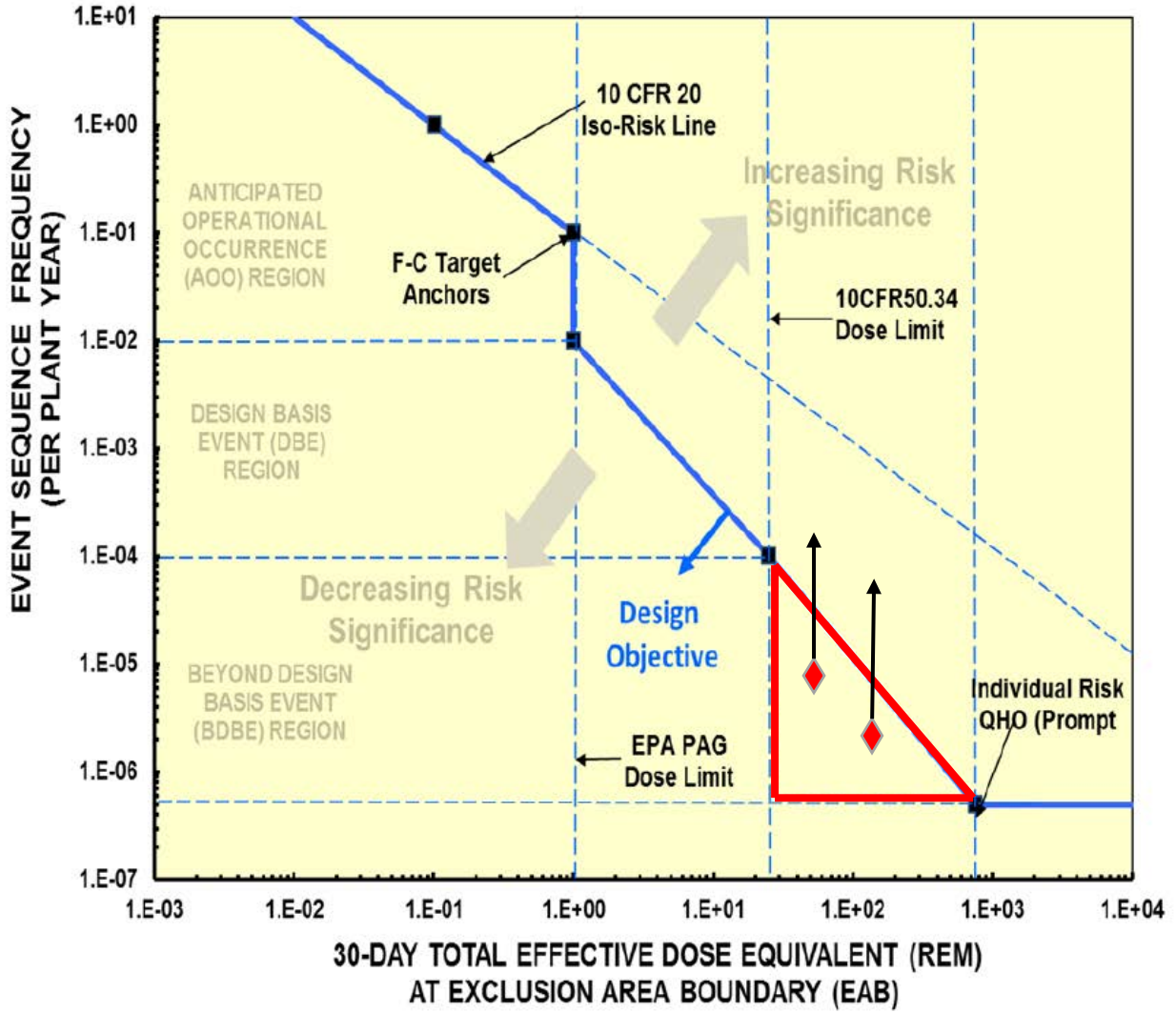
Beyond Design Basis Events (BDBEs)

- Xe-100 PDC that are categorized as required functional design criteria (RFDC) are designated as PDC-RFDC
- Xe-100 PDC-RFDC describe the functional design criteria and associated limits/conditions in response to design basis events (DBEs) and design basis accidents (DBAs)
  - RFDC flow down to safety-related design criteria (SRDC)
- The NEI 18-04 definitions of DBEs and DBAs effectively replace the terms “postulated accident” and “accident conditions” used in General Design Criteria (GDC) and the Advanced Reactor Design Criteria (ARDC) from RG 1.232

Beyond Design Basis Events (BDBEs)

- High consequence BDBEs (not all BDBEs) are an input to the selection of safety-related (SR) SSCs
  - If there are not any high consequence BDBEs, then the only inputs to SR SSC design bases would be DBEs and DBAs
  - Currently, the Xe-100 design does not have any high consequence BDBEs



Outside the Scope of PDC and Design Bases

Normal Ops & NST SSCs

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Normal Operations and NST SSCs

- The NEI 18-04 methodology is founded on and structured around licensing basis events (LBEs) as the driver to iterate the design and associated analyses, identification of RSFs and NSRST/NST PSFs, SSC classification, identification of special treatments, and a defense-in-depth (DID) adequacy evaluation
- Table 3-1 "Definitions of Licensing Basis Events" in NEI 18-04 describes the change in terminology

Event Type	Current Definition or Common Use	Guidance Document Definition
Anticipated Operational Occurrences (AOOs)	*"Conditions of normal operation that are expected to occur one or more times during the life of the nuclear power unit and include but are not limited to loss of power to all recirculation pumps, tripping of the turbine generator set, isolation of the main condenser, and loss of all offsite power."** [SRP 15.0 and 10 CFR 50 Appendix A]	Anticipated event sequences expected to occur one or more times during the life of a nuclear power plant, which may include one or more reactor modules. Event sequences with mean frequencies of 1×10^{-2}/plant-year and greater are classified as AOOs. AOOs take into account the expected response of all SSCs within the plant, regardless of safety classification.
Design Basis Events (DBEs)	*"Conditions of normal operation, including AOOs, design-basis accidents, external events, and natural phenomena, for which the plant must be designed to ensure functions of safety-related electric equipment that ensures the integrity of the reactor coolant pressure boundary; the capability to shut down the reactor and maintain it in a safe shutdown condition; or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures."* [SRP 15.0]	Infrequent event sequences that are not expected to occur in the life of a nuclear power plant, which may include one or more reactor modules, but are less likely than AOOs. Event sequences with mean frequencies of 1×10^{-4}/plant-year to 1×10^{-2}/plant-year are classified as DBEs. DBEs take into account the expected response of all SSCs within the plant regardless of safety classification.

Normal Operations and NST SSCs

- NST SSCs that perform NST PRA safety functions (PSFs) are not necessary to support the DID adequacy evaluation, as such, NST SSCs:
  - Are not described in Chapter 6 (SR SSCs) nor Chapter 7 (NSRST SSCs)
  - Are described at a high-level in Chapter 1 (General Plant and Site Description) and in Chapter 4 (Integrated Evaluations) in the Layers of Defense Evaluation (Layer 1 “Prevent off-normal operations and AOOs”)
- Safety-significant SSCs are those SSCs classified as either SR or NSRST
- NEI 21-07, Section 5.3, states “PDC establish the necessary design, fabrication, construction, testing and performance requirements for safety significant SSCs”

Normal Operations and NST SSCs

- NEI 18-04, Section 4.1:
  - Task 6 describes, “For those SSCs classified as NST, the reliability and capability targets are part of the non-regulatory owner design requirements”
  - Task 7 describes, “…owner design requirements for NST-classified SSCs.”
- Design criteria associated with NST SSCs needed a term similar to those defined in NEI 21-07 for SR SSCs (RFDC) and NSRST SSCs (CDC). As such, the term Owner Controlled Design Criteria (OCDC) was defined in the Xe-100 PDC LTR.
  - OCDC - Design-specific design criteria that are necessary and sufficient to meet the NST PSFs.

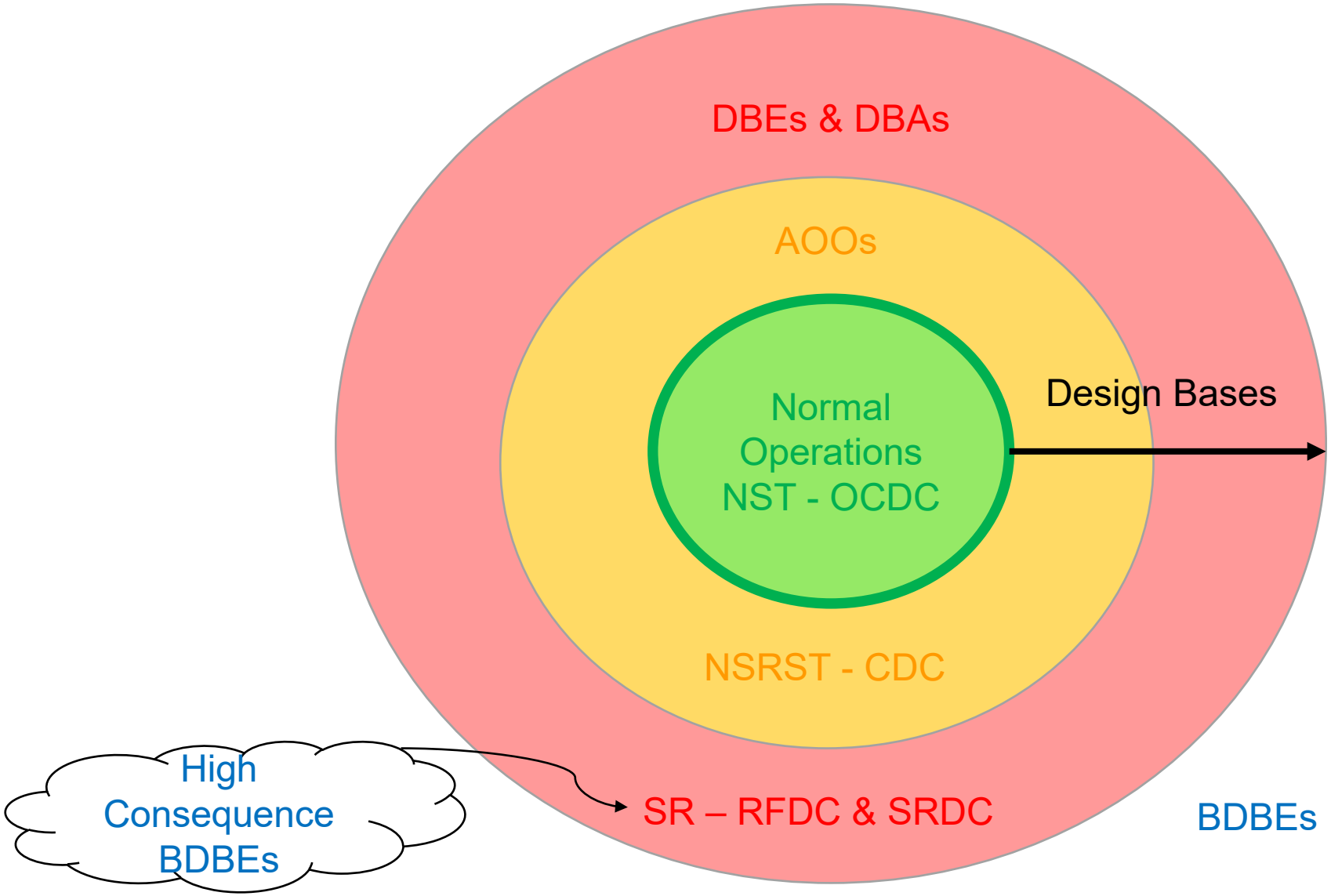
Normal Operations and NST SSCs

- Because NST SSCs:
  - Support maintaining the plant within the normal operating envelope
  - Are not relied on for DID adequacy
  - Do not require special treatments beyond normal industrial practices
  - Design criteria are “non-regulatory owner design requirements”
- It follows that, the design of NST SSCs are not in scope of the plant *design bases* as defined in 10 CFR 50.2 and clarified in NEI 97-04 “Design Bases Program Guidelines” and NEI 97-04 Appendix B as endorsed by RG 1.186

Normal Operations and NST SSCs

- One of the challenges with combing the RG 1.232 and NEI 18-04 paradigms is:
  - Many GDC and ARDC combine “normal operations and AOOs”
  - Grouping “normal operations and AOOs” as a single group is problematic when following the NEI 18-04 process given that normal operations in not an LBE and an AOO is an LBE
- Recall that:
  - Safety-significant SSCs are those SSCs classified as either SR or NSRST
  - NEI 21-07, Section 5.3, states “PDC establish the necessary design, fabrication, construction, testing and performance requirements for safety significant SSCs”
- It follows that the scope of PDC is there to support the development of design and performance requirements (i.e., design bases) for the safety significant SSCs

SSC, Design Criteria, and LBE Relational Diagram



Relation of PDC 1 to PDC 14

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PDC 1 Relation to PDC 14

- PDC 1 “ *Quality standards and records*” states:
  - “Safety-significant structures, systems, and components shall be designed, fabricated, constructed, and tested to quality standards commensurate with the safety significance of the functions to be performed…”
  - Applies to SR and NSRST SSCs and is a graded approach to quality assurance
- PDC 14 “*Reactor helium pressure boundary*” states:
  - “The reactor helium pressure boundary shall be designed to have an extremely low probability of abnormal leakage and unacceptable moisture ingress.”
  - The terms “fabricated” and “erected” were removed from the ARDC because those activities:
    - Are not design criteria
    - Are addressed from a quality assurance perspective in PDC 1
  - The term “testing” was removed because PDC 6 “*Monitoring, inspection, testing, and surveillance*” covers the testing of safety-significant SSCs

PDC 1 Relation to PDC 14

- PDC 14 “*Reactor helium pressure boundary*”
  - The phrases “extremely low probability of abnormal leakage” and “unacceptable moisture ingress” are reliability targets
- PDC-CDC 15 “*Reactor helium pressure boundary design*”, PDC-RFDC 30 and PDC-CDC 30 “*Integrity of reactor helium pressure boundary*”, and PDC-31 “*Fracture prevention of reactor helium pressure boundary*” may obviate the need for the current PDC 14

Questions & Closing Remarks