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Licensing Review Framework for Advanced Reactors Instrumentation and Controls (I&C) Workshop

February 23, 2023

Introduction and Requests for Workshops on I&C Design Review Guide (DRG) Implementation

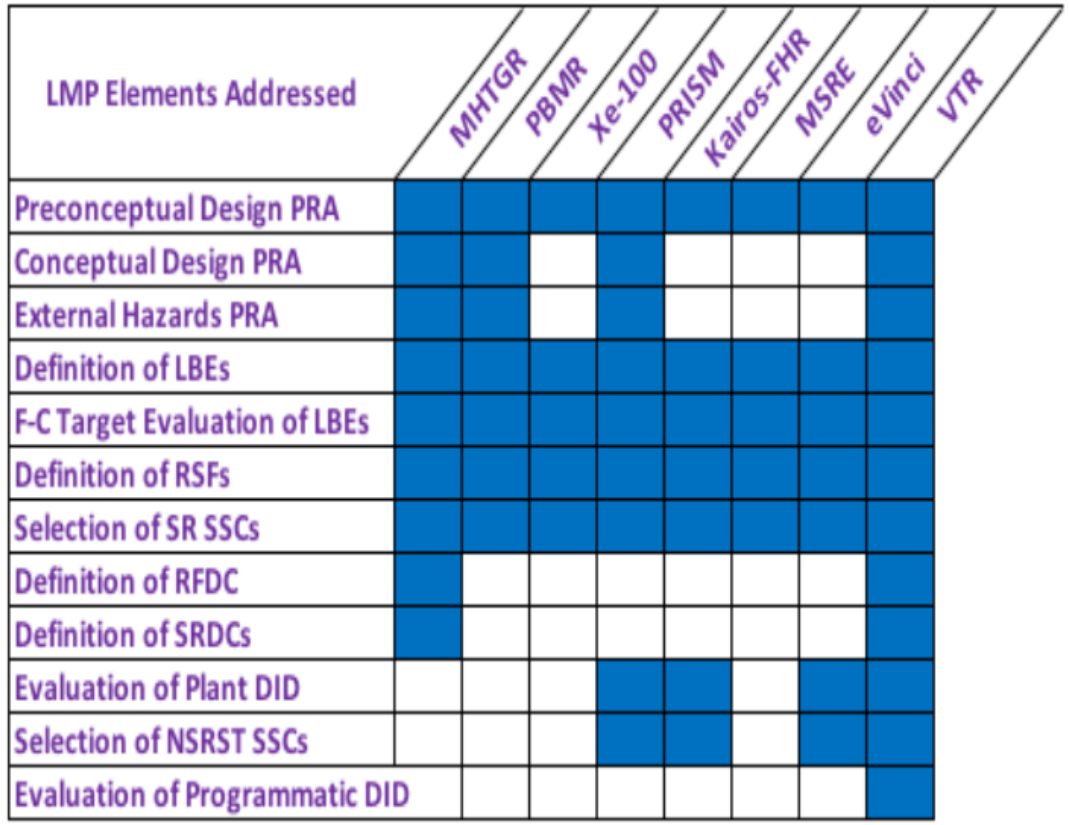
- Final I&C Design Review Guide (DRG) issued in February 2021 (ML21011A140) for I&C design reviews by NRC staff
- NRC staff reviews / pre-application engagements underway for a variety of potential LWR and non-LWR I&C designs
- NRC staff engaged by industry interested in the background and details on the DRG—and relationship to NEI documents

Workshop Agenda

- Overview of recent and ongoing initiatives:
  - Licensing Modernization Project (LMP) and RG 1.233
  - Technology-Inclusive Content of Application Project (TICAP)
  - Advanced Reactor Content of Application Project (ARCAP)
- Overview of I&C DRG
  - Focus on safety-significant SSCs; Use of reliability / capability targets
  - Developed for non-LWRs, but can be used for all reactor designs
- Specific industry perspectives and potential challenges

LMP Methodology Approach

- Foundations laid in MHTGR, PBMR, and NGNP projects and incorporates NRC and ACRS reviews on key topics
  - Technology-inclusive risk metrics
  - Use of frequency-consequence targets
  - Functional containment concept
  - Treatment of multi-module plants
  - Reliability targets in lieu of single failure criterion
  - Technology-inclusive approach to defense-in-depth
- Incorporates developments in risk-informed, performance-based decision making for wide spectrum of non-LWR designs

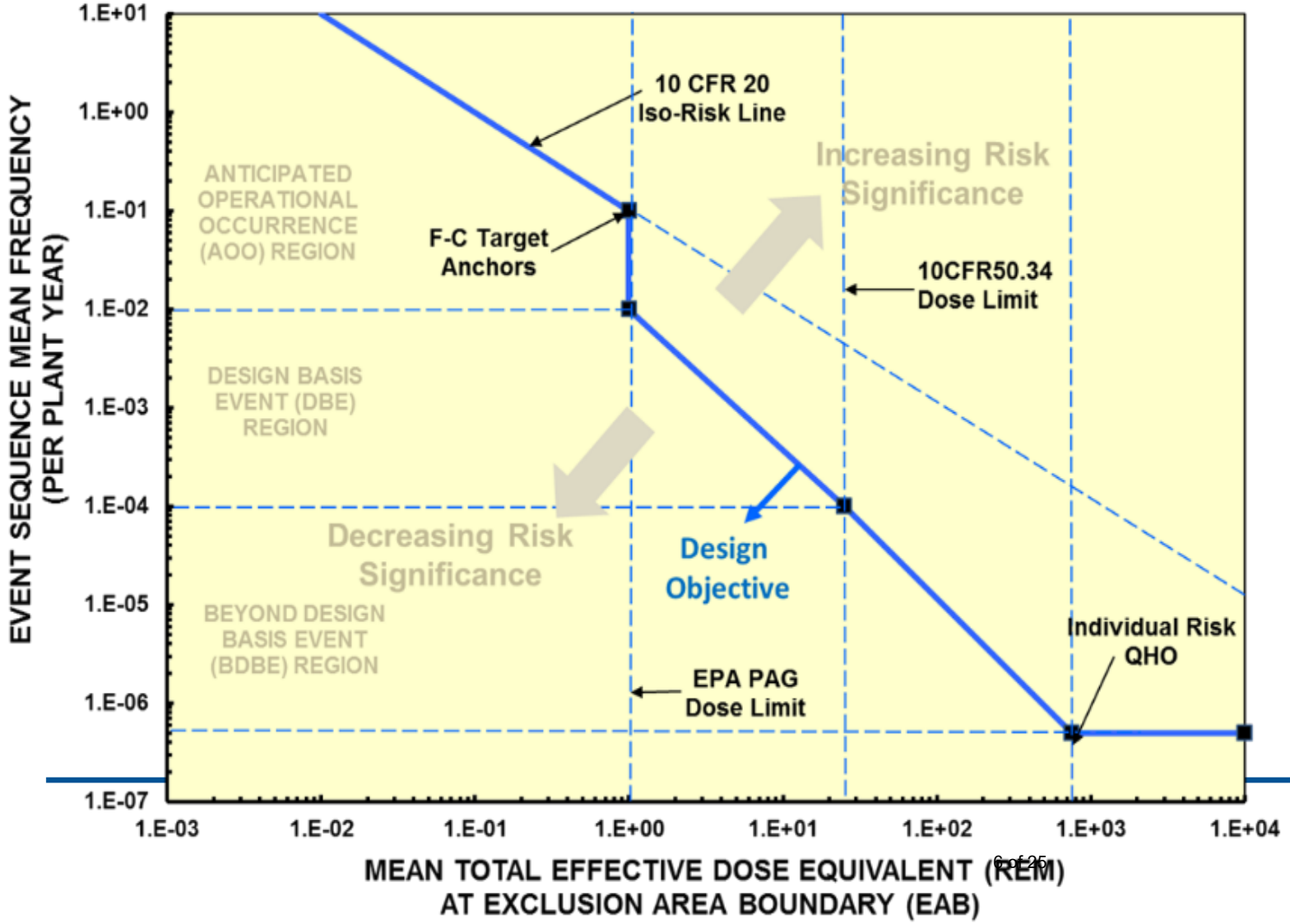


LMP is Risk-Informed and Performance-Based

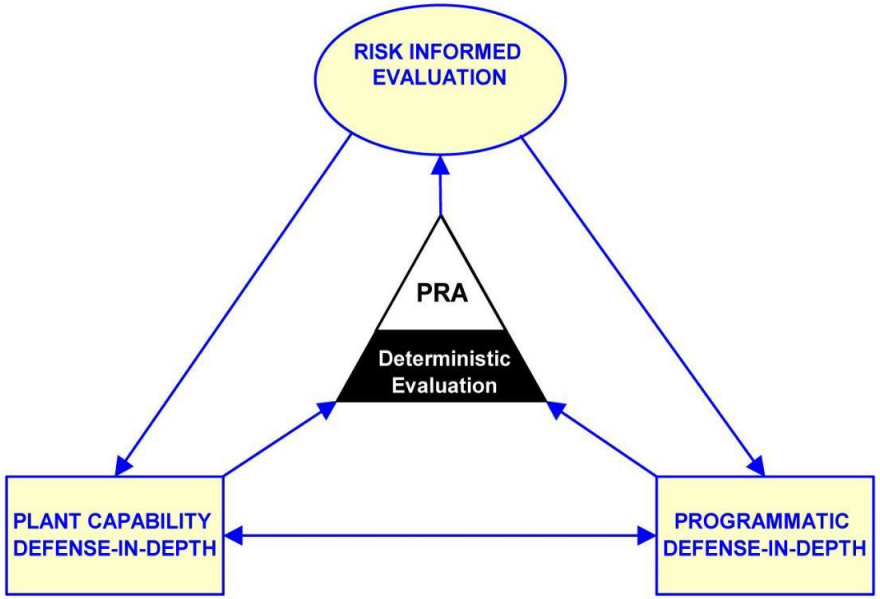
- Risk-informed
  - Incorporating key inputs from a PRA
  - Incorporating deterministic principles such as evaluation of defense-in-depth adequacy
- Performance-based
  - Use of a **Frequency Consequence (F-C) Target** and **Cumulative Risk Targets** to evaluate the risk significance of licensing basis events (LBEs) and structures, systems, and components (SSCs)
  - Selection of performance targets for the reliability and capability of SSCs in the prevention and mitigation of LBEs
  - Use of programs to monitor the performance of the plant and SSCs against the performance targets
- Use of an **Integrated Decision-Making Process** to implement RIPB decisions that impact the safety case and its objective evaluation

Licensing Modernization Project (LMP)

(NEI 18-04 and RG 1.233)



- Licensing Basis Events
- SSC Classification
- Defense-in-Depth



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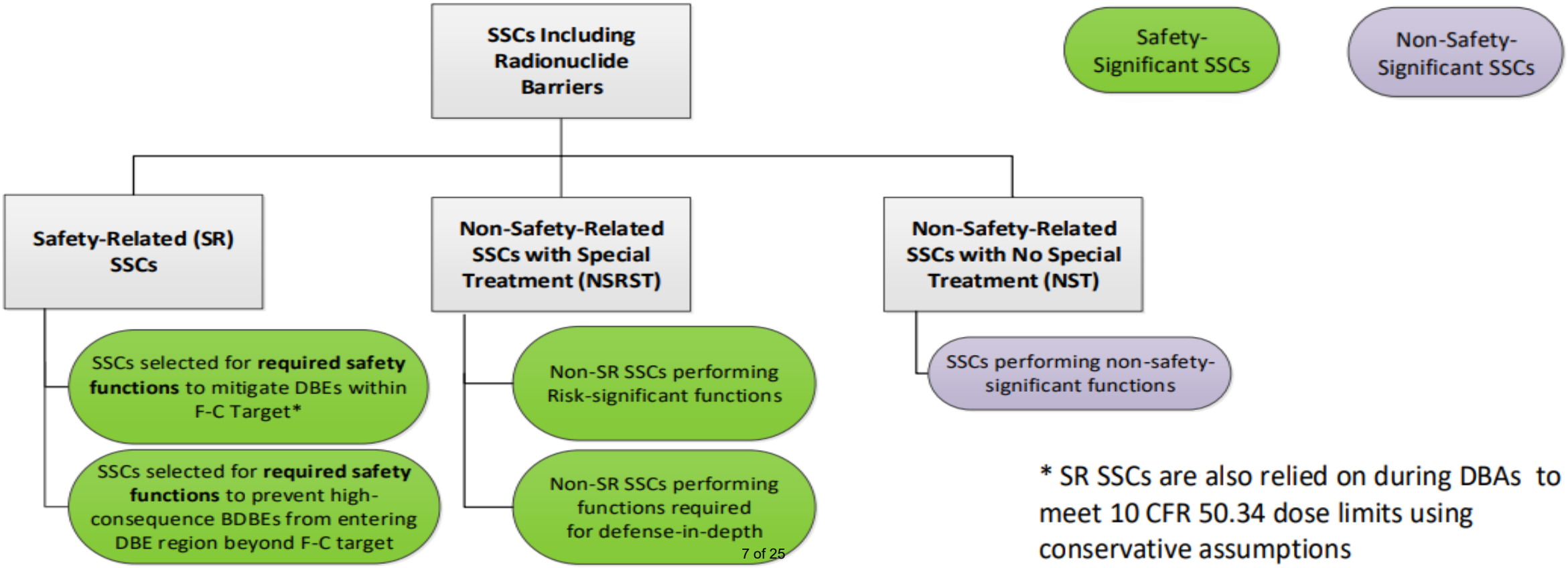
LMP SSC Classifications



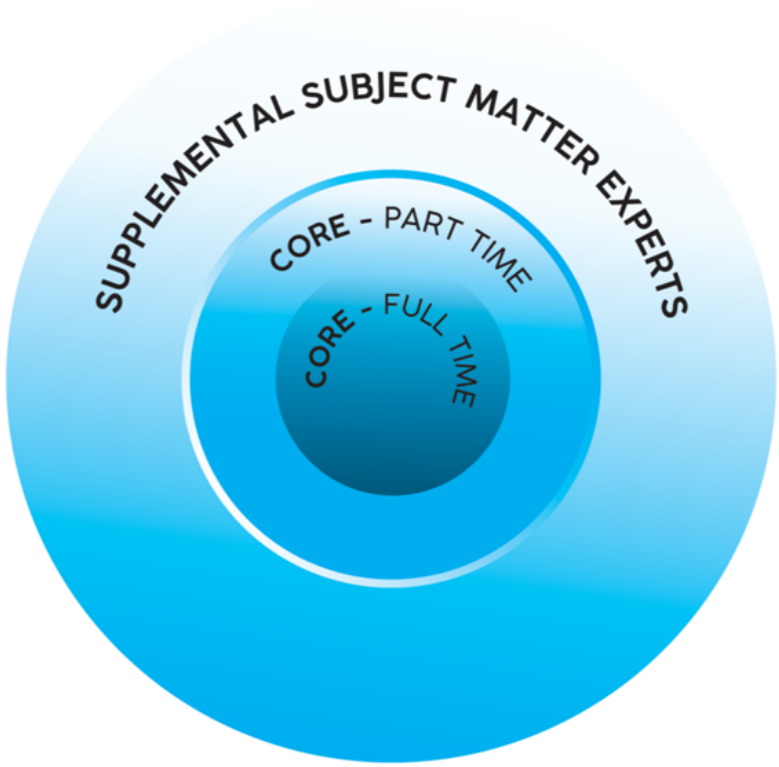
* SR SSCs are also relied on during DBAs to meet 10 CFR 50.34 dose limits using conservative assumptions

Derivation of Special Treatments

- SR SSCs
  - Functional Design Criteria derived from required safety functions
  - Lower level design criteria derived from safety-related design criteria (SRDC)
- SR and NSRST SSCs
  - SSC reliability and capability performance targets
  - Focus on prevention and mitigation functions from LBEs
  - Integrated decision-making process (IDP) to derive specific special treatments
  - Reflects Commission's expectations for RIPB regulation (SRM-SECY-98-0144)

Core Review Team Approach

- Non-LWR Review Strategy – successfully implementing for non-LWR preapplication and application reviews
- Multi-disciplinary core review team supported by subject matter experts from various offices
- Focus on the Fundamental Safety Functions
- Perform an integrated design review
- Demonstrate compliance with applicable regulations



Content of Applications - Overview

Content of Applications Projects

- **Technology-Inclusive Content of Applications Project (TICAP) (NEI 21-07)**
  - LMP process is used to define guidance for the content of major portions of the Safety Analysis Report (SAR)
    - Risk-informed, performance-based approach to select LBEs, develop SSC classification, identify special treatments for SSCs, and ensure DID adequacy
  - Industry developed TICAP guidance for key portions of the SAR for NRC endorsement
  - Industry TICAP guidance will be supplemented by NRC staff-developed guidance, as necessary
- **Advanced Reactor Content of Applications Project (ARCAP) (DG-1404 + 9 ISGs)**
  - Covers guidance for non-LWR applications under 10 CFR Part 50 and Part 52
  - Encompasses TICAP guidance, provides supplemental and additional guidance for SAR content, and covers application content guidance for areas that go beyond SAR

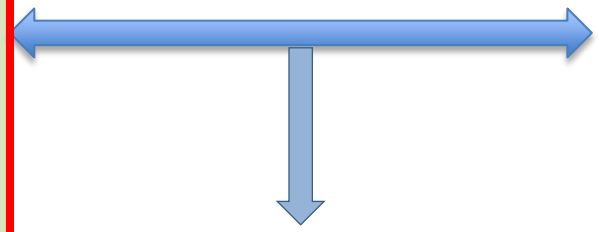
ARCAP and TICAP – Nexus

Outline Safety Analysis Report (SAR) – Based on TICAP Guidance

1. General Plant Information, Site Description, and Overview of the Safety Case
2. Methodologies and Analyses and Site Information*
3. Licensing Basis Event (LBE) Analysis
4. Integrated Evaluations
5. Safety Functions, Design Criteria, and SSC Safety Classification
6. Safety Related SSC Criteria and Capabilities
7. Non-safety related with special treatment SSC Criteria and Capabilities
8. Plant Programs

Additional SAR Content –Outside the Scope of TICAP

9. Control of Routine Plant Radioactive Effluents, Plant Contamination, and Solid Waste
10. Control of Occupational Doses
11. Organization and Human-System Considerations
12. Post-construction Inspection, Testing and Analysis Programs



Audit/inspection of Applicant Records

- Calculations
- Analyses
- P&IDs
- System Descriptions
- Design Drawings
- Design Specifications
- Procurement Specifications
- Probabilistic Risk Assessment

Additional Portions of Application

- Technical Specifications
- Technical Requirements Manual
- Quality Assurance Plan (design)
- Fire Protection Program (design)
- Quality Assurance Plan (construction and operations)
- Emergency Plan
- Physical Security Plan
- SNM physical protection program
- SNM material control and accounting plan
- Cyber Security Plan
- Fire Protection Program (operational)
- Radiation Protection Program
- Offsite Dose Calculation Manual
- Inservice inspection/Inservice testing (ISI/IST) Program
- Environmental Report
- Site Redress Plan
- Exemptions, Departures, and Variances
- Facility Safety Program (under consideration for Part 53 applications)
- Fitness for Duty Program
- Financial Qualification and Insurance
- Aircraft Impact Assessment

* SAR Chapter 2 derived from TICAP guidance as supplemented by ARCAP ISG Chapter 2, "Site Information"

- SAR structure based on clean sheet approach
- Additional contents of application outside of SAR are still under discussion. The above list is draft and for illustration purposes only.

ARCAP – High Level Overview

- ARCAP Roadmap ISG
  - Proposes a 12-chapter SAR guidance structure
  - Guidance for first 8 SAR chapters references the TICAP guidance
  - Chapters 9, 10, 11, and 12 point to individual ISGs developed for each SAR chapter
  - Includes pointers to draft white papers, guidance under development or to be developed for portions of the application outside the SAR
    - Examples of guidance that the staff has developed: TS, Risk Informed ISI/IST, and Fire Protection for Operations
    - Examples of high-level guidance embedded in the Roadmap ISG: Technical Requirements Manual, Quality Assurance Plan, Fire Protection (design), and Offsite Dose Calculation Model
    - Examples of guidance being considered: security, emergency planning, material control and accountability, financial qualification and cyber security

ARCAP – High Level Overview

- ARCAP Roadmap ISG (continued)
  - Includes several appendices:
    - Appendix A on preapplication engagement guidance
      - Based on white paper discussed extensively during advanced reactor public stakeholder meetings
      - To capture the white paper guidance in a durable product that will have the benefit of a formal public comment period
    - Appendix B on Analysis of Applicability of NRC Regulations to non-LWRs
      - Based on white paper discussed extensively during advanced reactor public stakeholder meetings (ADAMS Accession No. ML21175A287)
      - Purpose of Appendix B is to capture the white paper guidance in a durable product that will have the benefit of a formal public comment period

ARCAP – High Level Overview

- ARCAP Roadmap ISG (continued)
  - Includes several appendices (continued):
    - Appendix C on CP guidance
      - Common portions applicable to both LWRs and non-LWRs quoted from DNRL-ISG-2022-01
      - Detailed CP guidance specific to non-LWRs
    - Appendix D on ARCAP guidance documents currently under development
- **April 2023 – DG-1404 (endorsing NEI 21-07) and 9 ARCAP ISGs expected to be published for public comment**

Evolution of I&C Review Guidance

ADAMS Accession No. ML21011A140

- **NUREG-0800, Standard Review Plan (SRP) Chapter 7**
  - System-based approach for light-water reactor (LWR) licensing reviews
  - Guidance not suitable for non-LWRs applications
- **NuScale Design-Specific Review Standard (DSRS) Chapter 7**
  - Improved safety-focused licensing review approach
  - Improved licensing review's efficiency and effectiveness
- **DRG for I&C**
  - Leverages the DSRS concepts
  - Leverages lessons learned from recent new reactor I&C licensing reviews

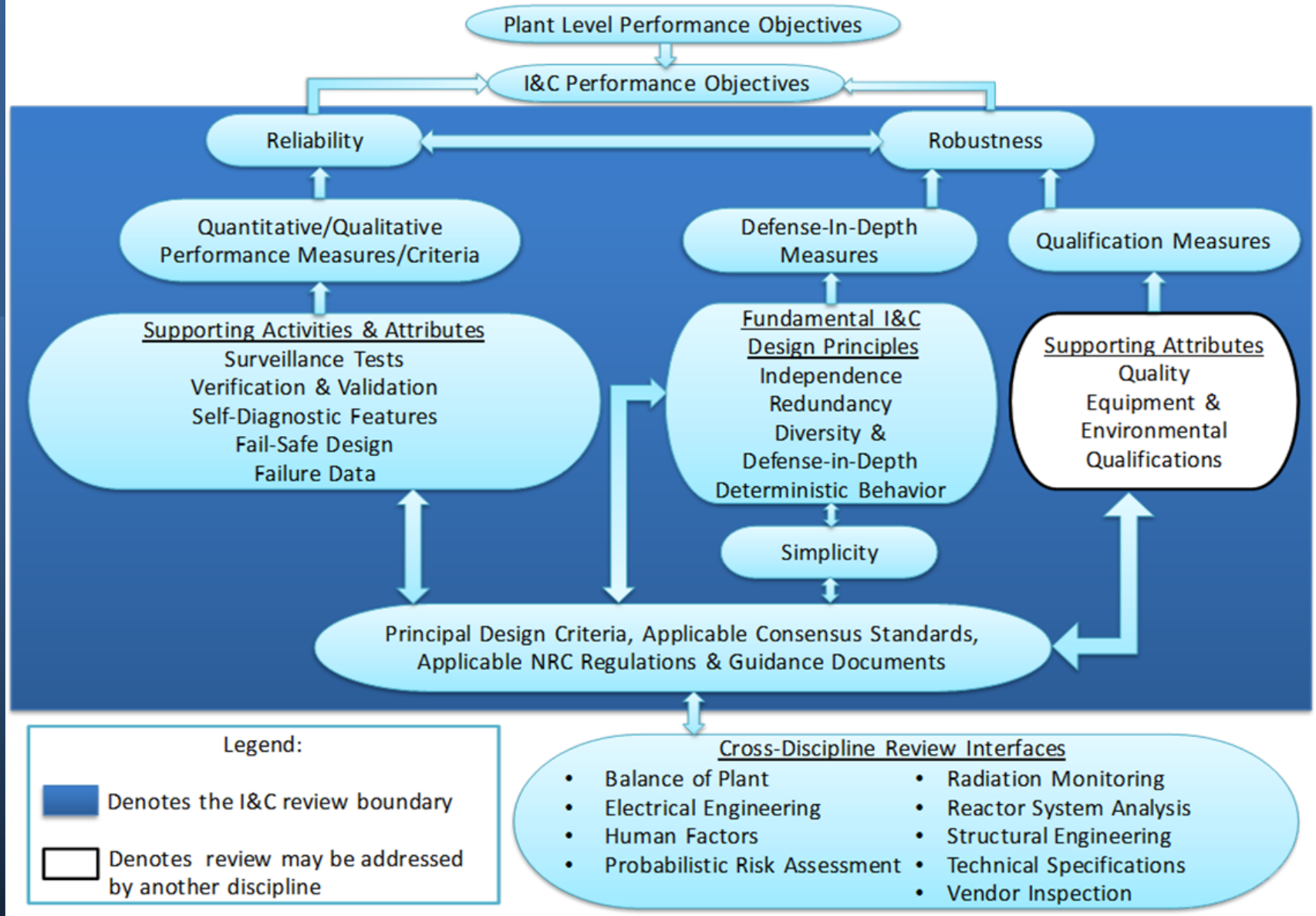
Goals of I&C DRG

- Modernizes the I&C safety review in support of advanced non-LWR licensing applications

Safety-focused | Risk-informed | Performance-based | Technology-Inclusive

- Supports the NRC's vision and strategy for advanced reactor safety reviews
- Incorporates principles from RG-1.233

I&C System Review Framework



Overall Review Approach

Architecture

- The NRC staff review starts at the I&C architecture level
- Ensure that the information necessary to understand the proposed I&C architecture and system functions are available

Safety-Significant Functions

- The NRC staff review focuses on safety-significant functions and selected SSCs that support them
- Ensure that the I&C performance objectives are met

Functions Not Safety-Significant

- The design-related review for SSCs that the NRC staff determined are not safety-related and not risk significant should be less
- The NRC staff review focuses on ensuring that failure or operation of such SSCs will not prevent other SSCs from performing their safety-significant functions or adversely affect DID adequacy

Industry-specific Areas of Interest

- DRG-related topics:
  - Dependencies between NUREG-0800 (or NUREG-1537) and DRG
  - Use of DRG for LWR designs
- LMP-related topics:
  - I&C design criteria for Anticipated Operational Occurrences (AOOs)
    - Can an applicant credit the expected response of all SSCs for AOOs?
  - Quantitatively determining software reliability for use within LMP
  - Non-safety functions to mitigate effects of CCF

Industry-specific Areas of Interest (continued)

- NSRST-related topics:
  - NSRST criteria limited to the DRG sections where specified, or consider the entire DRG?
  - DRG Appendix A design criteria to support reliability and robustness
  - Quality Assurance (QA) requirements/acceptance criteria for NSRST SSCs
  - Are special treatments differentiated between NSRST SSCs “relied on to perform risk-significant functions” and those “requirement special treatment for defense-in-depth adequacy”?

NRC-specific Areas of Interest

- Digital Technologies and use of NRC-approved I&C platforms
- Self-Diagnostics to accomplish surveillance functions
- Remote, Monitoring, and Control Rooms
- Design Standards (i.e., U.S. vs. International standards)
- Content of Applications Format (e.g., NUREG-0800, NUREG-1537, DSRS, DRG)
- Transition from LMP to specific I&C Design Requirements

Workshop #2 Proposed Topics

- Codes and Standards
  - How performance-based concepts can be applied to prescriptive requirements of endorsed codes and standards
  - Applicability of IEEE 603 and related standards
  - Use of international codes and standards
- Applicability of on-going I&C Commercial Grade Dedication and Common Cause Failure (CCF) activities to advanced reactors
- NRC staff review expectations
  - I&C-specific Principal Design Criteria
  - Fundamental I&C design principles
  - I&C architecture and safety classification of I&C platforms

Workshop #3 Proposed Topics

- Content of Applications (Near-term licensing actions)
  - Clarity on applicability of Part 50/52 requirements
  - Expectations for construction permit (CP) applications
  - Expectations for operating license applications
  - Non-power vs. power reactor applications
    - Difference in applicable regulatory requirements
    - Use of NUREG-1537 with I&C guidance and standards
    - Use of NUREG-0800 with I&C guidance and standards

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Questions?

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