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INL Accelerated Materials Deployment Overview

January 2023

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Idaho National Laboratory

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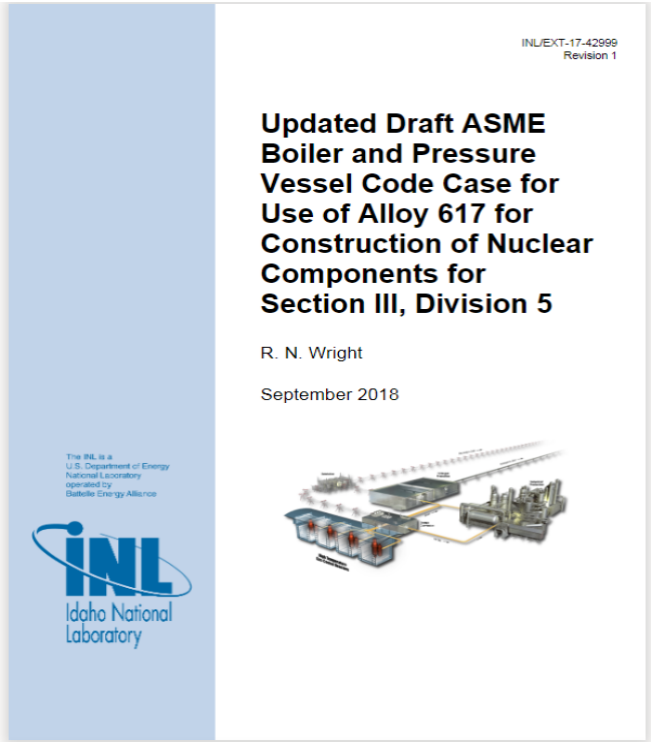
Regulatory Development Group

Battelle Energy Alliance manages INL for the
U.S. Department of Energy's Office of Nuclear Energy

Idaho National Laboratory

Project Scope and Objectives FY-2022 and 2023

- Overall Project Objective
  - Research and identify a regulatory approach, leveraging on current Advanced Reactor research, that provides a process for early use and deployment of an existing or novel material in a reactor application that does not have an existing code case for licensing
- The “Case” for the Research Activity and Program
  - Code case development can take years of testing, data collection, and NRC approvals/acceptance
    - Alloy 617 – Ongoing since 2005
  - Testing of materials in a representative environment can come at great cost and schedule impacts
  - Efficiencies and savings could be realized through baseline materials testing, performance modeling, and near real time in-situ risk informed performance-based Reliability and Integrity Management (RIM) program



Project Scope and Objectives FY-2022 and 2023 (cont.)

- Scope for FY-2022
  - Identify existing licensing pathways for early deployment of materials in novel environments where an established code case doesn't exist
  - Identify regulatory areas where risk is managed through similar methods where base knowledge is available, but operating experience is not
    - Reliability and Integrity Management (RIM), Time Limited Aging Analysis etc.

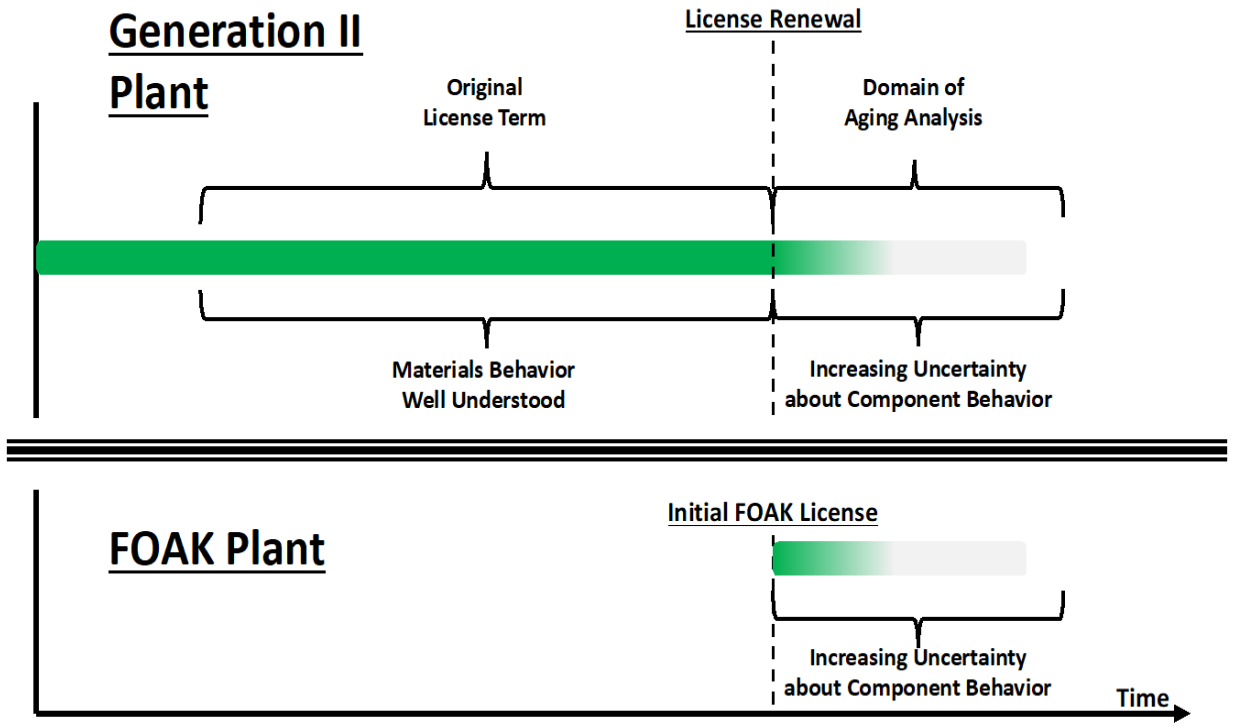


Figure 1. Time-dependent uncertainty in a Generation II Plant compared to a First of a Kind (FOAK) Plant.

Project Scope and Objectives FY-2022 and 2023 (cont.)

- Scope for FY-2022 (cont.)
  - Evaluated safety case development attributes for potential licensing case technical support including Anomaly Precursor Analysis, Modeling Inputs, and sister agency applications such as NASA
  - Developed FY-23 Path Forward and Engagement Plans
    - NRC / NEI / Industry / ANS / ASME

- FY-23 Activities
  - Industry Engagement and Insights
  - NRC, NEI, and Industry Engagement
  - Finalize Regulatory Pathway
    - 10 CFR Part 50.43 e (1) & (2) and GDC Criterion 4
  - Develop guidance document in a regulatory guide-like format for endorsement

Accelerated Materials Deployment Regulatory Approach and Provisions

- § 50.43 Additional standards and provisions affecting class 103 licenses and certifications for commercial power
  - (e) Applications for a design certification, combined license, manufacturing license, operating license or standard design approval that propose nuclear reactor designs which differ significantly from light-water reactor designs that were licensed before 1997. Or use simplified, inherent, passive, or other innovative means to accomplish their safety functions will be approved only if:
    - (1)(i) The performance of each safety feature of the design has been demonstrated through either analysis, appropriate test programs, experience, or a combination thereof;
    - (ii) Interdependent effects among the safety features of the design are acceptable, as demonstrated by analysis, appropriate test programs, experience, or a combination thereof; and
    - (iii) Sufficient data exist on the safety features of the design to assess the analytical tools used for safety analyses over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions; or

Accelerated Materials Deployment Regulatory Approach and Provisions

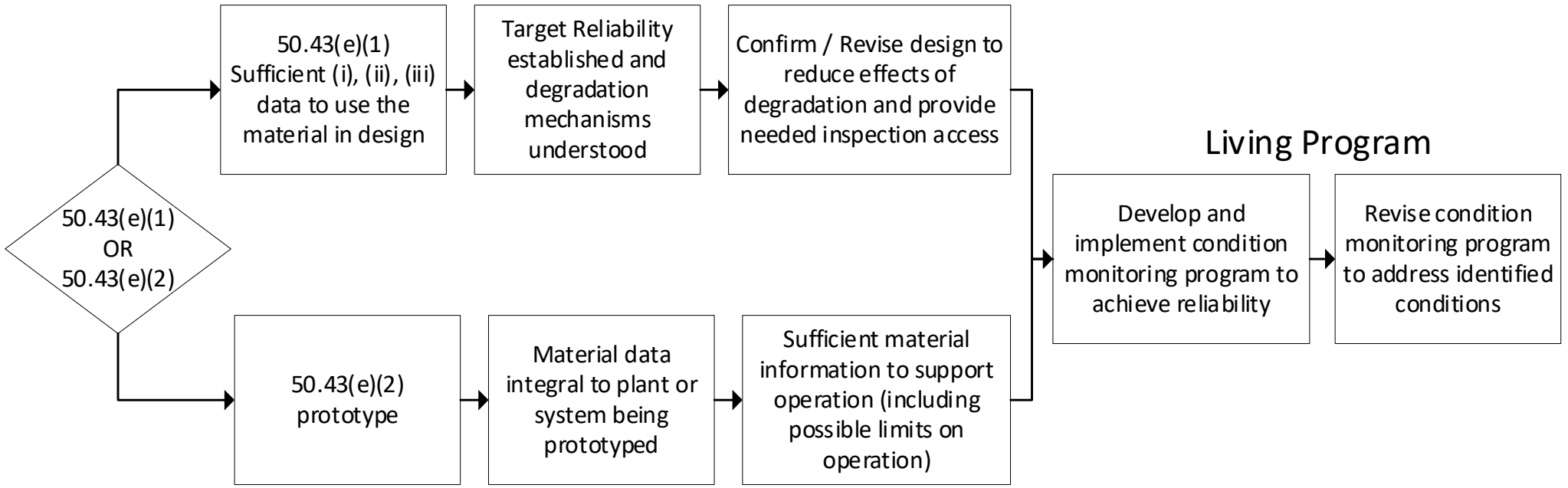
- § 50.43 Additional standards and provisions affecting class 103 licenses and certifications for commercial power (e)
    - (2) There has been acceptable testing of a prototype plant over a sufficient range of normal operating conditions, transient conditions, and specified accident sequences, including equilibrium core conditions. If a prototype plant is used to comply with the testing requirements….. then the NRC may impose additional requirements …….to protect the public and the plant staff from the possible consequences of accidents during the testing period.
- “Plant Application” of novel materials / technology deployment is meant to establish data and sufficient information to support operation (plant limitations may be imposed by the regulator)

Accelerated Materials Deployment Regulatory Approach – Design Criteria Evaluation

- Developers will need to evaluate novel material use in environments against design criteria based on technology type
  - Appendix A to 10 CFR Part 50, “General Design Criteria [GDC] for Nuclear Power Plants”
  - Regulatory Guide 1.232, “Guidance for Developing Principal Design Criteria for Non-Light-Water Reactors”

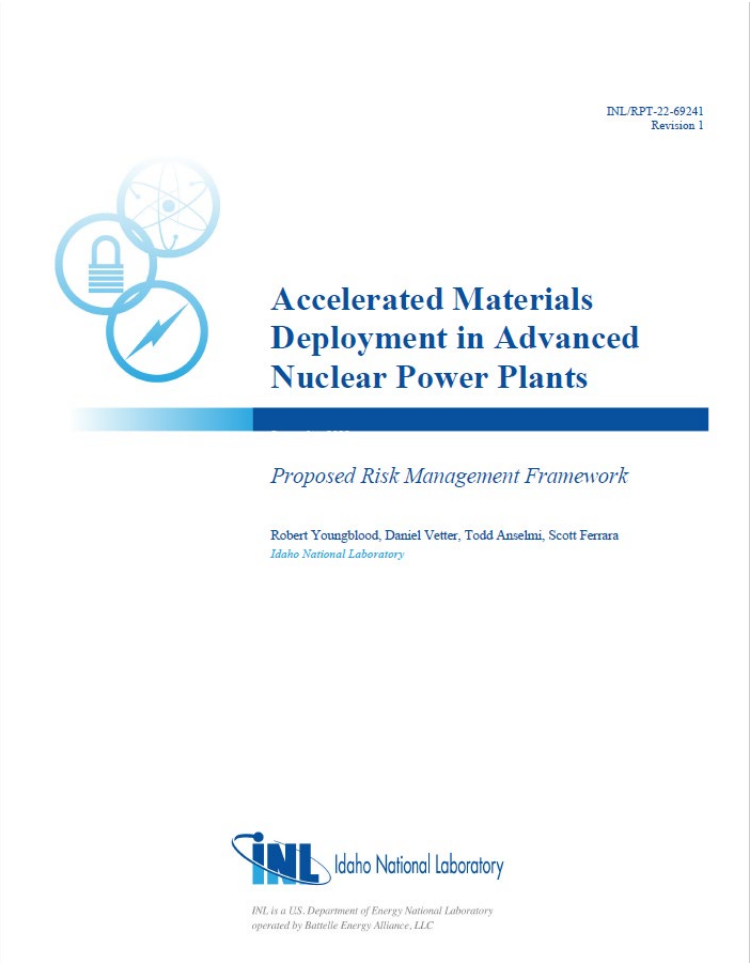
- GDC 4 - Environmental and Dynamic Effects Design Bases
  - “Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents….. These SSCs shall be appropriately protected against dynamic effects…….. that may result from equipment failures and from events and conditions outside the nuclear power unit…..”

Accelerated Materials Deployment Regulatory Approach and Provisions Generic Process Flow



Accelerated Materials Deployment Regulatory Approach FY-23 Deliverable

- A final report that includes:
  - A background of industry and regulatory needs,
  - Examples of previous efforts from both DOE/NRC and OGAs,
    - Aging Management Programs, License Extensions, Advanced Fuel Qualification (NUREG-2246), etc.
  - Technical bases for material deployment program implementation,
  - A regulatory pathway to accelerated material deployment,
  - Examples of the use of reliability target allocations and condition monitoring, and
  - A proposed regulatory guidance document.



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