Enclosure 2

Westinghouse Open Session Slide Package for the ACRS Full Committee Meeting on WCAP-18446-P/NP

(Non-Proprietary)

April 2024

Westinghouse Electric Company
1000 Westinghouse Drive
Cranberry Township, PA 16066

Meeting of the Advisory Committee on Reactor Safeguards (ACRS)

Incremental Extension of Burnup Limit for Westinghouse and Combustion Engineering Fuel Designs, Westinghouse Topical Report WCAP-18446-P/NP

Open Session

Jeffrey Kobelak
Safety Analysis, Westinghouse Electric Company
May 2024

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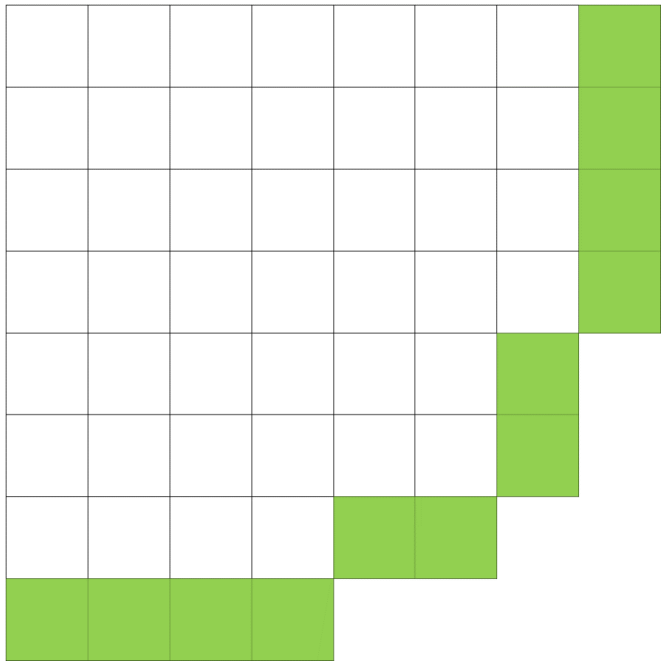
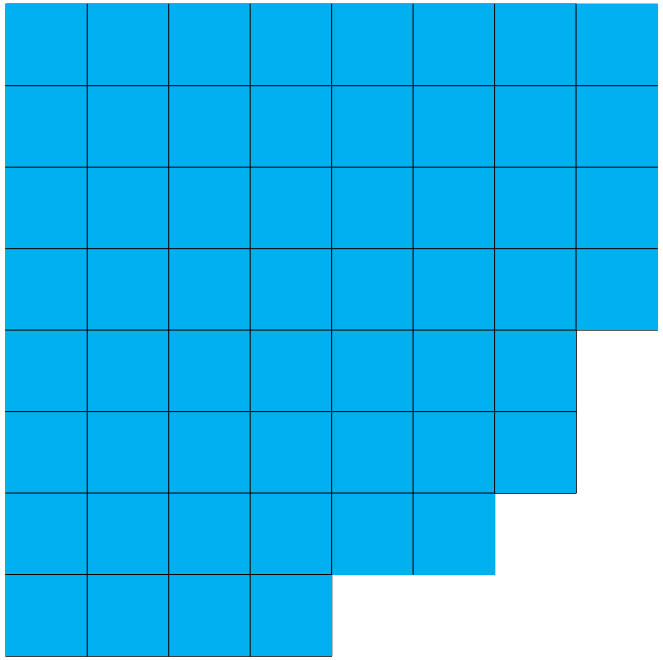
Burnup Extension Program as 2-Step Process



Step 1: Increase burnup limit for rods in peripheral assemblies above 62 GWd/MTU

Step 2: Increase burnup limit for entire core to above 70 GWd/MTU with enrichment increase



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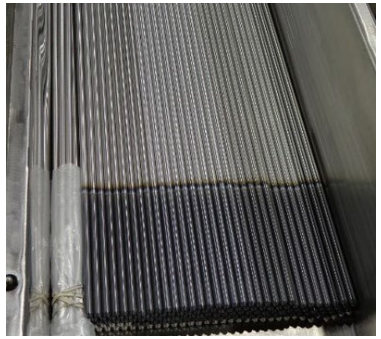
Westinghouse EnCore® Fuel and High Energy Fuel Programs

Timeline of Various Products

Approved 1 | Under Review 2 | Under Development 3 | Long Term 4

AXIOM® Cladding



Chromium-Coated Cladding

Uranium Nitride (UN) Pellets

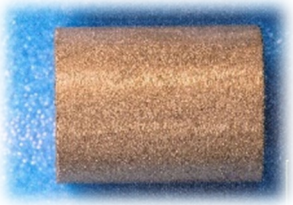


Photo courtesy of Los Alamos National Lab

Product and Methods Evolution

ADOPT™ Pellets

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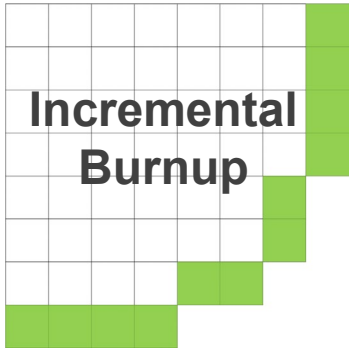
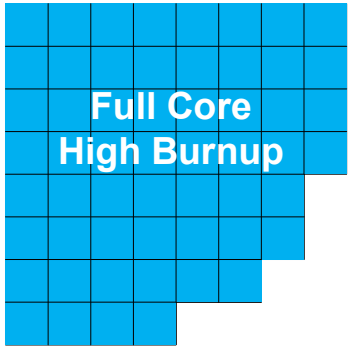


EPRI
Alternate
Licensing
Strategy



SiGA™ Silicon Carbide (SiC) Composite Cladding

Photo courtesy of General Atomics

Incremental Burnup Extension Benefits

- Primary benefit is improved fuel utilization
  - Enabling higher region discharge burnup → improved fuel utilization
  - Target is to reduce number of required feed assemblies each reload

- Improved backend cost
  - Optimum utilization of spent fuel pool capacity with higher burnup fuel
  - Lower dry cask storage needs with fewer fuel assemblies
  - Less volume for permanent storage

- Westinghouse has contracted with customers to implement **ADOPT™** fuel, **AXIOM®** cladding, and the incremental burnup extension (once approved)

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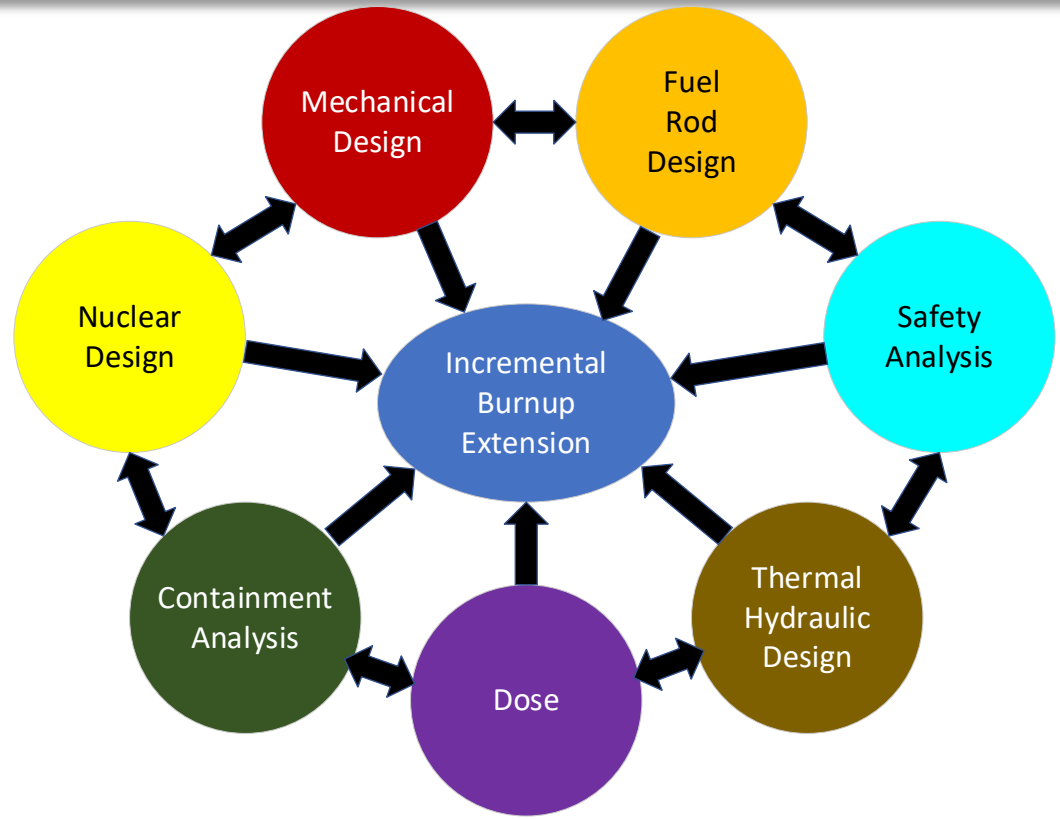
Incremental Burnup Extension Applicability

- Fuel Rod Average Burnup
  - > 62 GWd/MTU
- Fuel Rod Initial Enrichment
  - < 5 w/o enrichment
- Core Location
  - Peripheral Assemblies
- Fuel Assembly Designs
  - All



- Cladding Materials
  - **ZIRLO®**, **Optimized ZIRLO™**, and **AXIOM** cladding
  - Chromium-coated cladding (future)
- Fuel Pellets
  - Standard UO_2 and **ADOPT** fuel pellets

Incremental Burnup Extension Topical Report Overview

- WCAP-18446-P/NP was written to ensure efficient implementation of the incremental burnup extension
  - Limitations associated with prior topical reports which are superseded are identified in Section 1.4
  - Limitations of applicability clearly defined in Section 7.1
  - Licensee actions for implementation are discussed in Section 7.2

- Impacts of incremental burnup extension addressed functional area-by-functional area
  - Codes
  - Methods
  - Acceptance Criteria

Incremental Burnup Extension Topical Report Overview

- Mechanical Design
  - Fuel assembly design bases
  - Structural components
  - Materials

- Core and Fuel Rod Performance
  - Fuel Rod Design
    - Justify application of PAD5 to incremental burnup regime
  - Nuclear Design
    - Codes are already applicable to incremental burnup regime
  - Thermal-Hydraulic Design
    - DNB methods and determination of DNBR remain applicable to incremental burnup fuel rods
    - Incremental burnup rods are non-limiting for rod bow due to low power

Incremental Burnup Extension Topical Report Overview

- Loss-of-Coolant Accident Analysis
  - Update codes and methods to analyze higher burnup fuel rods
  - Address potential for fuel dispersal from fuel rods in the incremental burnup regime
- Transient and Containment Analysis
  - Assess / update decay heat modeling for analysis of higher burnup fuel rods
  - Address phenomena for high burnup fuel rods related to reactivity insertion accidents
- Radiological Consequence Analysis
  - Account for higher burnup fuel rods in dose analyses

Fuel Fragmentation, Relocation, and Dispersal (FFRD)

- Research regarding FFRD ongoing for the last decade
- Safety assessments were completed for FFRD relative to design basis non-LOCA and LOCA transients and accidents
  - SECY-15-0148: *The experimental results have continued to support the hypothesis that FFRD phenomena are primarily a high burnup fuel issue and that the current licensing limits in the U.S. are adequate to prevent dispersal of large quantities of fine fuel fragments.*
- RIL 2021-13 issued to provide conservative interpretation of subset of FFRD-related data at the time of publication

- **Incremental burnup extension considers potential for dispersal during various accidents and transients**

Incremental Burnup Topical Report Schedule

• Topical Report Submittal	December 2020
• NRC Acceptance Review	March 2021
• First Round of RAIs Issued	December 2021
• Responses to Round 1 RAIs	June 2022
• Second Round of RAIs Issued	September 2022
• Responses to Round 2 RAIs	February 2023
• Draft SER Issued	March 2024
• ACRS Sub-Committee	April 2024
• **ACRS Full Committee**	**May 2024**
• Final SER to be Issued	June 2024

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Questions

Acronyms / Codes / Labels

Acronym	Definition
ACRS	Advisory Committee on Reactor Safeguards
ADOPT	Advanced Doped Pellet Technology
ALS	Alternate Licensing Strategy (for FFRD)
DNB	Departure from Nucleate Boiling
DNBR	Departure from Nucleate Boiling Ratio
EPRI	Electric Power Research Institute
FFRD	Fuel Fragmentation, Relocation, and Dispersal
LOCA	Loss-of-Coolant Accident
NRC	Nuclear Regulatory Commission
PAD	Performance Analysis and Design

Acronyms / Codes / Labels (continued)

Acronym	Definition
RAI	Request for Additional Information
RIL	Research Information Letter
SER	Safety Evaluation Report
SiC	Silicon Carbide
UN	Uranium Nitride