ENCLOSURE 2

M210113

2021 Technology Update Presentation

Non-Proprietary Information

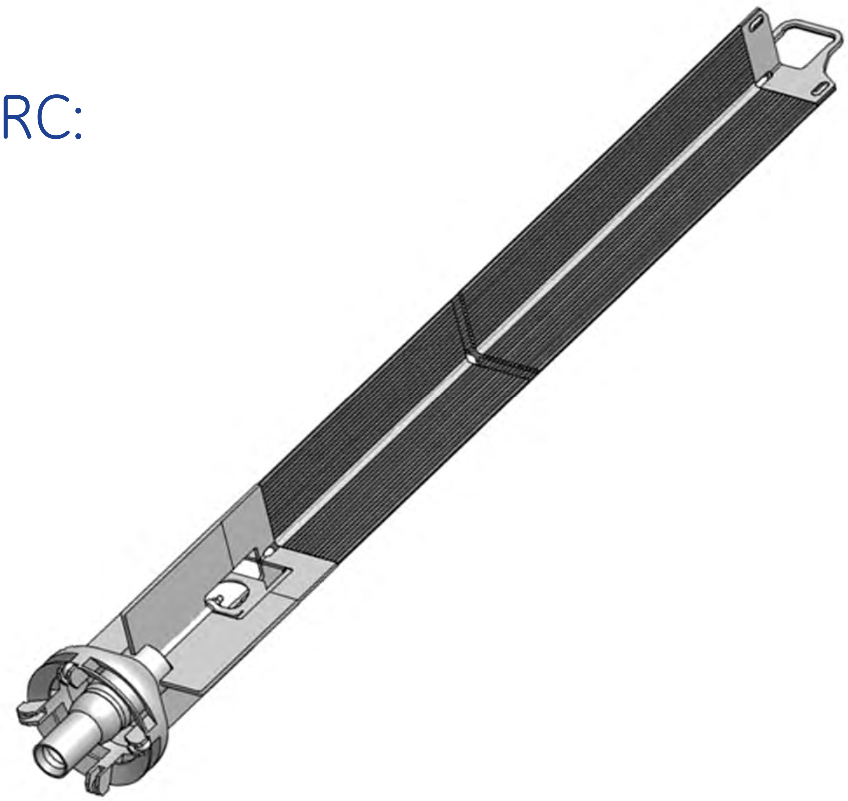
INFORMATION NOTICE

Enclosure 2 is a non-proprietary version of the 2021 Technology Update Presentations from Enclosure 1, which has the proprietary information removed. Portions that have been removed are indicated by open and closed double brackets as shown here [[ ]].

Technology Update for the US NRC August 2021

2021 Annual Report to NRC: M210093

August 17, 2021



Control Rods

Scott Nelson

DBR-0060199

HITACHI

Product Line Overview

Marathon (1991 – 2014)

- NEDE-31758P-A, 1991
- Lifetime reduction in 2011 due to observed cracks ([[ ]]).
- Continue to perform visual inspections to confirm lifetime limits.

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Ultra MD (2009 – present)

- NEDE-33284P-A Rev. 2, 2009
- Perform visual inspections of lead depletion control rods.
- **Zero** cracks observed to date.

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Ultra HD (2012 – present)

- NEDE-33284 Suppl. 1P-A Rev. 1, 2012
- Perform visual inspections of lead depletion control rods.
- **Zero** cracks observed to date.

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New Marathon Inspection Data

Plant	Absorber Tube Type	Tube Geom	Date	¼-Segment B-10 Depletion (%)	Nuclear End of Life (% B-10 Depletion)	Peak Local Depletion (%)	Results
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Plant J Marathon Inspection

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Ultra Surveillance Requirements

Ultra MD: NEDE-33284P-A Rev. 2 Safety Evaluation

- Inspect 2 lead depletion control rods.
- Inspect 2 lead depletion control rods of opposite lattice, once they have exceeded 75% of NEOL.
- Inspect 12 control rods of each lattice type upon end of life discharge.

Ultra HD: NEDE-33284 Suppl. 1P-A Rev. 1 Safety Evaluation

- Inspect 2 lead depletion control rods once they have exceeded 75% of NEOL.
- Inspect 2 lead depletion control rods of opposite lattice, once they have exceeded 90% of NEOL.
- Inspect 12 control rods of each lattice type upon end of life discharge.

NEOL = Nuclear End of Life

Ultra MD Visual Inspection Data

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Plant M-A Ultra MD Inspection

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Ultra MD Surveillance Summary

Ref: NEDE-33284P-A Rev. 2 Safety Evaluation

- Inspect 2 lead depletion control rods.
  - ✓ Plant M-B has the lead depletion Ultra MDs, inspected in fall 2019 and planned for fall 2021.
- Inspect 2 lead depletion control rods of opposite lattice, once they have exceeded 75% of NEOL.
  - ✓ Performed opposite lattice inspection at [[ ]] of NEOL, ahead of 75% NEOL requirement.
- Inspect 12 control rods of each lattice type upon end-of-life discharge.
  - ✓ First 3 Ultra MD control rods were permanently discharged from Plant M-A, fall 2020, inspected spring 2021.

No observed cracks to date on Ultra MD control rods.

Ultra HD Visual Inspection Data

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Plant J Ultra HD Inspection

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Plant O Ultra HD Inspection

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Plant U Ultra HD Inspection

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Ultra HD Surveillance Summary

Ref: NEDE-33284 Suppl. 1P-A Rev. 1 Safety Evaluation

- Inspect 2 lead depletion control rods once they have exceeded 75% of NEOL.
  - ✓ Lead depletion control rods are being inspected at multiple plants, far earlier than 75% NEOL requirement.
- Inspect 2 lead depletion control rods of opposite lattice, once they have exceeded 90% of NEOL.
  - ✓ Inspections to date are D/S lattice. C lattice Ultra HD at Plant V will become the lead depletion units, and be inspected in spring 2022.
- Inspect 12 control rods of each lattice type upon end-of-life discharge.
  - ✓ 4 Ultra HD control rods have been discharged from Plant O and inspected.

No observed cracks to date on Ultra HD control rods.

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GNF's Risk-Informed Licensing for Increasing Burnup Limits

2021 Technology Update

August 17, 2021

Acknowledgements

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Risk-Informed Approach

Approach to Licensing Topical Report requesting an Increase in Burnup Limits

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Risk-based Approach:

Regulatory decision-making is required in both the development of regulations and guidance and the determination of compliance with those regulations and guidance. A "risk-based" approach to regulatory decision-making is one in which such decision-making is solely based on the numerical results of a risk assessment. This places heavier reliance on risk assessment results than is currently practicable for reactors due to uncertainties in PRA such as completeness. Note that the Commission does not endorse an approach that is "risk-based"; however, this does not invalidate the use of probabilistic calculations to demonstrate compliance with certain criteria, such as dose limits.

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Risk-Informed Approach:

A "risk-informed" approach to regulatory decision-making represents a philosophy whereby risk insights are considered together with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety. A "risk-informed" approach enhances the deterministic approach by: (a) allowing explicit consideration of a broader set of potential challenges to safety, (b) providing a logical means for prioritizing these challenges based on risk significance, operating experience, and/or engineering judgment, (c) facilitating consideration of a broader set of resources to defend against these challenges, (d) explicitly identifying and quantifying sources of uncertainty in the analysis (although such analyses do not necessarily reflect all important sources of uncertainty), …

Risk-Informed Approach:

… and (e) leading to better decision-making by providing a means to test the sensitivity of the results to key assumptions. Where appropriate, a risk-informed regulatory approach can also be used to reduce unnecessary conservatism in purely deterministic approaches, or can be used to identify areas with insufficient conservatism in deterministic analyses and provide the bases for additional requirements or regulatory actions. "Risk-informed" approaches lie between the "risk-based" and purely deterministic approaches. The details of the regulatory issue under consideration will determine where the risk-informed decision falls within the spectrum.

Approach to Licensing Topical Report requesting an Increase in Burnup Limits

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In Summary

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Two Types of Methodologies

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Licensing Evaluation Risk Assessment Process for methodology used to show an acceptance criterion is met (e.g., [[ ]])

1. [[

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Input Risk Assessment Process for methodology that calculates an input for a licensing evaluation methodology (e.g, [[ ]])

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Risk Evaluation for Licensing Evaluation Risk Assessment

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Review Scope and Outline of LTR

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Approach to Licensing Topical Report requesting an Increase in Burnup Limits

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LTR Outline

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Section 1

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Section 2

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LTR Outline - Continued

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Section 3

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]] **If further technical information is needed to support application of the methodologies, it will be provided here**. Thermal-mechanical section will reference the PRIME supplement.

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Update of Approach to LOCA Methodology

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HBU Technical Risks for LOCA/ECCS Performance

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HBU Technical Risks for LOCA/ECCS Performance (cont.)

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Preliminary – For Discussion Only

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Remarks

- Additional studies are being conducted using TRACG LOCA methodology
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Conclusions

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2021 Technology Update
August 17

BWRX300

Characteristics and Analyses

Charles Heck
Consulting Engineer
Nuclear Applications Technology
Core & Fuel Engineering

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BWRX-300 Reactor Specification

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BWRX Natural Circulation Phenomena

- Hydrostatic Head
  - Downcomer vs. Core /Chimney
- Density Gradient
  - Temperature gradient in the coolant
  - Void fraction gradient/buoyancy
  - Heat addition (boiling)
- Condensation of steam in the chimney (startup)

RPV Relative Pressure Distribution at EOR

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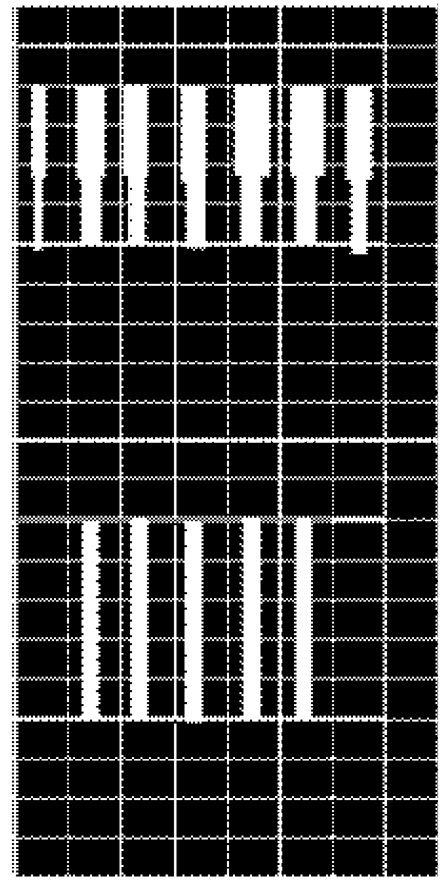

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Reactor Pressure Vessel (RPV)

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BWRX-300 Natural Circulation compared to Forced Circulation Operating BWRs

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CFD Analyses Confirm Chimney Modeling

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KKM, BWRX-300, ESBWR Comparison

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Comparison BWR Powers and Flows

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BWRX-300 (red) on KKM Power/Flow Map

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Selected Fuel Quantities at EOR for Highest, Average, & Lowest Power Channels

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Representative SBLOCA Results

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ATWS Results: MSIVC, 3 IC Trains, No Boron Injection

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Concluding Remarks

- BWRX-300 is the 10th generation in the evolution of BWRs
  - Natural circulation (used successfully in the earliest BWRs) provides simplification and cost reduction without loss of performance
  - Large amount of RPV coolant inventory enhances safety
  - Passive design enhances safety and reduces maintenance costs
- BWRX-300 Components
  - GNF2, control blades, AS2B steam separators, FMCRD like ABWR (and ESBWR)
  - Components proven by operating experience
- BWRX-300 Safety Evaluations
  - AOO less severe or approximately same as operating BWR fleet
  - LOCA much less severe than operating BWR fleet
  - ATWS easier to deal with than operating BWR fleet

BWRX300