Diablo Canyon Power Plant
Fuel Upgrade and Spent Fuel Pool Criticality Re-Analysis Pre-Submittal

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PG&E Project Team

Jordan Tyman – Director, Risk and Compliance

Al Bates – Director, Nuclear Fuel

Rob Norring – Project Manager

Michael Richardson – Regulatory Services

Shannon Conner – Manager, Nuclear Fuels Purchasing

Westinghouse Project Support

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Purpose and Desired Outcome

- Purpose
  - Discuss the planned Spent Fuel Pool Criticality (SFPC) Re-Analysis License Amendment Request (LAR)
  - Discuss the planned Fuel Upgrade LAR (the submittals are not linked)
- Desired Outcomes
  - Provide details regarding the LAR content and planned implementation schedule

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Meeting Agenda

- Objectives
- Completed or In Review Licensing Actions
- Proposed Licensing Actions
- SFPC Methodology & Approach
- SFPC Technical Specification Changes
- Fuel Upgrade Methodology & Approach
  - **ADOPT™** Fuel Introduction
  - **FSLOCA™** Evaluation
  - Non-LOCA Safety Re-Analysis
  - Other Fuel Methodology Upgrades
  - Demonstration Case
- Fuel Upgrade Technical Specification Changes
- Project Status
- Proposed Schedule
- Questions

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Objectives

- Provide overview of PG&E's plan to transition Diablo Canyon Units 1 and 2 to incorporate the latest fuel assembly technologies in order to maximalize fuel reliability
  - Scope and Content
  - Schedule

- Obtain NRC Feedback
  - LAR Content
  - Proposed schedule / NRC resource planning

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Completed or In Review Licensing Actions

- **Completed**
  - WCAP-16996-P-A, Revision 1 “Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes”
    - Amendments 234 and 236 – January 9, 2020 (ML19316A109)

- **Under NRC Review**
  - DCPP License Amendment Request 25-01 “Application to Utilize Optimized ZIRLO™ for Improved Fuel Rod Cladding Performance” – submitted 3/26/25 (ML25085A409)
    - NRC Acceptance Review – Received May 1, 2025 (ML25121A343)

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Proposed Licensing Actions

- **Spent Fuel Pool Criticality Re-Analysis LAR**
  - Incorporates fuel management and fuel features changes
  - Updated to incorporate latest guidance
  - New criticality analysis will supersede the current analysis when implemented

- **Fuel Upgrade LAR**
  - Fuel design change technical justifications for use of **ADOPT**
  - Specific enclosures will be provided for relevant analyses
    - Demonstration case will be provided for Locked Rotor Analysis. All other events being addressed through technical evaluation or analysis and will be available for review and audit.

- All proposed changes have regulatory precedent and will comply with relevant Limitations and Conditions (L&Cs) associated with any methodology updates

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SFPC Methodology & Approach

- **Current Analysis of Record was implemented in 2002 to credit soluble boron**

- **The updated analysis will**:
  - Include the Spent Fuel Pool and New Fuel Storage Vault
  - Use PARAGON 1.4.3 (ENDF/B-VI.3) for depletion and SCALE 6.3.1 using KENO-V.a (ENDF/B-VII.1 252 group library) for criticality
  - Incorporate fuel management changes as a result of:
    - **ADOPT** implementation
    - The incorporation of **Optimized ZIRLO** Cladding (no significant impact)
    - Incorporation of remaining **PRIME** fuel features including Low-Tin **ZIRLO®** grids and reinforced dashpot (no significant impact)
    - Conservatively includes additional margin

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SFPC Methodology & Approach

- **The updated analysis will**:
  - Incorporate changes consistent with current guidance (RG 1.240 Rev. 0 and NEI-12-16 Rev. 4) including treatment of:
    - Fuel density change
    - Burnable absorbers usage
    - Axial profiles (temperature and burnup)
    - Soluble boron during depletion
    - Soluble boron will continue to be credited
    - Updated burnup curves

- **NEI-12-16 Rev. 4 Checklist B followed and will disposition any deviations**
  - Depletion uncertainty of 5% and administrative margin of 0.005 to the limit remain included

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SFPC Technical Specification Changes

- **The following Technical Specifications and associated Figures will be updated to reflect the SFPC Re-Analysis:**
  - TS 3.7.16, “Spent Fuel Pool Boron Concentration”
  - TS 3.7.17, “Spent Fuel Assembly Storage”
  - Figure 3.7.17-1, “Allowable Storage Configurations (All Cell, 2x2 Array, Checkerboard) for the Permanent Spent Fuel Pool Storage Racks”
  - Figure 3.7.17-2, “Minimum Required Assembly Discharge Burnup as a Function of Initial Enrichment and Fuel Pellet Diameter for an All Cell Storage Configuration for the Permanent Spent Fuel Pool Storage Racks”
  - Figure 3.7.17-3, “Minimum Required Assembly Discharge Burnup as a Function of Initial Enrichment for a 2x2 Array Storage Configuration for the Permanent Spent Fuel Pool Storage Racks”
  - Figure 3.7.17-4, “Minimum Required Assembly Discharge Burnup as a Function of Initial Enrichment for Spent Fuel Storage in the Cask Pit Storage Rack”
  - TS 4.3 “Fuel Storage”
- **Technical Specification Bases Changes (Information Only):**
  - TSB 3.7.16, “Spent Fuel Pool Boron Concentration”
  - TSB 3.7.17, “Spent Fuel Assembly Storage”

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Fuel Upgrade Methodology & Approach – ADOPT fuel Introduction

- **Reason for Change:**
  - Increased thermal stability
  - Enhanced corrosion resistance
  - Increased fuel creep resistance at high temperatures
  - Reduced fission gas release (FGR) under short-term transient conditions
  - Pellet density increase provides improved core design flexibility

- **NRC approved ADOPT in November 2022 (ML22325A254, WCAP-18482-P/NP-A, Rev.0)**

- **Licensed for use in all PWR reactor designs**
  - Compatible with NRC-approved zirconium based cladding materials, including **Optimized ZIRLO™**
  - Existing NRC-approved analytical methods and models are appropriate for **ADOPT**
  - Will comply with the L&Cs associated with methodology changes including RG 1.236 Rev. 0

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Fuel Upgrade Methodology & Approach – FSLOCA Evaluation

- **FSLOCA Evaluation**
  - An assessment of the estimated impact on Peak Clad Temperature (PCT) pursuant to 10 CFR 50.46(a)(3) for change in fuel related inputs will be performed in support of the transition to **ADOPT**

- **Westinghouse FSLOCA Methods approved WCAP-16996-P-A, Revision 1**
  - Plant-specific application of the FSLOCA evaluation model approved for Diablo Canyon Units 1 and 2, January 2020 (ML19316A109)

- **The evaluation will be subject to reporting pursuant to 10 CFR 50.46 (a)(3)(ii)**

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Fuel Upgrade Methodology & Approach – Non-LOCA Safety Re-Analysis

- **Technical evaluations for UFSAR Chapter 15 Non-LOCA analyses:**
  - Upgrade to WCAP-14882-P-A (Proprietary) / WCAP-15234-A "RETRAN-02 Modeling and Qualification for Westinghouse Pressurized Water Reactor Non-LOCA Safety Analyses" to use the newest available methods
    - Some events being re-analyzed already implemented use of RETRAN-02W in current UFSAR analyses
    - Upgrade limited to events being re-analyzed that were not previously analyzed with RETRAN-02W
  - Upgrade to codes, methods, and correlations for Departure from Nuclear Boiling Ratio (DNBR) calculations
    - Detailed in Thermal Hydraulics discussion
  - Upgrade to fuel performance codes and methods
    - Detailed in Fuel Performance discussion

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Fuel Upgrade Methodology & Approach – Other Fuel Methodology Upgrades

- **All methodology upgrades use NRC-approved methodologies**

- **Control Rod Ejection**
  - 3D Rod Ejection Methods as outlined in WCAP-15806-P-A, “Westinghouse Control Rod Ejection Accident Analysis Methodology Using Multi-Dimensional Kinetics”, approved December 9, 2003 (ML033350109)

- **Thermal Hydraulics**
  - VIPRE-W as outlined in WCAP-14565-P-A, “VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis”
  - ABB-NV Correlation as outlined in WCAP-14565-P-A, Addendum 2, “Addendum 2 to WCAP-14565-P-A Extended Application of ABBNV Correlation and Modified ABB-NV correlation WLOP PWR Low Pressure Applications”
  - Westinghouse Thermal Design Procedure as outlined in WCAP-18240-P-A, “Westinghouse Thermal Design Procedure (WTDP),” April 2020
  - Conservatively includes additional margin

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Fuel Upgrade Methodology & Approach – Other Fuel Methodology Upgrades

- **Fuel Performance**
  - Transitioning to PAD5 Methodology: WCAP-17642-P-A Revision 1 (Proprietary) / WCAP-17642-NP-A Revision 1 (Non-Proprietary), “Westinghouse Performance Analysis and Design Model (PAD5)”
  - Inclusion of the Hydrogen-Based Transient Cladding Strain Limit (PWROG-21001-P-A) via 10 CFR 50.59 process

- **Other methodologies, Critical Heat Flux (CHF) correlations, and Topical Reports already approved for use at Diablo Canyon**

- **Will comply with the L&Cs associated with methodology changes**

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Fuel Upgrade Methodology & Approach – Demonstration Case

- **LAR will include a single demonstration analysis with updated methods of the UFSAR 15.4.4 Single Reactor Coolant Pump Locked Rotor event**
  - Implements use of upgraded computer codes and models
    - RETRAN-02W used in place of LOFTRAN
    - VIPRE-W used in place of FACTRAN and THINC
  - Demonstrates applicable criteria are satisfied
    - Peak Reactor Coolant System (RCS) Pressure
    - Peak Cladding Average Temperature
    - Rods-in-DNB (Departure from Nucleate Boiling)
  - Utilizes Westinghouse Thermal Design Procedure (WTDP) in place of Improved Thermal Design Procedure (ITDP) for DNB evaluation
  - Other non-LOCA analyses will be completed and available at time of audit

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Fuel Upgrade Technical Specification Changes

- **The following Technical Specifications will be updated to support the Fuel Upgrade:**
  - TS Figure 2.1.1-1, “Reactor Core Safety Limit” is modified to incorporate the change to the DNB design basis for WTDP and VIPRE-W
  - TS 4.2.1, “Fuel Assemblies” is modified to recognize the inclusion of **ADOPT** dopants into the standard fuel pellets

- Changes to UFSAR Section 15.4.6, “Rupture of a Control Rod Drive Mechanism House (Rod Cluster Control Assembly Ejection)” will be incorporated outside the submittal to reflect the use of new methodology for analyzing the impact of control rod ejection consistent with RG 1.236 Rev. 0

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Project Status

- **Project Kickoff occurred in 2023**
- **Spent Fuel Pool Criticality Re-Analysis LAR**
  - Most work complete, WCAP compilation in progress
- **Fuel Upgrade LAR**
  - Most work complete, summary reports in progress
  - Remaining work expected to be complete and available for audit during the NRC's review cycle

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Proposed Schedule

Submit Fuel Upgrade LAR	October 2025
Submit SFPC Re-Analysis LAR	November 2025
Requested Approval for Fuel Upgrade LAR	September 2026
Requested Approval for SFPC Re-Analysis LAR	September 2026
First Reload Cycle Implementation (Unit 2)	Spring 2027

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Questions?

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Thank You

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