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Byron-2 Cycle 25 High Burnup Lead Test Assembly Pre-Submittal Meeting

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Summary

- The purpose of this Pre-Submittal Meeting is to introduce the project to deploy one high burnup Lead Test Assembly at Byron-2 Cycle 25.
- Westinghouse and Constellation (then Exelon) embarked on an ATF program at Byron-2 in 2019.
- This project continues our ATF collaboration and further expands into the high burnup domain.

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Background - LAR for the Byron 2 Cycle 22 – 24 LTAs

- The LAR that provided justification to allow the Byron Unit 2 to operate Cycles 22, 23, and 24 with 2 LTAs, U75Y and U72Y, was approved on April 3, 2019 (ML19038A017).
- The LAR justified the use of U72Y LTA with:
  - Up to 4 rods loaded with **ADOPT™** uranium dioxide pellets fuel and chrome coated **Optimized ZIRLO™** cladding
  - Up to 8 rods loaded with standard uranium dioxide pellets and chrome coated **Optimized ZIRLO™** cladding
- Cycle 22 operated as expected. LTA U72Y was re-inserted in Cycle 23, and it is anticipated to be discharged at the end of Cycle 23. Poolside Inspection/Evaluation (PIE) is anticipated to be performed by mid-2022.
- LTA U72Y is not planned to be re-inserted in Cycle 24.

Proposed Re-insertion of U72Y LTA in Byron-2

- LTA U72Y is proposed to be re-inserted into the reactor for Cycle 25 in the rodded core center location to achieve burnups above the current analytical methods limit of 62 GWD/MTU.
- U72Y will be reconstituted after Cycle 23 to insert 7 stainless steel rods, and will then consist of:
  - 7 stainless steel rods
  - *2 **ADOPT™** fuel rods with chrome coated **Optimized ZIRLO™** cladding
  - *4 uranium dioxide fuel rods with chrome coated **Optimized ZIRLO™** cladding
  - *Balance of fuel rods are uranium dioxide with uncoated **Optimized ZIRLO™** cladding

  * Previously irradiated fuel rods from Cycles 22 and 23.

- Data acquired from U72Y burnup will support improved fuel performance and fuel economics for accident tolerant fuel.

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Regulatory and Technical Issues

Analysis of the LTA will be consistent with 2019 LTA guidance letter (ML18323A169):

- Use of available data
  - PIE of U72Y
  - Prior high burnup LTA experience
  - LTA specific testing conducted on coated cladding thermal-hydraulic characteristics
- Use NRC-approved methods where possible
- Conservative evaluations with sound engineering judgment applied
- Codes and methods reflecting well-established engineering principles

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Regulatory Overview

- Anticipate LAR to revise Technical Specification 4.2.1 (cycle 25, single LTA, center location)
- No 10 CFR 50.46 exemption anticipated (none required for prior LTA amendment)
- The following will be addressed in the LAR to address burnup levels achieved in Cycle 25:
  - Fuel assembly mechanical and thermal-hydraulic design criteria
  - Fuel rod design criteria (fuel rod growth, clad fatigue and corrosion, rod internal pressure)
  - LOCA analyses (FFRD, 10 CFR 50.46c ECCS criteria)
  - Non-LOCA analyses demonstrate high burnup fuel does not go through DNB
  - Radiological consequences (fuel handling accident involving high burnup LTA)

PIE

- LTA U72Y will be inspected and evaluated at the end of Cycle 23
- The following PIE data is planned to be obtained to provide input for LTA evaluations:
  - Fuel assembly bow
  - RCCA drag forces
  - Fuel assembly length
  - Shoulder gap (space between top of rod and top nozzle)
  - Fuel rod bow

Key Fuel Assembly Skeleton Parameters

- Data from the U72Y PIE campaign, prior high burnup LTA experience with 17x17 OFA assemblies, as well as standard analytical methods will be used to demonstrate that assembly U72Y will perform safely for a third cycle to the higher burnup levels.
- The following parameters are planned to be evaluated:
  - **RCCA insertion**: Assembly bow as well as RCCA drag forces will be measured on U72Y at the end of Cycle 23 and compared to existing fuel assembly bow database as well as available plant data for RCCA drag force.
  - **Assembly growth**: Assembly length will be measured, and third cycle growth will be projected in order to demonstrate sufficient axial room in the core to accommodate growth.
    - Assembly length measurement will also feed fuel assembly holddown evaluation.
  - **Shoulder gap** (space between top of rod and top nozzle): Shoulder gap will be measured during PIE. Conservative projected assembly growth and rod growth will demonstrate acceptable gap at the end of Cycle 25.
  - **Rod bow**: Rod bow measurements will be taken during PIE. Results will be compared to existing rod bow correlation nominal and upper bound limits.

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Fuel Rod Design

- Higher burnup operation will result in more limiting performance for the following fuel rod criteria:
  - Rod internal pressure
  - Clad corrosion
  - Fuel rod growth
  - Clad fatigue
- PAD5 will be used for approved cladding alloys and fuel
  - PAD5 was developed using high burnup data and is adequate for evaluating high burnup fuel
- Conservative consideration of the LTA materials will be used where appropriate

Thermal-Hydraulics

- No adverse thermal-hydraulic impacts for LTRs due to coated cladding
  - Pre-irradiation testing verified no margin loss for critical heat flux
  - LTR surface roughness similar to standard fuel rod – no local hydraulic mismatch
  - No adverse thermal-hydraulic impacts on reload core due to presence of LTA
- Current rod bow DNB penalty will be extrapolated to LTA burnup for DNB analysis
  - PIE - rod bow measurements will be made to assess rod bow DNB penalty
  - LTA will remain non-limiting due to lower assembly power
- No rods in LTA expected to experience DNB failure for ANS Condition III/IV events
  - Therefore, no FFRD concern for high burnup fuel rods

Core Physics

- No adverse core physics impacts expected
- Center location of LTA will be non-limiting in power and peaking factors compared to lead assemblies in core
- Co-resident fuel assemblies will behave similarly to typical Byron core design
- Same analytical methods as previously approved by Byron 2 Amendment 207 will be used
  - **ADOPT™** and coated **Optimized ZIRLO™** cladding modeled explicitly
  - Anticipated to have minor neutronic effects

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Analysis of LOCA

- Use existing approved models and methods
- Negligible impact due to single LTA impact on core-wide effects
- High burnup effects (FFRD) will be qualitatively evaluated crediting reduced assembly power and probabilistic arguments
- No 10 CFR 50.46 exemption expected (LTA not impacting co-resident fuel, LOCA response unchanged)
- UFSAR conclusions for LOCA analyses expected to remain valid

Analysis of Non-LOCA Accidents

- Use existing approved models and methods
- Negligible impact due to single LTA impact on core-wide effects
- High burnup effects are evaluated to be acceptable
- Rod Ejection Accident
  - LTA location is non-limiting for this accident
  - Existing analysis expected to remain bounding for Cycle 25
- UFSAR conclusions for non-LOCA accident analyses expected to remain valid

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Dose Analysis

- Core-wide impacts are negligible due to single LTA at high burnup
- Use existing methods and models with actual LTA fission product inventories
  - Radiological source term assessed using ORIGEN considering high burnup LTA
    - ORIGEN code using high burnup cross-section libraries
    - No method changes required
  - LTA location is non-limiting
  - For fuel handling accident, demonstrate conservative assumptions provide margin to limits consistent with high burnup LTA precedents
- UFSAR conclusions for dose expected to remain valid

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LAR Schedule

- NRC Pre-Submittal Meeting (Project Overview) – April 11, 2022
- NRC Pre-Submittal Meeting (LAR Content) – early August 2022
- Submittal of LAR to the NRC – August 31, 2022
- Anticipated approval of LAR – September 13, 2023