Byron Station
Accident Tolerant Fuel
Lead Test Assembly Deployment

(An Exelon/Westinghouse Initiative)

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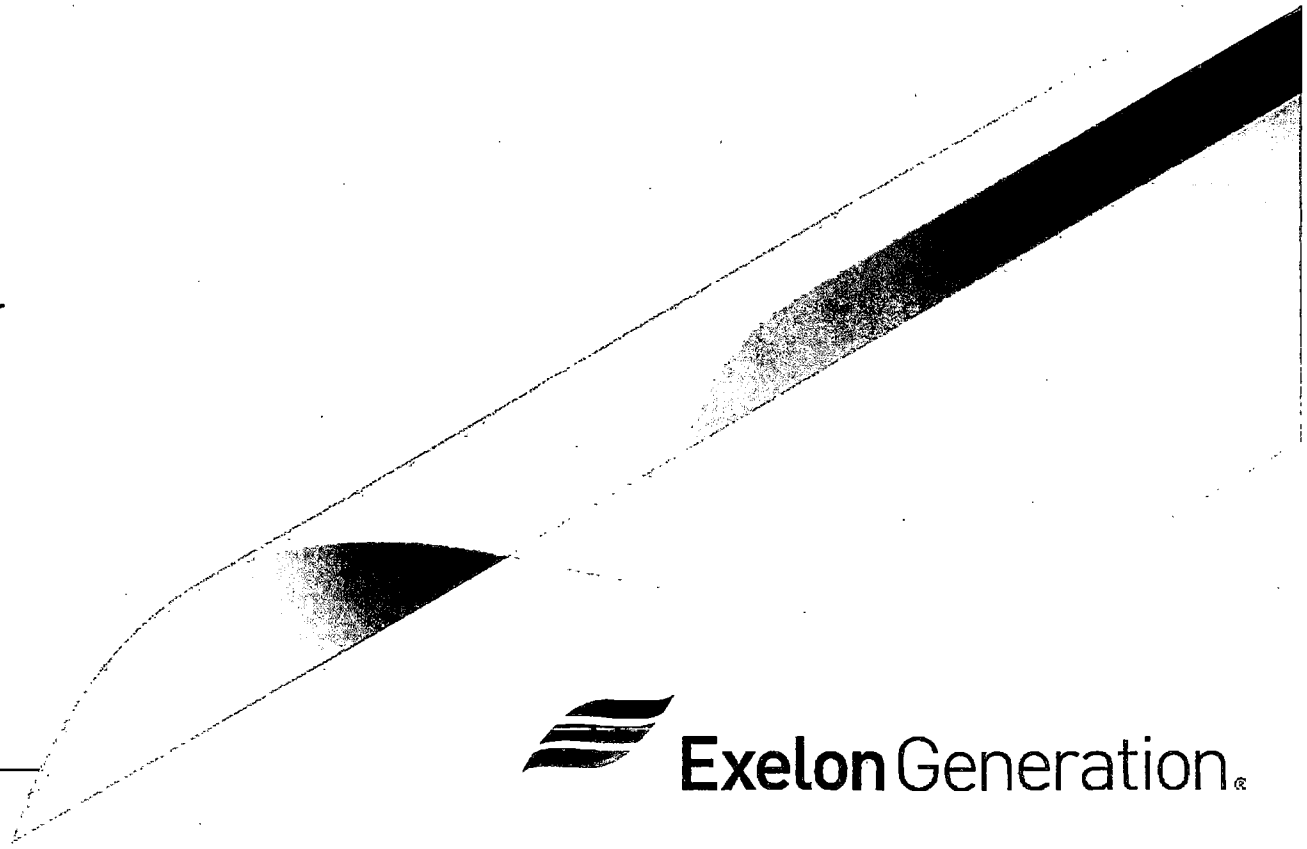
NRC Briefing
October 3, 2017



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Agenda

- Introductions and Opening Remarks
- Meeting Purpose
- Project Overview
- Lead Test Assembly/Lead Test Rod Design Change Overview
- Lead Test Assembly/Lead Test Rod Design Change Analysis
- Fuel Reliability, Reactivity, Shipping and Handling
- Reload Analysis Considerations
- 10 CFR 50.46 and Appendix K
- Project Schedule/Milestones
- NRC Questions/Feedback

Meeting Purpose

- Describe the Westinghouse Accident Tolerant Fuel (ATF) Lead Test Assembly (LTA) and Lead Test Rod (LTR) design features that will be deployed at Byron Station
- Summarize the safety-related design change process that will demonstrate:
  - The Byron Station ATF LTA program is within the Technical Specification 4.2.1 requirements
  - The LTAs are compatible with the co-resident Westinghouse fuel; and
  - All applicable core safety and licensing basis criteria continue to be met
- Present the milestones and timeline for ATF LTA deployment at Byron Station
- Obtain NRC feedback on the ATF LTA program and plans at Byron Station

Project Overview

- After the accident at Fukushima Daiichi, the U.S. Congress mandated the development of nuclear fuels with enhanced accident tolerance to improve performance under beyond design basis accident (BDBA) conditions
- Major expectations for accident tolerant fuel (ATF) designs:
  - Improved cladding reaction to high temperature steam
  - Reduced hydrogen generation
  - Reduced BDBA source term
- Westinghouse ATF concepts satisfy these expectations
- The Byron Station ATF LTA/LTR Program is a joint initiative between Exelon and Westinghouse

LTA/LTR Design Change Overview

- Westinghouse has developed a new fuel type and a new cladding type to satisfy ATF requirements:
  - Uranium silicide (U_3Si_2) fuel pellets will replace standard uranium dioxide (UO_2) fuel pellets
  - Coated zirconium alloy cladding will replace standard Optimized ZIRLO cladding
    - Chromium is a coating candidate, but R&D continues and other coatings may be considered

LTA/LTR Design Change Overview

- Exelon plans to load two LTAs containing up to 20 LTRs in Byron Station, Unit 2 during Cycles 22, 23 and 24 (Cycle 22 begins operation in Spring 2019)
- The LTRs include a combination of:
  - Coated zirconium alloy cladding containing standard uranium dioxide fuel pellets or uranium silicide fuel pellets
  - Optimized ZIRLO cladding containing uranium silicide fuel pellets
- The 20 LTRs represent 0.04% of the total fuel rods in the core
- The purpose of this LTR Program is to allow Exelon/Westinghouse to collect further data regarding the performance of the Westinghouse accident tolerant fuel rods

LTA/LTR Design Change Analysis

- The Byron Unit 2 Cycle 22 core reload analysis will be a safety related analysis completed under the Westinghouse and Exelon 10 CFR 50, Appendix B engineering change processes
- Core Reload analysis will confirm acceptable safety margin for all LTA/LTR critical parameters and requirements
- Currently licensed fuel design and reload analysis methods for the reactor core do not fully accommodate the LTA/LTR design and materials
- Methods will be supplemented with additional analysis and evaluations - conservative assumptions will be employed
- 10 CFR 50.59 process applied to the full core reload analysis will appropriately consider the allowance in TS 4.2.1 for a limited number of LTAs that have not completed representative testing
  - The answer all 10 CFR 50.59 Questions, including Question (viii), is anticipated to be "No"

LTA/LTR Design Change Analysis

- LTAs will be fully compatible with:
  - Co-resident fuel assemblies
  - Control rods, inserts and core instrumentation
  - Other reactor pressure vessel internals
- LTAs will have no impact on the projected Energy Utilization Plan
  - Cycle length and operating capacity factor
  - Load following/de-rating and coastdown length
  - Cycle extension techniques and outage length
- Neutronic impact of small amount of U_3Si_2 and coating will be negligible

Effects on Fuel Reliability

- No issues anticipated
- Investigation of new LTR/LTA attributes continues in test reactors and the laboratory
  - No significant issues have been identified or are expected Testing continues in several areas
    - Pellet-clad compatibility
    - Integrity of coating
    - U_3Si_2 pellet performance and mechanical design
- Standard fuel reliability concerns are also satisfactorily addressed

Reactivity Management

- U_3Si_2 pellets will have reduced enrichment
  - Rod power similar to symmetric UO_2 rods
- Coating has negligible neutronic impact
- LTAs will be loaded in non-limiting core locations
  - 5% peaking factor reduction will be used
  - LTRs will be located in non-limiting locations within the LTAs
- Negligible impact on rod worth, thermal limits, shutdown margin, and reactivity coefficients
- There are no changes to thermal limits or thermal limits monitoring
- No anticipated mixed core concerns

Fuel Shipping and Handling

- Standard shipping containers will be used
- Standard receipt, handling, and inspection processes will apply
- No changes needed to fuel handling equipment
- Westinghouse taking licensing actions on shipping containers
  - Received approval for transport of U_3Si_2 in June 2017

Reload Analysis Considerations

- Standard reload deliverables will be provided per the normal reload schedule
- Items required for LTAs beyond the normal reload scope are:
  - Thermal-hydraulic Analysis Methods
  - Fuel Rod Design
  - Neutronics
  - Nuclear Design
  - Criticality Analyses
  - Loss of Coolant Accident Analysis
  - Transient Analysis
  - Alternate Source Term

Reload Analysis Considerations -- Operating Limits

- Standard reload design margins will be used for non-ATF fuel
  - Thermal limits
  - Shutdown Margin
  - Fuel Exposure
  - Hot Excess Reactivity
- Margin to operating limits for non-ATF fuel will be unaffected

Reload Analysis Considerations – Fuel Storage

- No significant technical concerns exist
- Westinghouse will perform New Fuel Storage Rack, Spent Fuel Storage Rack, and Fuel Rod Storage Basket criticality evaluations
- Addressing the codes and methods question regarding spent fuel pool analysis is ongoing

Reload Analysis Considerations -- Use of Proven Design

- LTRs/LTAs will be of standard 17x17 Optimized Fuel Assembly (OFA) design
- Mechanical, neutronic, and thermal-hydraulic differences from standard 17x17 OFA fuel will be negligible
- Nuclear Fuels Vendor Oversight will focus on pellet/clad fabrication differences and closely monitor fabrication process
- Contingency will be to replace the twenty LTRs with standard UO_2 and Optimized ZIRLO if unexpected challenges arise

Reload Analysis Considerations – Model Accuracy

- Currently licensed fuel design and reload analysis methods do not fully accommodate the LTRs/LTA design and materials
- Methods will be supplemented with additional analysis and evaluations, as necessary
- Conservative assumptions will be employed as necessary to ensure appropriate LTR/LTA margin in all aspects of operation
- Methods adequacy will be treated in Exelon Engineering Configuration Change package and recognize TS provision that methods not submitted to NRC are acceptable for LTAs
- LTRs and LTAs will be placed in appropriate locations to maximize fidelity of online core monitoring
  - Impact will be negligible

Need for an Exemption from 10 CFR 50.46 and Appendix K

- Historically, some licensees implementing LTA programs have requested exemptions for developmental fuel types
- Exelon and Westinghouse are seeking further understanding regarding the need for an exemption to 10 CFR 50.46 and Appendix K
- Based on NRC discussions to date, Exelon proposes that the subject LTRs/LTAs may be appropriately inserted in the reactor core with:
  - Safety analysis performed under the safety related engineering design change processes
  - The need for a license amendment request (LAR) for the core reload will be evaluated under the 10 CFR 50.59; an LAR is not anticipated
  - Exemption from 10 CFR 50.46 and Appendix K are not anticipated

Project Schedule/Milestones

- 4Q2017 NRC Briefing
- 4Q2017 Finalize Regulatory Approach
- 4Q2017 Initiation of Exelon Engineering Change Package
- 4Q2018 Completion of Exelon Engineering Change Evaluation and Documentation
- 4Q2018 Complete LTR Fabrication
- 1Q2019 LTRs Delivered to Byron Station
- 2Q2019 Byron Unit 2 Cycle 22 Startup

NRC Questions/Feedback