

Meeting Between NRC and Exelon Regarding Calvert Cliffs-2 LAR to Use Framatome ATF LTAs

Bill Gassmann

Exelon Nuclear

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Non-Proprietary



Agenda

- Background
- General Information on Lead Test Assemblies (LTAs)
- Framatome PROtect™ ATF
- Licensing Actions
- Technical Evaluation Summary
- Summary

Background

- Exelon has taken a leadership role in the U.S. DOE program to develop LWR fuels with enhanced accident tolerance
- Exelon has loaded Accident Tolerant Fuel (ATF) Lead Test Assemblies (LTAs) at Byron-2 in April 2019, and will load ATF LTAs at Clinton in September 2019
- Exelon plans to load two full Framatome LTAs at Calvert Cliffs-2 in March 2021 to be operated in Cycles 24 through 26

3



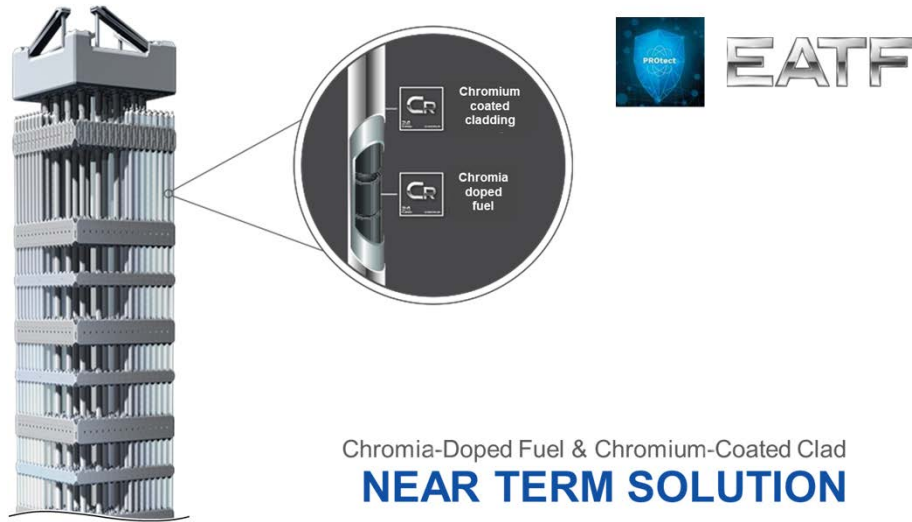
Calvert Cliffs-2 ATF LTAs

- LTAs are based on the Advanced CE14x14 HTP/HMP Framatome fuel design
- All fuel rods will utilize Chromium-coated M5 cladding
- Fuel pellets will be Chromia-enhanced, except for
 - Blanket UO_2 pellets
 - Gadolinia ($\text{UO}_2\text{-Gd}_2\text{O}_3$) fuel pellets
- LTAs will be placed in non-rodded, non-instrumented locations
- To gain valuable data, the LTA power reduction will be limited to 2% lower in peak pin power than the peak pin power of the co-resident fuel throughout each cycle
- This is the first deployment of “full” ATF LTAs

4



Framatome PROtect™ ATF



5

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Calvert Cliffs-2 ATF LTAs

- The current NRC-approved Framatome fuel design and reload analysis methods are not fully applicable to the LTA fuel design and materials
 - Analytical codes and methods will be modified as necessary using conservative assumptions and qualitative assessments
 - Exelon plans to apply for a License Amendment under 10CFR50.90 in order to implement this proposed activity
 - LAR content will be similar to the Byron-2 ATF LAR and will contain a description of the approaches planned and analytical expectations

6

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Licensing Actions

- Technical Specification 2.1.1.2.a
 - Peak fuel centerline temperature

“In MODES 1 and 2, the peak fuel centerline temperature shall be maintained at less than 5081 F, decreasing by 58 F per 10,000 MWD/MTU and adjusted for burnable poison per XN-NF-79-56(P)(A), Revision 1, Supplement 1.”
 - Chromia introduction decreases melt temperature; as a result, this Tech Spec temperature limit will become non-conservative for Chromia-enhanced UO₂ fuel pellets
 - Exelon will revise this TS to add the centerline temperature limit applicable to the LTAs
- Exelon will also request an administrative change to this TS to change the word “AREVA” to “Framatome”

7



Licensing Actions

- Technical Specification 4.2.1
 - LTAs will be loaded in core locations which may be limiting under certain conditions as discussed later in these slides
 - Exelon will request an addition to this TS to describe LTA compliance/exceptions to the nonlimiting requirement
- License Condition for rod internal pressure shall remain below the steady state system pressure
 - Exelon will request an exemption from the current Appendix C License Condition on internal rod pressure for the LTAs
- 10 CFR 50.46 Exemption
 - Exelon will comply with the requirements of 10 CFR 50.46

8



Framatome PROtect™ ATF

- The thermal, physical, and chemical properties of the fuel pellets are sufficiently understood to give a high level of confidence in the safety of the proposed activity
- The mechanical, material, and chemical properties of the coated clad are sufficiently understood to give a high level of confidence in the safety of the proposed activity
- Framatome previously manufactured similar pellets and similar coated cladding that is currently in operation in some test rods at Vogtle. The main difference between the Vogtle and Calvert Cliffs programs is that Calvert Cliffs will use full assemblies of ATF PROtect™ fuel rods

9



Technical Evaluation Fuel Rod Thermal-Mechanical Design

- RODEX2 is typically used for Calvert Cliffs fuel performance analyses. COPENIC was previously modified for LTAs with Chromia-enhanced fuel to properly model the thermal-mechanical behavior of the Chromia-enhanced fuel pellets and will be used for the Calvert Cliffs LTAs
- The Chromium-coated cladding will be explicitly addressed for each thermal-mechanical analysis using conservative assumptions, and quantitative assessments when applicable
- Evaluation of fuel centerline melt and transient cladding strain during AOOs will utilize a COPENIC-based method adapted from existing NRC-approved methods
- LAR will address COPENIC approval for this Calvert Cliffs-2 application

10



Technical Evaluation Fuel Assembly Design

- The most significant affected areas will be evaluated, and no adverse mechanical design impacts are anticipated
 - Fuel rod interaction with assembly subcomponents
 - No change to fuel assembly subcomponents, except for fuel rods
 - Fuel assembly weight
 - Spacers or grid-to-rod fretting
 - Fuel handling equipment
 - Fuel shipping, handling, and storage
 - Lost parts analysis

11



Loss-of-Coolant Accidents

- There is a potential that, for the same system response as the current LOCA licensing basis, a rod in the LTA (with only a 2% peak pin power reduction) could have a higher reported PCT than a standard fuel rod
- The Calvert Cliffs plant and ECCS design results in reported PCTs for the standard fuel product that are below the point of significant metal water reaction, which is the primary LOCA benefit from coated cladding
- A change in a product inherently changes some properties in beneficial ways and others in detrimental ways
- Slight detriments to properties, such as reduced emissivity and reduced fuel thermal conductivity, cannot be offset due to this plant's low LOCA temperature regime
- Additionally, the uncertainty in the LTA properties must be bounded and that will also contribute to higher reported LOCA results

12



Core Loading Pattern

- The LTAs will be placed in core locations where sufficient duty and data can be obtained to advance the Framatome ATF program
- The LTAs will be at least 2% lower in peak pin power than the peak pin power of the co-resident fuel throughout each cycle
- The selection of 2% is consistent with the recent NRC approval of the Byron-2 ATF LTA program

13



Summary

- Exelon desires to insert two PROtect™ LTAs in Calvert Cliffs-2 during the March 2021 refueling outage
- Licensing Actions needed
 - Tech Spec 2.1.1.2.a will become non-conservative for Chromia-enhanced UO₂ fuel pellets
 - Tech Spec 4.2.1 - LTAs may be limiting under certain conditions
 - License Condition on rod internal pressure (COPERNIC)
- Exelon will comply with the requirements of 10 CFR 50.46
- Current goal is LAR submittal in early 4th quarter 2019

14

