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10 CFR 50.90

December 12, 2019

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Calvert Cliffs Nuclear Power Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
Docket Nos. 50-317 and 50-318

Subject: License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies

In accordance with 10 CFR 50.90, "Application for amendment of license, construction permit or early site permit," Exelon Generation Company, LLC, (Exelon) requests an amendment to the license of Calvert Cliffs Nuclear Power Plant (CCNPP), Units 1 and 2.

Exelon will load up to two lead test assemblies (LTAs) of the Framatome PROtect™ fuel design into the Calvert Cliffs' reactors for up to three (3) cycles commencing with the approval of this request. The key features of the PROtect™ LTAs are the Chromium coated M5® cladding and Chromia-doped fuel pellets.

Attachment 1 contains the evaluation of the proposed change except for the Technical Justification Section. Attachment 2 contains the Technical Justification Section, which is a detailed Framatome proprietary evaluation to confirm that all applicable limits associated with the LTAs (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, Emergency Core Cooling Systems limits, nuclear limits such as shutdown margin, transient analysis limits and accident analysis limits) are met.

Exelon requests that Attachment 2 be withheld from public disclosure pursuant to 10 CFR 2.390(a)(4). Attachment 3 contains the redacted version of Attachment 2. Attachment 4 contains the required affidavit.

Attachment 5 contains the mark-up Technical Specification pages and proposed License Condition wording.

There are no regulatory commitments contained in this letter. Exelon requests approval of the proposed license amendment by November 30, 2020, with the Amendment being implemented prior to loading the LTAs into the core.

These proposed changes have been reviewed by the Plant Operations Review Committee.

In accordance with 10 CFR 50.91, "Notice for public comment; state consultation," a copy of this application, with attachments, is being provided to the designated State Official.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 12th day of December 2019.

If you should have any questions regarding this submittal, please contact Enrique Villar at 610-765-5736.

Respectfully,

Shannon Rafferty-Czincila
Director, Licensing
Exelon Generation Company, LLC

Attachments:
1. Evaluation of Proposed Change – Except Section 3.0 "Technical Justification"
2. Technical Justification – ANP-3799P "PROtect™ Lead Test Assemblies for Calvert Cliffs" (Proprietary Information)
3. Technical Justification – "ANP-3799NP PROtect™ Lead Test Assemblies for Calvert Cliffs" (Non-Proprietary Information)
4. Affidavit
5. Mark-up of Technical Specifications Page and Proposed License Condition

cc:	NRC Regional Administrator, Region I	w/attachments
	NRC Senior Resident Inspector, CCNPP	"
	NRC Project Manager, NRR, CCNPP	"
	D. A. Tancabel, State of Maryland	w/o/attachment 2

ATTACHMENT 1

EVALUATION OF PROPOSED CHANGE

Subject: License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies

1.0 SUMMARY DESCRIPTION

2.0 DETAILED DESCRIPTION

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1.0 SUMMARY DESCRIPTION

Up to two lead test assemblies (LTAs) of the Framatome PROtect^{TM} fuel design will be loaded into the Calvert Cliffs Nuclear Power Plants (CCNPP) Units 1 and/or 2. The key features of the PROtect^{TM} LTAs are Chromium coated M5® cladding and Chromia-doped fuel pellets.

The current USNRC-approved fuel design and reload analysis methods are not fully applicable to the LTA fuel rod design and materials; therefore, the Framatome analytical codes and methods will be modified, as necessary, using conservative assumptions and qualitative assessments based on available test results. An evaluation has been made using the modified methods to confirm that all applicable limits associated with the LTAs (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, Emergency Core Cooling Systems limits, nuclear limits such as shutdown margin, transient analysis limits and accident analysis limits) are met.

Therefore, in order to load these two LTAs, the following Technical Specifications (TS) changes (License Conditions) are proposed to be included in the CCNPP TS:

Amendment No	Additional Condition	Implementation date
TBD	Up to two Framatome PROtect^{TM} Lead Test Assemblies utilizing Chromium-coated M5® cladding and Chromia doped pellets may be placed in limiting regions of the core for up to 3 cycles commencing with the implementation of amendment TBD.	With implementation of this Amendment

Amendment No	Additional Condition	Implementation date
TBD	The safety limits specified in TS 2.1.1.2 regarding fuel centerline melt temperature for Framatome fuel, < 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 is not applicable for the Framatome PROtect^{TM} Lead Test Assemblies utilizing Chromium-coated M5® cladding and Chromia doped pellets for up to 3 cycles commencing with the implementation of Amendment TBD.	With implementation of this Amendment

Amendment No	Additional Condition	Implementation date
TBD	The requirement that the RODEX2 predicted rod internal pressure shall remain below the steady state system pressure is not applicable for the Framatome PROtect^{TM} Lead Test Assemblies utilizing Chromium-coated M5® cladding and Chromia doped pellets for up to 3 cycles commencing with the implementation of Amendment TBD.	With implementation of this Amendment

Additionally, TS 2.1.1.2 is revised as follows:

2.1.1.2 In MODES 1 and 2, the peak fuel centerline temperature shall be maintained at:

a. For ~~AREVA~~ Framatome fuel, < 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.

b. For Westinghouse fuel, < 5080 °F, decreasing by 58 °F per 10,000 MWD/MTU and adjusted for burnable poison per CENPD-382-P-A.

2.0 DETAILED DESIGN DESCRIPTION

The proposed License Conditions (LC) are needed because:

1. The two LTAs will not be located in a non-limiting core region as required by TS 4.2.1 "Fuel Assemblies" (Reference 2).
2. Chromia doped fuel pellets will not be able to meet the requirements that the fuel centerline melt temperature for Framatome fuel, < 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.
3. Amendments 297 and 273 for CCNPP Units 1 and 2 included a LC that requires that the "predicted rod internal pressure shall remain below the steady system pressure," the two LTAs are expected to have a rod internal pressure which may exceed the steady system pressure.

The revision to TS 2.1.1.2 is an editorial change in nature that changes the name from AREVA to Framatome to reflect the vendor's name change.

3.0 TECHNICAL EVALUATION

Technical justification contained in Attachment 2 is Framatome proprietary information and should be withheld from public disclosure per 10 CFR 2.390

Attachment 3 contains the non-proprietary redacted version of the Technical Justification from Attachment 2.

4.0 REGULATORY EVALUATION

4.1 Applicable Regulatory Requirements/Criteria

10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," requires nuclear power reactors fueled with uranium oxide pellets within cylindrical Zircaloy or ZIRLO cladding to be provided with an Emergency Core Cooling System with certain performance requirements.

10 CFR Part 50, Appendix K, "ECCS [Emergency Core Cooling System] Evaluation Models," Section I, "Required and Acceptable Features of the Evaluation Models," specifies the required attributes of the ECCS Evaluation Models. Paragraph A.1, "The Initial Stored Energy in the Fuel," states that, “the thermal conductivity of the $U0_2$ [uranium dioxide] shall be evaluated as a function of burn-up and temperature ...” Paragraph I.A.5, "Metal-Water Reaction Rate,” specifies that "the rate of energy release, hydrogen generation, and cladding oxidation from the metal/ water reaction shall be calculated using the Baker-Just equation,” where the Baker-Just equation applies specifically to the "zirconium-water” reaction. Based on the evaluation described above the results of the ECCS Evaluation Models for the resident fuel remain bounding when considering the impact of the Lead Test Assemblies.

4.2 Precedence

Exelon, along with many other licensees, have previously conducted numerous LTA campaigns; however, the potential use of LTAs loaded with up to a full complement of LTAs is a “first of a kind.”

4.3 No Significant Hazards Consideration

Overview

Exelon has evaluated the proposed loading of two lead test assemblies (LTAs) of the Framatome PROtect™ fuel design and its associated proposed license conditions as stated below do not involve a Significant Hazards Consideration.

Amendment No	Additional Condition	Implementation date
TBD	Up to two Framatome PROtect™ Lead Test Assemblies utilizing Chromium-coated M5® cladding and Chromia doped pellets may be placed in limiting regions of the core for up to 3 cycles commencing with the implementation of amendment TBD.	With implementation of this Amendment

Amendment No	Additional Condition	Implementation date
TBD	The safety limits specified in TS 2.1.1.2 regarding fuel centerline melt temperature for Framatome fuel, < 5081°F, decreasing by 58°F per 10,000 MWD/MTU and adjusted for burnable poison per XN-NF-79-56(P)(A),	With implementation of this Amendment

Amendment No	Additional Condition	Implementation date
	Revision 1, Supplement 1 is not applicable for the Framatome PROtect^{TM} Lead Test Assemblies utilizing Chromium-coated M5® cladding and Chromia doped pellets for up to 3 cycles commencing with the implementation of Amendment TBD.	

Amendment No	Additional Condition	Implementation date
TBD	The requirement that the RODEX2 predicted rod internal pressure shall remain below the steady state system pressure is not applicable for the Framatome PROtect^{TM} Lead Test Assemblies utilizing Chromium-coated M5® cladding and Chromia doped pellets for up to 3 cycles commencing with the implementation of Amendment TBD.	With implementation of this Amendment

Exelon has evaluated the proposed amendment to determine whether or not a significant hazards consideration is involved by focusing on the three standards set forth in 10 CFR 50.92 "Issuance of amendment," as discussed below:

Does the proposed amendment involve a significant increase in the probability or consequences of any accident previously evaluated?

Response: No.

Loading of two lead test assemblies (LTAs) of the Framatome PROtect^{TM} fuel design does not involve any changes to how the facility is operated or maintained and therefore it has negligible impact on the probability or consequences of an accident previously evaluated.

The current Framatome analytical methods are capable of accurately modeling all aspects of neutronic behavior, including thermal margin, hot and cold reactivity, reactivity coefficients, reactor kinetics, and stability. All parameters associated with the fuel pellets and rods can be modeled conservatively.

Furthermore, a thorough understanding of the mechanical, material, and chemical properties of the coated clad, as well as thermal, physical, and chemical properties of the fuel pellets provides a high level of confidence in the safety of the proposed activity.

Additionally, given the small percentage of PROtect^{TM} fuel rods in the core, all parameters associated with core-wide neutronic design basis limits will be negligibly affected.

Based on the above discussion, the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

Response: No.

Loading of two LTAs of the Framatome PROtect^{TM} fuel design does not involve any alteration to plant equipment or procedures that would introduce any new or unique operational modes or accident precursors.

The Calvert Cliffs reactor cores will be designed to meet all applicable design and licensing basis criteria. Demonstrated adherence to these standards and criteria precludes new challenges to components and systems that could introduce a new type of accident.

Therefore, the proposed change will not create the possibility of a new or different kind of accident than those previously evaluated.

Does the proposed change involve a significant reduction in a margin of safety?

Response: No.

Operation of Calvert Cliffs Units with two (2) LTAs of the Framatome PROtect^{TM} fuel design does not change the performance requirements on any system or component such that any design criteria will be exceeded. The proposed change does not involve a significant reduction in a margin of safety.

Preliminary analyses show adequate margin to all Specified Acceptable Fuel Design Limits (SAFDLs). Some LTA SAFDLs are expected to have less margin to existing UO_2/Zirconium alloy acceptance criteria than the co-resident fuel, but the reduction is not significant.

The Framatome analytical methods are capable of accurately modeling all aspects of neutronic behavior, including thermal margin, hot and cold reactivity, reactivity coefficients, reactor kinetics, and stability. All parameters associated with the fuel pellets and rods can be modeled conservatively.

Additionally, given the small percentage of PROtect^{TM} fuel rods in the core, all parameters associated with core-wide neutronic design basis limits will be negligibly affected. The mechanical, material, and chemical properties of the coated clad are sufficiently well understood.

Based on the above, Exelon concludes that the proposed amendment does not involve a significant hazards consideration under the standards set forth in 10 CFR 50.92, and accordingly, a finding of "no significant hazards consideration" is justified.

Conclusions

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission’s regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or the health and safety of the public.

5.0 ENVIRONMENTAL CONSIDERATION

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve: (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure.

Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6.0 REFERENCES

As stated in Section 4.0 of Attachment 2 (Proprietary Information) and Attachment 3 (Non-Proprietary Information)

ATTACHMENT 3

Technical Justification – AMP-3799P " PROtect^{TM} Lead Test Assemblies for Calvert Cliffs" (Non-Proprietary Information)

PROtect Lead Test Assemblies for Calvert Cliffs

ANP-3799NP
Revision 0

Licensing Report

December 2019

Trademarks

PROtect, HTP, HMP, MONOBLOC, and $M5_{Framatome}$ are trademarks or registered trademarks of Framatome Inc., or its affiliates, in the USA or other countries.

Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Initial Issue

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Nomenclature

Acronym	Definition
AOO	Anticipated Operational Occurrence
CHF	Critical Heat Flux
FCM	Fuel Centerline Melt
FGR	Fission Gas Release
LOCA	Loss of Coolant Accident
LTA	Lead Test Assembly
RCS	Reactor Coolant System
TCS	Transient Cladding Strain
TD	Theoretical Density
PCT	Peak Clad Temperature
UFSAR	Updated Final Safety Analysis Report
USNRC	United States Nuclear Regulatory Commission

1.0 SUMMARY DESCRIPTION

Up to two lead test assemblies (LTAs) of the Framatome PROtect fuel design will be loaded into the Calvert Cliffs Nuclear Power Plants (CCNPP) Units 1 and/or 2. The key features of the PROtect LTAs are chromium coated $M5_{Framatome}$ cladding and chromia-doped fuel pellets.

The current USNRC-approved fuel design and reload analysis methods are not fully applicable to the LTA fuel rod design and materials; therefore, the Framatome analytical codes and methods will be modified, as necessary, using conservative assumptions and qualitative assessments based on available test results. An evaluation will be made using the modified methods to confirm that all applicable limits associated with the LTAs (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, Emergency Core Cooling Systems limits, nuclear limits such as Shutdown Margin, transient analysis limits and accident analysis limits) are met.

This report provides a description for the PROtect LTAs and of the evaluations that will be performed to assure that all limits are met.

2.0 DETAILED DESIGN DESCRIPTION

The specific composition/details of the two LTAs are as follows:

- The LTAs are based on the Advanced CE14X14 HTP Framatome fuel assembly design similar to the ones used in the current reloads.
- The two LTAs contain up to a combined total of 352 PROtect fuel rods.
- The number of gadolinia rods will depend on the final cycle design.
- PROtect fuel rod design details:
  - UO_2 pellets in the central fuel rod zone are PROtect chromia-doped (Cr_2O_3) with a nominal theoretical density (TD) of [ ].
  - Blanket UO_2 and gadolinia fuel pellets (UO_2-Gd_2O_3) are not chromia-doped with a nominal TD of [ ].
  - Chromium coating thickness on the cladding is [ ].
- There are no other significant changes to the existing fuel assembly design.

3.0 TECHNICAL EVALUATION

The technical evaluation and description of the proposed Calvert Cliffs Lead Test Assembly deployment is presented below in the following sections to demonstrate that the LTAs satisfy all relevant acceptance criteria. A portion of the technical information presented here is based on extensive Framatome analyses to date but has not yet been formally documented in an approved/verified Engineering Report.

3.1 *Current Calvert Cliffs Core Configuration*

A complete description of the Calvert Cliffs Nuclear Power Plant fuel system design basis can be found in the Updated Final Safety Analysis Report (UFSAR), Chapter 3.0 "Reactor" (Reference 1). Some key details are presented below.

Calvert Cliffs Nuclear Power Plant Unit 1 and Unit 2 core consists of 217 fuel assemblies. The current cores consist entirely of Framatome’s Advanced CE14X14 HTP fuel design, which features $M5_{Framatome}$ fuel rod cladding, Zircaloy-4 MONOBLOC guide tubes, Zircaloy-4 HTP intermediate grids, and an Alloy 718 HMP lower end grid. Each fuel assembly contains up to 176 fuel rods arranged in a 14x14 array. There are a total of up to 38,192 fuel rods in the core. Some of the fuel rods contain gadolinia dispersed in the UO_2 fuel as a burnable absorber. Non-gadolinia bearing fuel rods use 6-inch low enriched axial blankets on the top and bottom. The gadolinia bearing rods use 12-inch low enriched axial blankets on the top and bottom.

3.2 *Nuclear Safety and Design Considerations*

The specific composition of the two LTAs is detailed above in Section 2.0. Use of the subject LTAs will be evaluated using USNRC-approved methods (Reference 3) modified as necessary to reflect the LTA characteristics. The Framatome analytical codes and methods will be modified as necessary using conservative assumptions and qualitative assessments based on available test results. An evaluation will be performed to confirm that all applicable limits associated with the LTAs (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, Emergency Core Cooling Systems limits, nuclear limits such as Shutdown Margin, transient analysis limits and accident analysis limits) are met.

The core design will ensure that the PROtect LTAs will have the following characteristics:

(a) LTAs will be designed to have a Total Integrated Radial Peaking Factor (F_r^T) which is at least 2% lower than the core leading value throughout the cycles.

- This setdown will apply during steady state, planned normal operations.
- Chromia-doped fuel will be accounted for in neutronic modeling.
- Chromium coating will be accounted for in neutronic modeling.

(b) safety parameters related to peaking factors/thermal limits will be analyzed.

(c) the LTAs will be placed in non-rodded locations, negating concerns of Rod Ejection Accidents.

There are several design bases of the fuel system, which are potentially impacted by the proposed LTA usage. These design bases limits/criteria will be evaluated to confirm safe operation. Since only a very limited number of LTAs are involved, it is expected (and will be confirmed prior to use) that the LTAs present a negligible impact on reactor operation or nuclear safety.

- The fuel rod cladding must exhibit satisfactory mechanical, material, and chemical properties, and must satisfy stress/strain and vibration/fatigue limits.

- The fuel pellet must exhibit satisfactory thermal, physical, and chemical properties including dimensional, densification and swelling performance.

- The fuel rod must exhibit satisfactory pellet-to-clad mechanical interaction characteristics, pellet-to-clad gap and gas plenum dimensional stability, conformance to fuel temperature and internal gas pressure limits, heat transfer, fuel reliability, and overall dimensional stability.

- The fuel rod must be compatible with the overall fuel assembly design. The fuel rod must not compromise the performance or structural integrity of the fuel assembly or impair its ability to accommodate inserts; and must not impair the performance of the reactivity control systems or the incore nuclear instrumentation.

- The fuel rods must not impair any aspect of neutronic behavior, including thermal margin, hot and cold reactivity, reactivity coefficients, reactor kinetics, and stability.

- The fuel rod and fuel assembly must be thermal-hydraulically compatible with the core and reactor coolant system (RCS), and must be compatible with all core and RCS materials and other plant equipment.

Since only a limited number of LTAs are utilized, the impact on any aspect of reactor operation or safety will be negligible. The current Framatome analytical methods are capable of accurately modeling all aspects of neutronic behavior, including thermal margin, hot and cold reactivity, reactivity coefficients, reactor kinetics, and stability. All parameters associated with the fuel pellets and rods can be modeled conservatively. Additionally, given the small percentage of PROtect fuel rods in the core, all parameters associated with core-wide neutronic design basis limits will be negligibly affected.

The thermal, physical, and chemical properties of the fuel pellets are sufficiently well understood to give a high level of confidence in the safety of the proposed activity. Sufficient design margin will be employed to ensure that pellet dimensional changes during operation will not pose a safety or operational concern.

The mechanical, material, and chemical properties of the coated fuel rod cladding are sufficiently understood. The chromium-coated clad will be harder and more resistant to oxidation than the standard cladding while maintaining the strength of $M5_{Framatome}$ cladding thus satisfying the existing stress/strain and vibration/fatigue criteria.

Based on industry and testing experience to date, the performance of the PROtect fuel rods with respect to the shape, volume, and function of the pellet-to-clad gap is sufficiently understood. The ability of the gap to accommodate fission product gases will not be significantly affected, and there are no new pellet-to-clad interaction concerns. Fuel temperature and pellet-to-clad heat transfer will be conservatively modeled and will not pose a safety or operational concern. There are no significant new fuel reliability concerns anticipated; it is projected that the fuel rod will perform well in all modes of operation; and no adverse interactions with the current RCS chemistry regime are anticipated.

The PROtect fuel rods will be essentially mechanically identical and compatible with the co-resident fuel rods. The structural integrity of the assembly will be maintained and there will be no adverse effect on any piece of assembly hardware or method of fabrication; therefore, the ability of the assembly to accommodate inserts will not be affected. In particular, control rod motion will be unaffected during normal operation and transients, and the ability to control reactivity will be unaffected since the LTAs will not operate in rodded locations.

In summary, the use of a limited number of LTAs will not impact the public health and safety. There will not be a significant impact on any aspect of normal plant operations or accident analyses.

3.3 *Evaluation Summary*

Fuel Rod Thermal-Mechanical Design

Consistent with NUREG-0800 Chapter 4.2, fuel rod thermal-mechanical performance will be evaluated for the fuel design containing chromia-doped fuel pellets and chromium-coated cladding using modifications (to reflect these materials) to USNRC-approved codes and methodologies as documented in References 4 through 7. [

]

Fuel rod analyses include:

- Cladding fatigue
- Cladding oxidation
- Internal pin pressure
- Cladding creep collapse
- Fuel centerline melt
- Transient cladding strain
- Cladding stress and buckling

It is recognized that currently licensed fuel rod analysis methods and codes are not fully applicable to the PROtect LTAs. Therefore, Framatome's USNRC-approved version of the COPERNIC fuel performance code has been modified to properly model the thermal-mechanical behavior of the chromia-doped fuel pellets during irradiation. The modified version of COPERNIC was benchmarked to the measured data available for chromia-doped fuel rods.

[

]

These benchmarks confirmed the code's ability to accurately predict the thermal-mechanical behavior of chromia-doped fuel rods during irradiation. [

] Modifications made to COPERNIC code are consistent with the chromia-doped fuel properties and behaviors as described in the USNRC-approved topical report (Reference 14).

[

] However, the impact of chromium-coated cladding will be explicitly addressed for each thermal-mechanical analysis using conservative assumptions and quantitative assessments based on test results wherever applicable.

Validation of the fuel centerline melt (FCM) limits calculated by COPERNIC (modified version) is performed using a method adapted from Framatome's USNRC-approved methods (References 8 and 9) to ensure adequate protection against fuel melt in the LTA assemblies. Verification of transient cladding strain (TCS) limits calculated by COPERNIC (modified version) is also performed. [

] The peak linear heat rates for these AOO events are compared to the TCS limits to confirm that 1% cladding strain limit will not be exceeded during AOOs for the LTA assemblies.

With the code modification described herein, all fuel rod design criteria consistent with NUREG-0800 Chapter 4.2 will be evaluated to confirm that each design criterion will be met for rod average burnup up to [

]

Fuel Assembly Mechanical Design Methodology

Framatome will evaluate the mechanical design impact of the PROtect fuel rods on the PROtect LTA fuel assembly and its subcomponents. No component changes or changes to the basic fuel assembly design requirements are expected, and no adverse mechanical design impacts are anticipated as a result of introducing the PROtect fuel rod to the fuel design.

Impacts of the PROtect fuel rods on LTAs will be evaluated. These items will include the physical interface/interaction with the upper tie plate, lower tie plate, hold-down spring system, guide tubes, spacer grid assemblies, and connection hardware. [

] No changes are expected to the Advanced CE14X14 HTP fuel assembly subcomponents [ ]. The chromia-doped fuel pellets and chromium-coated cladding will have an insignificant impact to the fuel rod and fuel assembly weight. The interface between the fuel rods and fuel assembly will be assessed to ensure changes to the spacer support system are not required. No grid-to-rod fretting or grid damage is expected. There are no changes to the fuel assembly components that interface with plant tooling, handling equipment, and that could affect plant procedures. There will not be any change or impact to the storage of the LTAs as the LTA weight is minimally changed and the LTA reactivity will fall within the current analyzed envelope. The LTA shipping and handling loads will be evaluated and documented; no adverse impact is expected.

Seismic

The impact of the LTAs on the seismic evaluation will be negligible. The maximum expected change in fuel assembly weight (containing the chromium-coated cladding and chromia-doped pellets) is well within the normal variation in the fuel assembly weight, and therefore, is not anticipated to have a detrimental impact on fuel assembly dynamic characteristics (such as natural frequencies). Framatome will evaluate the grid deformation analysis for the LTAs to ensure that adequate margin is maintained and that the ability to maintain a coolable geometry is not impacted.

Core Physics

Framatome will employ a conservative nuclear design for the PROtect LTAs. No adverse core physics impacts are anticipated from the proposed activity.

Current standard Advanced CE14X14 HTP fuel assembly design dimensions will be employed for the LTAs and PROtect fuel rods. Neutronically similar assemblies are placed at symmetric locations to maintain symmetry. [ ]

The [ ] chromium coating on the cladding will be accounted for in the neutronic models. The core-wide impact is negligible considering the limited number of rods involved. The rod power will be slightly suppressed due to the parasitic neutron absorption of the chromium. For conservatism, the LTAs will employ a Total Integrated Radial Peaking Factor (F_r^T) setdown of 2% as described above. There will be no change to the standard overall nuclear design process in terms of incore fuel management, safety analyses, or operational data evaluation.

The standard uranium dioxide fuel will dominate the global neutronic behavior. There will accordingly be no neutronic impact on reactor operation, core performance, or reactivity management. Safety parameters related to peaking factors and fuel melting will be analyzed with the chromia-doped pellets explicitly modeled. The LTAs will be placed in non-rodded locations to ensure negligible impact on the Rod Ejection Accident consequences.

Loss-of-Coolant Accidents (LOCA)

The presence of the LTAs will not impact the system response characteristics during a LOCA, but can impact the fuel rod performance under those conditions. The USNRC-approved LOCA methods and codes (References 10, 11, 12, and 13) do not include models applicable to chromium-coated cladding and chromia-doped fuel pellets. The LOCA analyses for Calvert Cliffs applied the methods in References 10 and 11 for small break and Reference 13 for large break with modifications approved by the USNRC. The LTA characteristics which can potentially impact LOCA analyses will be identified and evaluated relative to the current Framatome fuel design in the LOCA analyses for Calvert Cliffs. Both small and large break analyses will be considered. Based on the identified LOCA-relevant impact, a technical evaluation will be performed to estimate the change to the Calvert Cliffs specific LOCA analyses predictions.

[

] The result of this evaluation will be a confirmation that the 10 CFR 50.46 limits continue to be met. An estimate of the delta Peak Clad Temperature (PCT) will be made for the LTAs.

Non-LOCA Events

Non-LOCA events can be broadly classified in two categories. Those events that are primarily impacted by the fuel design parameters and those which are primarily impacted by the plant related system responses rather than the fuel design parameters. Only the events impacted by the fuel design parameters are potentially impacted by the LTAs. Of those events impacted by the LTAs, the events that are dependent on core-average parameters, such as initial stored energy and decay heat, are not expected to be significantly altered as a result of the LTAs. Events which are impacted by local effects in the fuel rods could be more significantly affected and require more detailed consideration. Framatome will complete a detailed evaluation of the non-LOCA events. The conclusions documented in the applicable UFSAR sections will be validated.

Thermal-Hydraulic

Framatome will perform the thermal-hydraulic design evaluations using the existing methods applicable to Calvert Cliffs Units 1 and 2. The evaluations are intended to verify that the LTAs are less limiting than the standard fuel assemblies with respect to thermal-hydraulic margin and that the LTAs are hydraulically compatible with the resident fuel assemblies. An evaluation will be performed to justify the applicability of the resident hydraulic loss coefficients to the full-length chromium-coated fuel rods. [

] An assessment will be performed to validate that the LTA thermal-hydraulic reload design evaluations remain bounded. An evaluation will be performed to justify the applicability of the current Critical Heat Flux (CHF) correlations to the LTAs.

Fuel Handling, Storage, and Shipping

The LTAs are not expected to have an impact on any aspect of the criticality analyses. This includes criticality analyses for the Spent Fuel Pool, New Fuel Vault, MAP-12 PWR Fuel Shipping Package, and fuel handling equipment. Impacts to criticality for dry cask storage will be analyzed in the future. Specific to the Spent Fuel Pool and New Fuel Vault, fuel pellet theoretical density and enrichments will be equivalent or bounded by the existing resident fuel design.

Similarly, with respect to fuel burnup it is expected that the reactivity trajectory of the LTAs with exposure will be very similar to that of the standard fuel assemblies when placed in the Spent Fuel Pool Racks or dry casks. Additionally, the LTAs fall within the existing MAP-12 package license. It is concluded that the LTAs will have a negligible impact on reactivity associated with fuel handling, storage or shipping.

Core Monitoring System

Online core monitoring with the POWERTRAX Core Monitoring System will not be affected by the LTAs and the ability to accurately calculate the reactor 3-dimensional power shape will not be affected. The placement of the LTAs in the core will be designed to have a negligible effect on the measurements of the incore flux detectors and the excore nuclear instrumentation system detectors. Nuclear data libraries for the chromia-doped pellets and chromium-coated cladding for the fuel rods will be developed so these rods can be sufficiently modeled.

Accident Source Term

The radiological source term will not be significantly affected by the LTAs. The fissile material (i.e., low enriched uranium) has not changed and the fuel form and chemical properties are not significantly different. The timing, magnitude, and chemical form of fission products released during an accident will not be significantly different. The radiological release limits for design basis accidents will not be challenged.

Post-Irradiation Examinations

Post-irradiation fuel exams will be conducted at the end of each cycle of operation to ensure that the performance of the LTAs conforms to expectation.

4.0 REFERENCES

1. Calvert Cliffs Nuclear Power Plant, Updated Final Safety Analysis Report, Chapter 3.0, "Reactor." Revision 51.
2. Calvert Cliffs Nuclear Power Plant Units 1 and 2, Technical Specifications, 4.2.1, "Fuel Assemblies." Amendment Nos.: 329/307, May 14, 2019.
3. EMF-96-029(P)(A), Volumes 1 and 2, Reactor Analysis System for PWRs, Volume 1 – Methodology Description, Volume 2 – Benchmarking Results, Siemens Power Corporation, January 1997.
4. BAW-10231P-A, Revision 1, COPERNIC Fuel Rod Design Computer Code, January 2004.
5. BAW-10227P-A, Revision 1, Evaluation of Advanced Cladding and Structural Material (M5) in PWR Reactor Fuel, June 2003.
6. BAW-10084P-A, Revision 3, Program to Determine In-Reactor Performance of BWFC Fuel Cladding Creep Collapse, July 1995.
7. BAW-10183P-A, Revision 0, Fuel Rod Gas Pressure Criterion (FRGPC), July 1995.
8. EMF-1961(P)(A), Revision 0, Statistical Setpoint/Transient Methodology for Combustion Engineering Type Reactors, July 2000.
9. EMF-92-116(P)(A), Revision 0, Supplement 1 (P)(A), Revision 0, General Mechanical Design Criteria for PWR Fuel Designs, February 2015.
10. EMF-2328(P)(A), Revision 0, PWR Small Break LOCA Evaluation Model, S-RELAP5 Based, March 2001.
11. EMF-2328(P)(A), Revision 0, Supplement 1, Revision 0 (P)(A), PWR Small Break LOCA Evaluation Model, S-RELAP5 Based, December 2016.
12. EMF-2103(P)(A), Revision 3, Realistic Large Break LOCA Methodology for Pressurized Water Reactors, June 2016.
13. EMF-2103(P)(A), Revision 0, Realistic Large Break LOCA Methodology for Pressurized Water Reactors, April 2003.
14. ANF-10340P-A, Revision 0, Incorporation of Chromia-Doped Fuel Properties in AREVA Approved Methods, May 2018.

ATTACHMENT 4

AFFIDAVIT

AFFIDAVIT

1. My name is Gayle Elliott. I am Deputy Director, Licensing & Regulatory Affairs for Framatome Inc. (Framatome) and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in the Licensing Report ANP-3799P, Revision 0, entitled, "PROtect Lead Test Assemblies for Calvert Cliffs," dated December 2019 and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by Framatome to determine whether information should be classified as proprietary:

(a) The information reveals details of Framatome's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome in product optimization or marketability.

(e) The information is vital to a competitive advantage held by Framatome, would be helpful to competitors to Framatome, and would likely cause substantial harm to the competitive position of Framatome.

The information in this Document is considered proprietary for the reasons set forth in paragraphs 6(d) and 6(e) above.

7. In accordance with Framatome's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside Framatome only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Gayle Elliott

Commonwealth of Virginia)
) ss.
City of Lynchburg)

SUBSCRIBED before me this 6 day of December, 2019.

Heidi Elder
NOTARY PUBLIC, COMMONWEALTH OF VIRGINIA
MY COMMISSION EXPIRES: 12/31/22
Reg. # 7777873

ATTACHMENT 5

Mark-Up of Technical Specifications Page
and
Proposed License Conditions

2.0 SAFETY LIMITS (SLs)

2.1 SLs

2.1.1 Reactor Core SLs

2.1.1.1 In MODES 1 and 2, the combination of THERMAL POWER, pressurizer pressure, and the highest operating loop cold leg coolant temperature shall not exceed the limits shown in Figure 2.1.1-1.

2.1.1.2 In MODES 1 and 2, the peak fuel centerline temperature shall be maintained at:

a. For Framatome ~~AREVA~~ fuel, < 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.

b. For Westinghouse fuel, < 5080°F, decreasing by 58°F per 10,000 MWD/MTU and adjusted for burnable poison per CENPD-382-P-A.

2.1.2 Reactor Coolant System (RCS) Pressure SL

In MODES 1, 2, 3, 4, and 5, the RCS pressure shall be maintained ≤ 2750 psia.

2.2 SL Violations

2.2.1 If SL 2.1.1 is violated, restore compliance and be in MODE 3 within 1 hour.

2.2.2 If SL 2.1.2 is violated:

2.2.2.1 In MODE 1 or 2, restore compliance and be in MODE 3 within 1 hour.

PROPOSED LICENSE CONDITONS

Amendment No	Additional Condition	Implementation date
TBD	Up to two Framatome PROtect™ Lead Test Assemblies utilizing Chromium-coated M5® cladding and chromia doped pellets may be placed in limiting regions of the core for up to 3 cycles commencing with the implementation of amendment XYZ	With implementation of this Amendment

Amendment No	Additional Condition	Implementation date
TBD	The safety limits specified in TS 2.1.1.2 regarding fuel centerline melt temperature for Framatome fuel, < 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 is not applicable for the Framatome PROtect™ Lead Test Assemblies utilizing Chromium-coated M5® cladding and chromia doped pellets for up to 3 cycles commencing with the implementation of Amendment XYZ	With implementation of this Amendment

Amendment No	Additional Condition	Implementation date
TBD	The requirement that the RODEX2 predicted rod internal pressure shall remain below the steady state system pressure is not applicable for the Framatome PROtect™ Lead Test Assemblies utilizing Chromium-coated M5® cladding and chromia doped pellets for up to 3 cycles commencing with the implementation of Amendment XYZ.	With implementation of this Amendment